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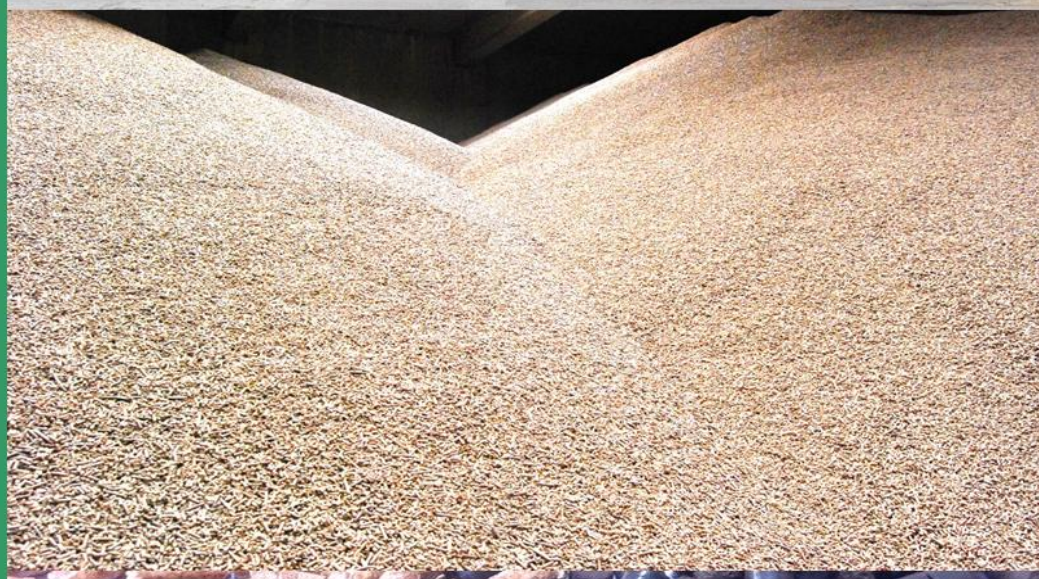

Global Wood Pellet Industry Market and Trade Study

IEA Bioenergy

Task 40: Sustainable International Bioenergy trade

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1 Executive Summary

Maurizio Cocchi

The wood pellet market has experienced a large growth in the last five years. In 2006 the production of wood pellets was estimated between 6 and 7 million tonsworldwide (not including Asia, Latin America and Australia), as shown in figure 1.1, drawn from a previous Task 40 pellet market study published in 2007[1]. In 2010 the global wood pellet production reached 14.3 million tons, including the above mentioned countries, while the consumption was close to 13.5 million tons[2] thus recording an increase of more than 110% if compared to 2006 (fig. 1.2)

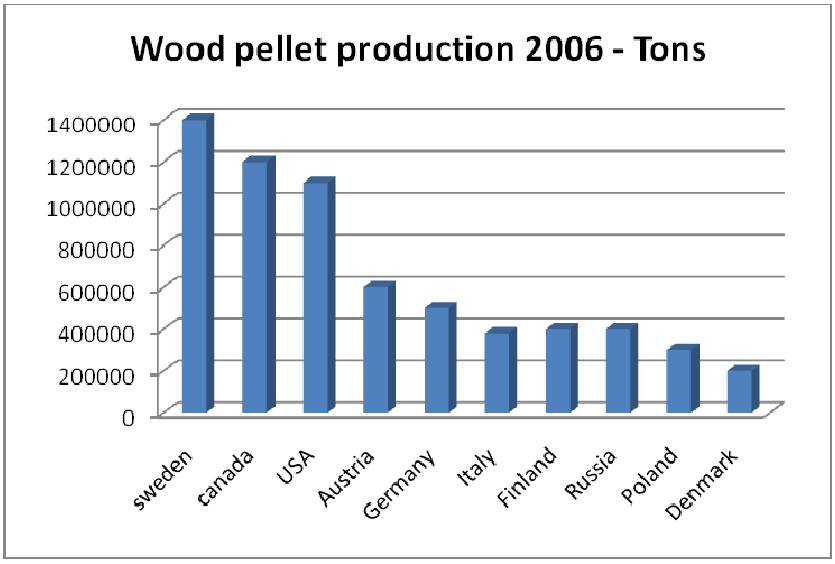


Fig. 1.1- Wood pellet production in 2006

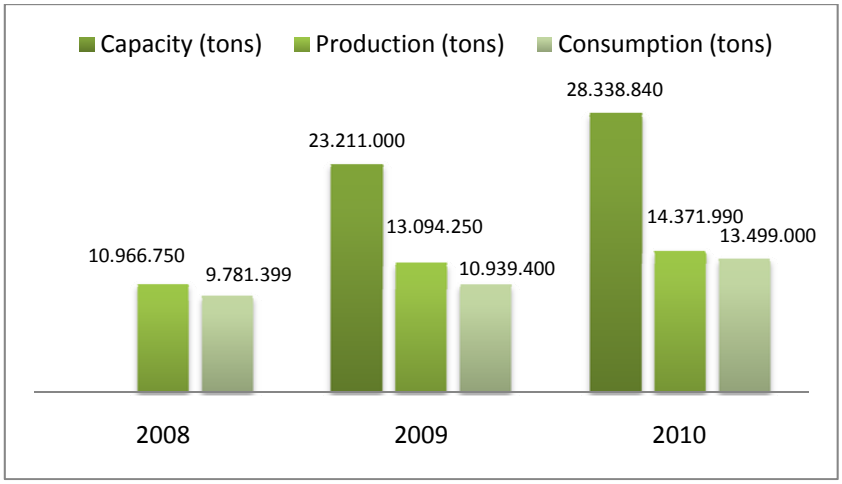


Fig. 1.2 – Global wood pellet production and consumption

[1]"Global Wood Pellets Market and Industry: Policy Drivers, Market Status and Raw Material"(2007) available at www.bioenergytrade.org

[2] These values were estimated through an in depth data collection performed by several Task 40 members, based on country specific data as presented in Chapter 2 whenever possible, in addition to a thorough contextual literature search for missing data. References are available in the country specific chapters of the present study.

Worldwide, the production capacity of pellet plants is also increasing, as well as their average size. Between 2009 and 2010 the global installed production capacity of the pellet industry has recorded a 22% increase, reaching over 28 million tons. Full statistics for 2011 are not yet available, however, anecdotal data seem to indicate that the production capacity may have reached 30 million tons.

The highest increase in production capacity was observed in North America (the U.S., Canada) and Russia, followed by traditional European producing countries such as Germany, Sweden and Austria.

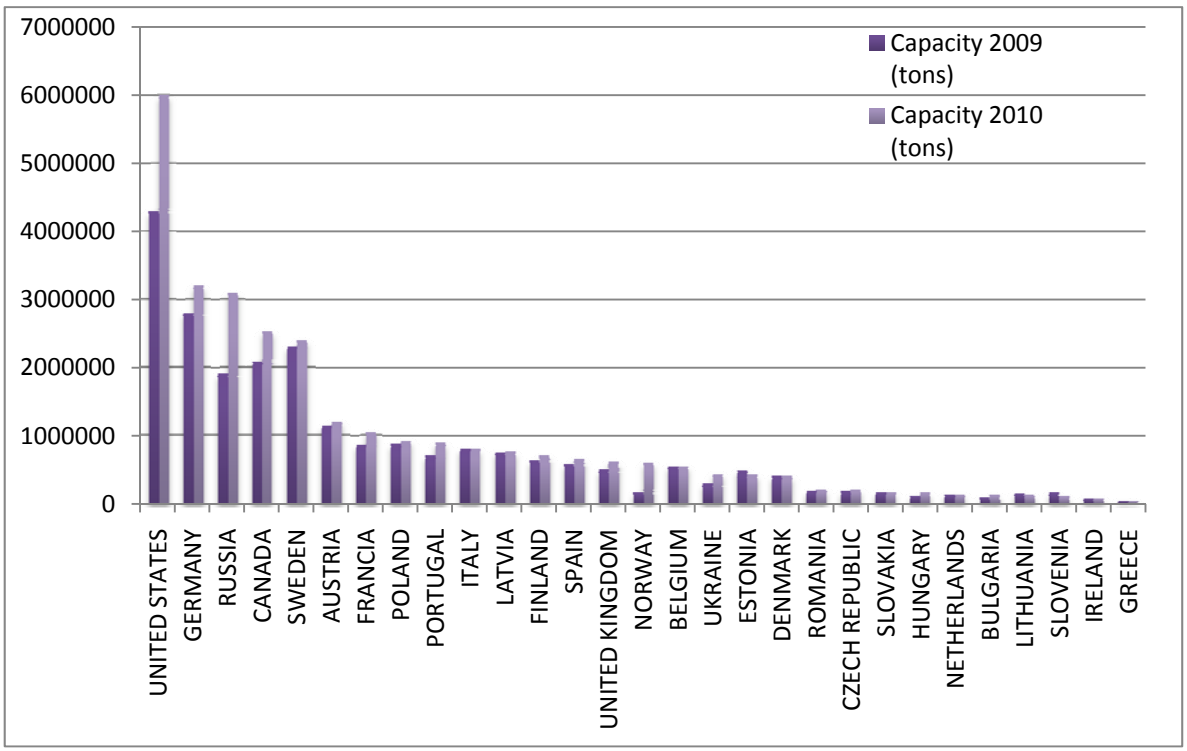


Fig. 1.3 – Wood pellet production capacity by country

In 2009 around 670 pellet plants were active in EU, 30% of them with a rather small production capacity below10,000 tons/y (Sikkema et al. 2011).
Sawdust is still the main raw material for the production of wood pellets; many pellet plants source their feedstock from sawmills or are often directly co-located at sawmills; therefore, the availability and price of feedstock are subject to the trends and market dynamics of the wood industry. Since 2008/2009 the rapid growth of pellet demand has stimulated investments in large-scale plants in the range of several hundred thousand tons in EU as well as in the U.S., Russian Federation and other countries.In the same period, the availability of traditional sawmill residues has decreased sensibly in EU and in North America in particular, due to the crisis of the housing sector, but also due to the growth of the pellet industry itself and other competing sectors. As a matter of fact, difficulties in sourcing feedstock at competitive prices are an important factor contributing to the generally low utilization rate of the installed capacity in many pellet mills, only 53% on average.

As a consequence, a need for a more stable and secure supply of feedstock has emerged and, therefore, the interest of producers in the supply of alternative feedstock such as round-wood and forest residues is growing.

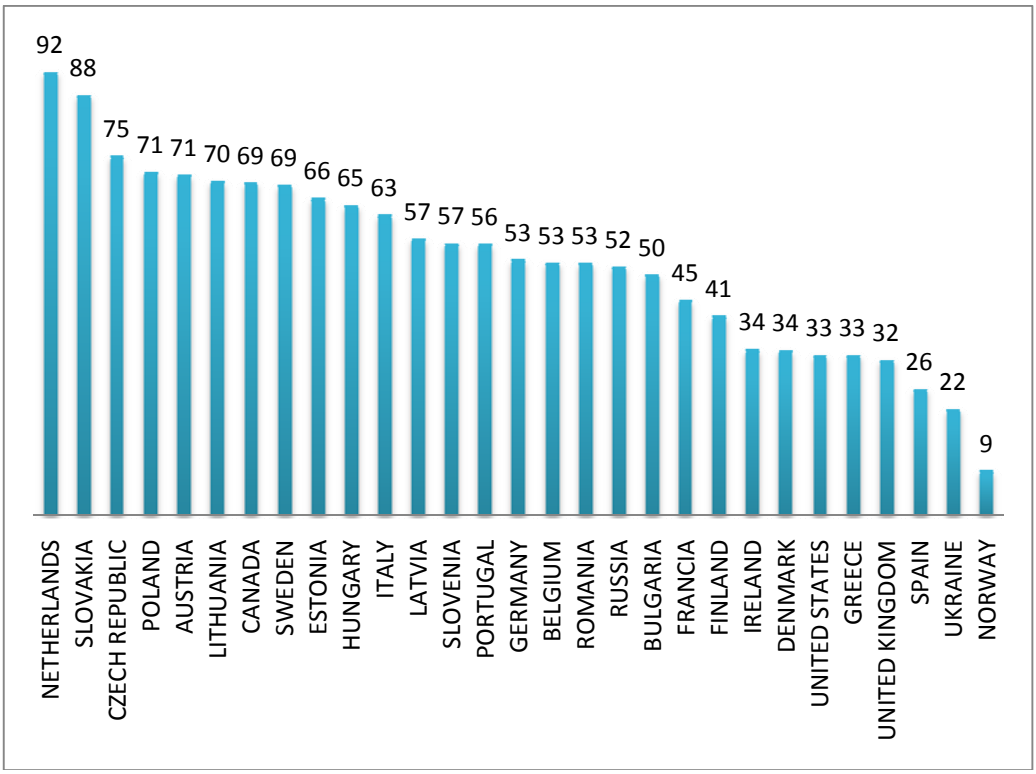


Fig. 1.4 – Wood pellet plant capacity utilization rate (%) by country in 2010

The European Union is still the main market for wood pellets and will remain as such for the next several years. Between 2008 and 2010 the production of wood pellets in EU increased by 20.5%, reaching 9.2 million tons in 2010, equal to 61% of the global production. In the same period, EU wood pellet consumption increased by 43.5% to reach over 11.4 million tons in 2010, equal to nearly 85% of the global wood pellet demand. The European pellet industry still covered 81% of the EU demand in 2010; however, the gap between production and consumption in EU has been growing from only 262,250 tons in 2008 to 2,148,000 tons in 2010, more than an 8-fold increase.

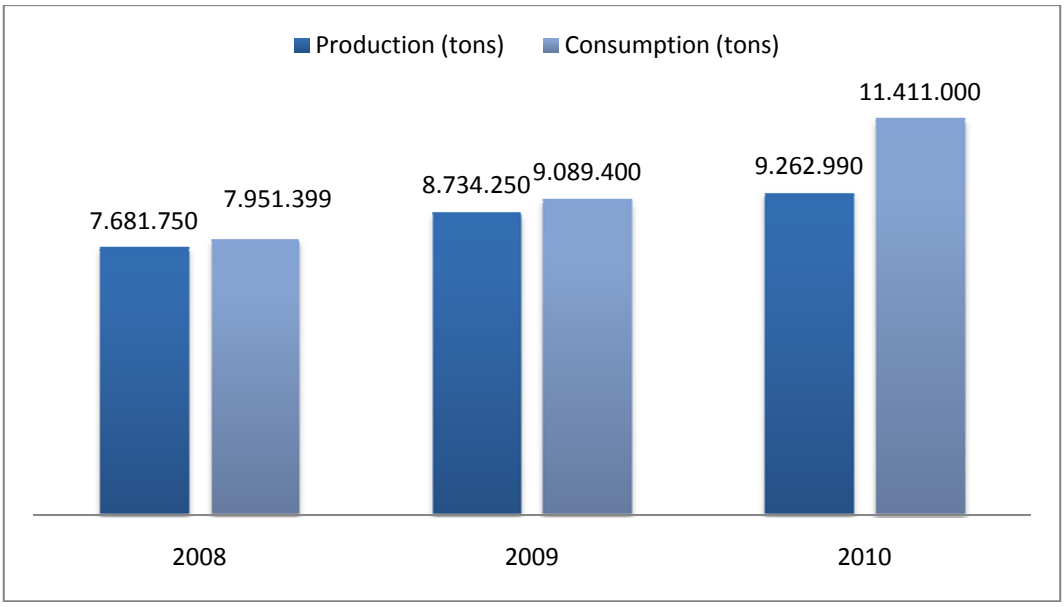


Fig. 1.5 – Production and consumption of wood pellets in EU

The steady and rapid growth of the market is driven by various factors related to the different market segments (industrial pellet for co-firing, industrial pellet for CHP and district heating, pellet for residential heating); however, the markets are still quite dependent to different extents on the availability of direct or indirect support measures.

The large increase inthe demand for industrial pellets for co-firing in Northern European countries such as the Netherlands, Belgium, Denmark and lately the UK is driven mainly by the availability of feed in premiums for green electricity and the relative cost competitiveness of biomass with the cost of coal plus CO2 emission allowances. The prospects for market growth in this segment are very positive, though still heavily relying on the continuity and stability of the supporting policy framework in the respective countries. Also in Sweden, a traditional large consumer and producer of wood pellets, the consumption has sensibly increased and is well above the production.

In the segment of residential heating the main drivers for market expansion are often indirect support measures for the installation of pellet stoves and boilers as well as the relative cost competitiveness of wood pellets compared to traditional fuels such as LPGheating oil and natural gas, especially in rural areas that are not yet served by gas grids. In this market segment Italy, Austria, Germany and Denmark are among the main consumers.

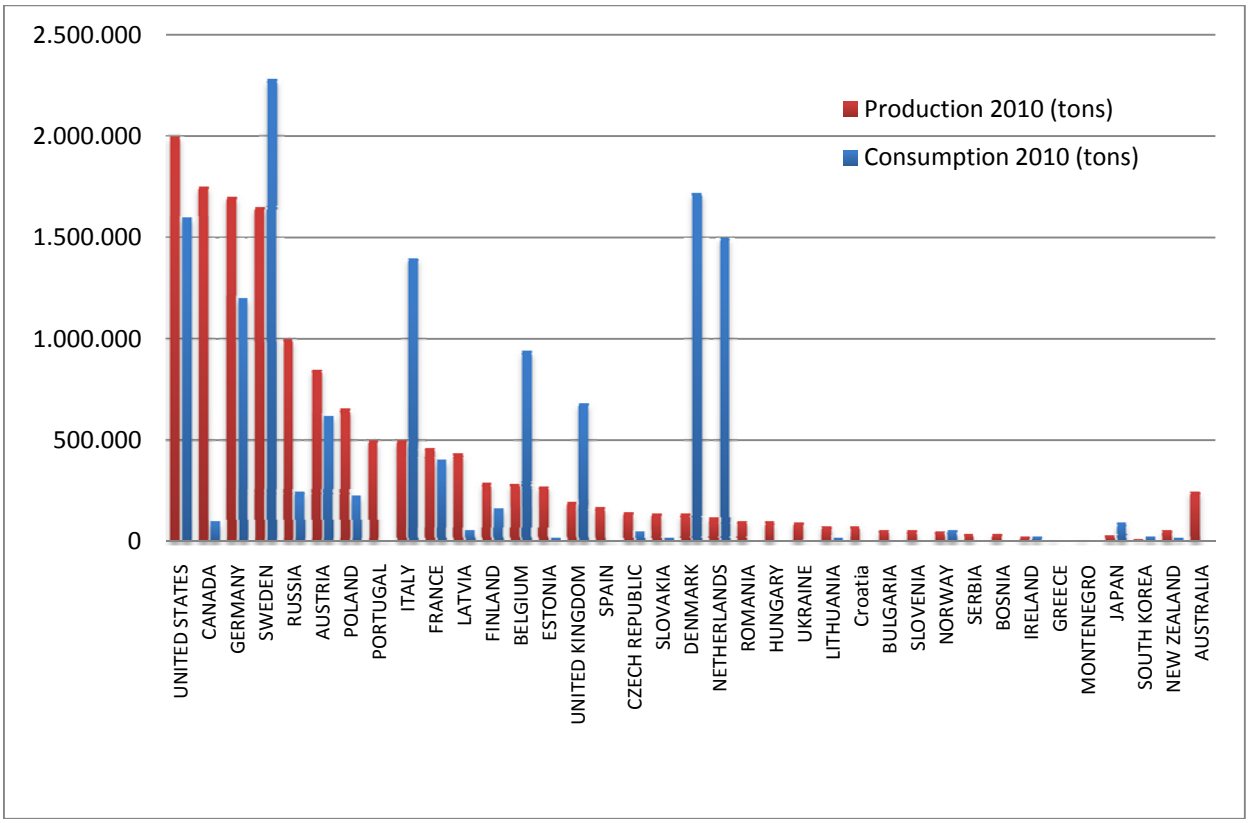


Fig. 1.6 – Wood pellet production and consumption by country in 2010

Inside EU, countries such as Germany, Austria, Poland, Finland, the Baltic States, and recently Portugal and Spain hold an important export capacity, particularly in the segment of high quality pellets for residential heating. Indeed, the rising demand in the market sector of residential heating is driving the internal trade among EU member states, with Italy being now one of the largest consumers of high quality pellets in EU and more and more relying on imports (as well as Denmark, Germany, Austria and France, altough to a lesser extent).

On the other hand, the demand for industrial pellets for co-firing, CHP and district heating (i.e in Sweden) is stimulating increasing import flows from non-EU countries overseas.

Since 2009 pellet has its own standard CN code and official Eurostat statistics for pellet trade are available. According to Eurostat, in 2010 Europe (EU27) imported more than 2.6 million tons of pellets from non-EU countries; in the same year more than 4 million tons were traded among EU member states.

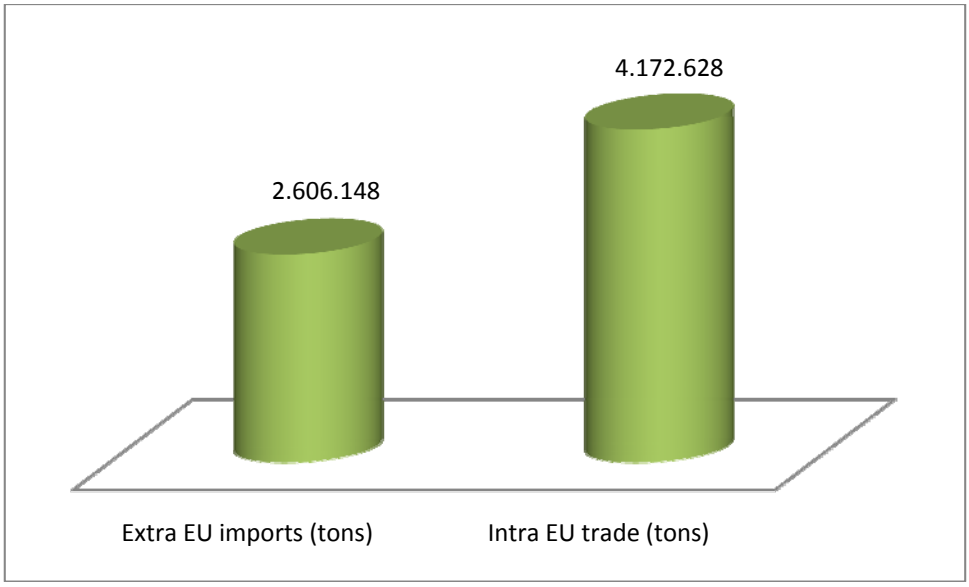


Fig. 1.7 – EU27 Pellet Trade in 2010 Source Eurostat

The increase of the demand in EU is stimulating large investments in new pellet plants and a rapidly increasing production capacity in countries such as Canada, the U.S. and the Russian Federation, that are by far the largest exporters of wood pellets to EU (fig. 1.8)[3]. Several other countries exported pellets to Europe in 2010, although in much smaller quantities than those three major exporters.
On the other hand, exports from EU member states to non-EU countries are almost negligible, only 71,000 tons in 2010 and mainly to countries inside the European continent (Switzerland, Norway, Lichtenstein, Iceland).

[3] Some discrepancies were observed between Eurostat trade data and the data provided by country specific sources (associations, national experts, Task 40 members etc.), therefore the data presented in this figure should be regarded only as indicative of the general trends, the scale and order of magnitude of the main export flows to EU27.

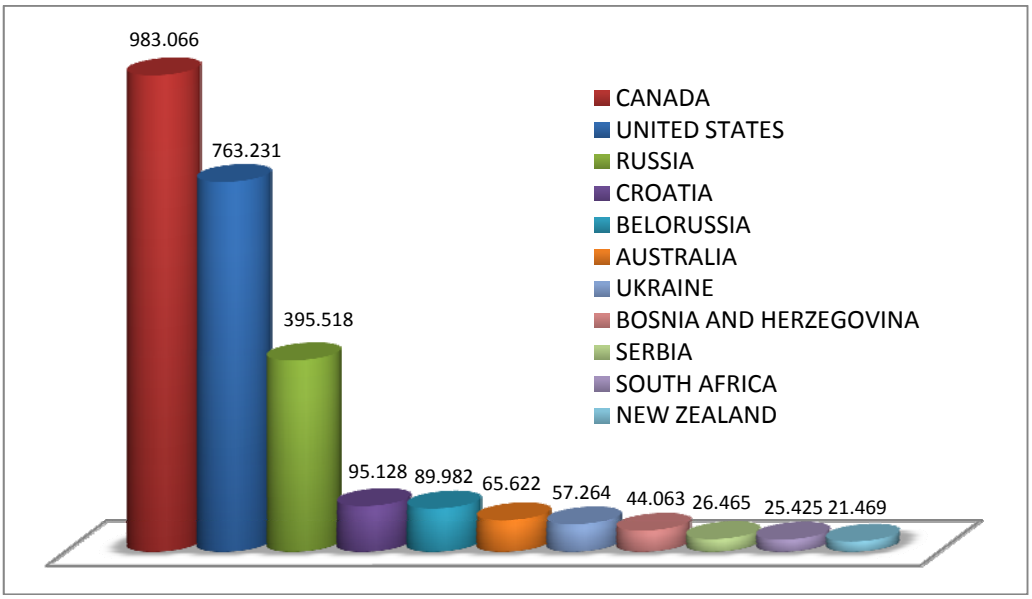


Fig. 1.8 – Extra EU imports of wood pellets by country in 2010 (tons). Source Eurostat

Canada is increasing its export capacity again. In 2008-2009 the financial crisis in the U.S. drastically reduced home building and, subsequently, the demand for Canadian lumber wiping out mill residue surpluses. By December 2009 sawmill production began to increase again, and with coming sawmill production increases, it is foreseen that 5.5 million ODt of new mill residues will come on the market annually by 2012.

As of 2010 the production capacity of the Canadian pellet industry is above 2 million tons and around 1.7 million tons were produced in 2010 (estimated). 15 new proposed pellet plants may soon add 1.1 additional million tons of capacity.

Furthermore, the pellet industry is rapidly learning how to use alternative feedstock such as harvest residues from full tree harvesting, in an effort to decouple the production of pellets from the availability of the mill residues of lumber industry. Compared to the total production, the Canadian domestic market is still quite small; despite the ongoing initiatives to stimulate the use of pellets for residential heating and the possible opening of a market for co-firing by 2014, the consumption is still around 100,000 tons/y; therefore, the export potential for this country remains high in the short and medium term.

The U.S. have also expanded their export capacity lately, although unlike Canada, their domestic market is quite developed.In 2008, over 80% of the pellets produced in the U.S. was used domestically, the remaining 20% being exported almost entirely to Europe. In 2010 the U.S. domestic demand was still growing and estimated at 1.6 million tons; a large share of this demand is generated by the development of the residential heating market in North East U.S.. As for Canada, in the past years the reliance of the U.S. pellet industry on sawmill residues led to imbalances between supply and demand for biomass as the sawmilling sector retrenched in the 2008–2009 recession. This led pellet mills to turn to roundwood or other non-sawmill sources of biomass. A number of new mills have been recently built to process chipped roundwood, especially in the wood basket of South East U.S.. Their independence from the sawmill industry has allowed a focus on export of wood pellets, and many of the newer plants have capacities of several hundred thousand tons per year. A combination of factors such as a large availability of feedstock at competitive prices, as well as a sound and sustainable forest management system, relatively easy logistics and cheap transports has rapidly attracted investments in South East U.S. from American as well as European companies. As a consequence, in 2009 the U.S. pellet industry

was projected to have a total capacity of over 4.3 million tones,while recent additions have brought the total capacity to around 6 million tons in 2010 and several new projects are in the pipeline. A large share of the U.S. pellets is now exported to Europe: according to Eurostat, exports to EU reached over 750,000 tons in 2010 driven mainly by the demand for industrial pellet by co-firing plants in Northern EU countries and to a much lesser extent by the increasing demand for residential heating in Italy.

The Russian Federation is also becoming an important supplier of wood pellets. Being the country with the largest forest area in the world, Russia has a potential of more than 20 million tons of biomass from forest residues annually. The domestic consumption of pellets is limited to 30% of the current production, the production capacity was estimated at 3 million tons in 2010 and the actual production volume around 1 million tons, 600,000 of which were exported to Europe. Russia will therefore play a greater role in the global pellet market; however, unlike the U.S., logistic issues affect the mobilization of feedstock especially from the inner areas.

Other countries inside EU such as the Baltic States and Ukraine can become major suppliers of wood pellets in the future, as well as emerging countries in Latin America and Australia though their full potential will probably be achieved in the mid-term. Ukraine in particular is becoming an important producer of agropellets (pellets made using agricultural residues as feedstock), the main consumers of which are now co-firing plants in Poland and Denmark.

Market forecasts and potential supply

Several studies recently performed by renowned and acknowledged organizations have investigated the potential demand for wood pellet in the year to come. Existing analysis include forecasts by Pöyry,Ekman & Co., AEBIOM and NewEnergy Finance.All projections are based on Europe, butestimates are for different years. According to such estimates, EU demand could range between 20 and 50 million tons by 2020, depending to a large extent on:

- the policies on co-firing in a.o. the UK, Netherlands, Belgium, Germany, Poland, as well as the combination of market dynamics for coal plus CO2 emission allowances;
- the continuity of support measures for the uptake of the market for pellet stoves and boilers, as well as the price of fossil fuels for heating and the related attractiveness to switch to wood pellets for small-scale users (households and medium-sized residential buildings).

By extrapolating the demand exponentially, based on current consumption levels as they have grown in the past, a consumption a little lower than 35 million tons could be reached in EU by 2020.

The demand in East Asia will depend strongly on developments in Japan, South Korea and China, but can be assessed in the range between 5-10 million tons by 2020.
The demand in the U.S. will be probably limited to small-scale use in households and main imports will come from Central and Eastern Canada.
The demand in Canada and the country's subsequent export capacity will be correlated to the actual implementation of co-firing plans announced by the Ontario Power Generation to phase out coal; depending on the extent of OPG fuel switch projects, the domestic biomass demand might increase of several hundred thousand tons per year. However, the export capacity of Canada is likely to remain strong in the future.

In a "business as usual scenario" the total potential available for import to EU may increase drastically from about 42 PJ in 2010 to over 280 PJ in 2020 (almost 16 million tons) as shown in figure 1.9. This scenario is based on past and current import trends, industry expectations, press releases of individual companies, expert opinions and on scenario studies by Schouwenberg and de Wolff (2011), through which a number of main future sourcing areas was identified.

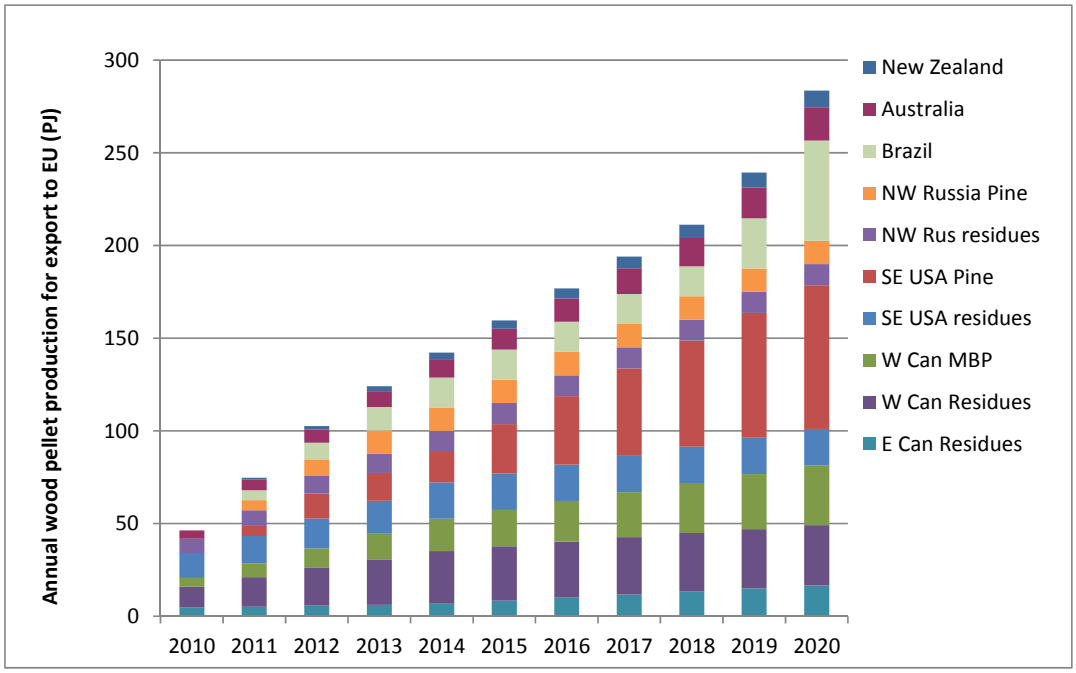


Fig. 1.9 - Anticipated growth in available solid biomass supply from the various sourcing regions. residues = woody industry residues (e.g. sawdust), MPB = Mountain pine beetle affected wood

A "high import" scenario was also developed, based on the assumptions that the rapid growth of biomass demand in EU would trigger investments in additional pellet plants and a strong development of short rotation crops and energy plantations (i.e. Eucalyptus) in some areas of the world such as Brazil, Uruguay, West Africa, Mozambique and Russia.

These assumptions lead to an additional amount of 17 million tons of wood pellets in 2020 compared to the business as usual scenario, bringing the total to almost 33 million tons or 600 PJ by 2020. Such assumptions are to some extent arbitrary, but reflect the current dominant position of Latin America, the expected rise of Sub-Saharan production potential, and the large existing potential from forests in North-West Russia. While all developments are not deemed unrealistic, they are highly speculative, and would depend amongst others on a strong demand for solid biomass in the EU and elsewhere and on very rapid investments in the sourcing areas.

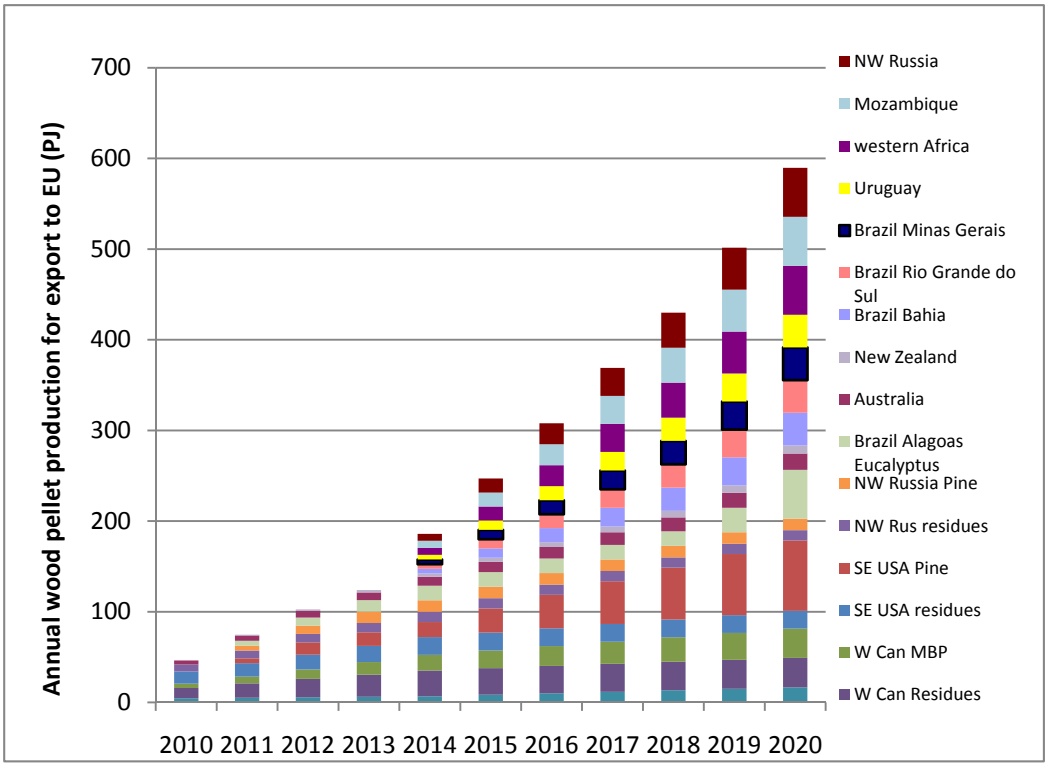


Fig. 1.10 - Anticipated growth in available solid biomass supply from the various sourcing regions in the high import scenario from 2010 (1) to 2020 (11)

In order to allow the large potential of biomass to be converted intoactual supply in a sustainable way, the pellet industry faces anumber of challenges. Some of the most important ones can be summarized asfollows.

Enlarging the feedstock base for wood pellets

As mentioned above, the vast majority of pellet plants, especially those created in the early days of the industry still rely on the use of sawmill residues as feedstock; however, in several countries the demand for wood pellets already outstripped the supply of residues such as saw dust and shavings.

Pellet producers have already started to source additional and alternative sorts of woody feedstock. These include wood chips from saw mills, forest industrial round wood, forest residues, bark, used wood and wood produced from short rotation forestry plantations for the production of either residential grade or industrial grade pellets. Besides feedstock shortage there is also another increasingly important reason for pellet mill operators to diversify their feedstock base. Large-scale pellet consumers such as European or North American power plants are increasingly looking for medium and long term supply agreements with well-defined volumes and prices that mirror their domestic feed in tariffs. This growing need for stability on the feedstock side in both price and volume conflicts with the volatile supply situation of the residue stream of the saw milling industry.In several cases, larger pellet manufacturers and even some energy producers are moving upstream along their supply chain, in an effort to secure their feedstock base on a long term basis through either long term forest concessions or long term supply agreements with forest owners.

Exploiting the basin of agricultural feedstock with agropellets

Next to woody biomass as feedstock for the pellet production alternative resources are becoming more prominent.Agricultural residues such as straw, hay and husks as well as energy crops like miscanthus are the most popular raw materials for the agropellets production today.

Countries with significant developments and activities in this area so far are Denmark, Poland, the Czech Republic, Ukraine, and the United Kingdom. Further interesting and significant agropellet markets with a still unexploited potential are Hungary, France and Germany, as well as the Netherlands and Belgium. Few trading streams can be noticed among countries,in particular between bordering regions. A significant stream can be noticed between Ukraine and Poland. The export of sunflower husks from Ukraine to Poland amounted to approximately 150,000 tons in 2009.Agropellets are currently mainly used for co-firing in coal power plants, while small-scale applications for heating systems are not yet fully developed, mainly due to technical problems during combustion and emissions. In this regard, initiatives for the general standardisation of the quality of agropellets are being implemented, as exemplified by the new European multipart-standard EN 14961 defining quality specifications for solid biofuels, which specifies five quality classes for non-woody pellets for non-industrial use.

Refining the quality of pellets: the promise of torrefaction

The development of chemical and thermal preconditioning technologies in addition to densification will be essential to allow a broader feedstock portfolio for the production of pellets. Among these, torrefaction presents several advantages along the biomass to pellet value chain. Virtually all biomass resources are suitable for torrefaction, and the physical and chemical properties of both woody and herbaceous biomass significantly improve after this treatment. Torrefied biomass becomes hydrophobic and can therefore be stored in the open air and is easier to dry. The process also increases the energy density of biomass in respect to its overall weight; this can drastically reduce logistical costs. The use of torrefied biomass will substantially increase the potential share of co-firing in standard coal power plants (up to 100% in comparison to about 10% based on wood pellets) and will allow to co-feed woody biomass in industrial sized coal gasifiers.

There are a number of initiatives at different development stages currently working on such torrefaction technologies, mainly based in Europe or North America. The most promising technological approaches are based on continuous processes such as vertical moving bed reactors, screw reactors, drum reactors or fluidized bed reactors.A number of demonstration plants will be commissioned by the end of 2012.The efforts already being carried out by world scale companies will most certainly lead to commercially available torrefaction technologies in the near future.

Adapting logistics and transportation infrastructures

Trade in bio-products is now experiencing an explosive growth, both in volumes, sources and destinations.The last years have seen developments of new pellet plants, with major capacity building in Canada, the US South East, mostly for export, and also Australia and New Zealand, with the prospect of many more, creating new trade routes to Europe.To accommodate the quickly growing pellet markets, infrastructure requirements for existing major suppliers such as BC and the US South will chiefly be reduction of bottlenecks and other simple capacity increases. Large investments will be required to achieve these logistic and infrastructural improvements. Furthermore, many regions rich in biomass resources do not have the financial capability of developing the resource. In this regard, a new Bio-trade Equity Fund could be created to fill the investment gap, enabling development in new biomass supplies, reducing risk by investing in the whole supply chain and securing fibre supply contracts, efficient ground transport, large conversion plants, efficient ports and safe off-take agreements.

Ensuring sustainability along the value chain

Ensuring sustainable production, trade and use of wood pellets has become an essential issue for the further development of the market, in particular for the industrial use of pellets.

In recent times concerns have been expressed that an expansion of international trade of biomass and increasing imports from third countries may lead to the unsustainable production of solid biomass. As a consequence, the main importing countries of biomass have started or are planning to develop their own national sustainability requirements, and recommendations on sustainability requirements for voluntary initiatives were issued by the European Commission. At the same time industrial and business-to-business schemes are being developed. This may lead to voluntary or mandatory certification schemes,which are not necessarily complementary or compatible to each other, so that a uniform and common approach is necessary to harmonize sustainability schemes for solid biomass.

Utilities in the electricity and heating sector as well as the national governments from biomass importing countries are calling for a common sustainability scheme for solid biomass in order to limit intra-EU cross-border barriers in setting up bioenergy projects and to create a level-playing field for the whole sector.

Transforming wood pellets into a global commodity

The wood pellets market is not yet a commodity market as it is not transparent and carries large risks, the most important being the supply of biomass feedstock. Most bioenergy projects have low technology risk, they use proven processes and equipment and have well-defined supply chains. Transportation risk can be significant, as evidenced by the volatility in maritime shipping prices during 2006-2009. Such risk can be mitigated by long term shipping contracts, or dedicated specialized ships. Regulatory risk is a major factor as economics of bioenergy are supported by government incentives and renewable portfolio standards.

In order to reduce such risks a steering committee comprising the seven largest European wood pellets consumers named “Initiative Wood Pellet Buyers” is working towards the standardization of the pellet market focusing on important aspects such as the legal framework, contractual and financial measures to increase market liquidity and price stability, technical specifications, sampling standards and common sustainability requirements.

An important step forward towards the transformation of wood pellets into a global commodity is represented by the world’s first biomass exchange that was launched in November 2011 by APX-ENDEX, a provider of power and gas exchange services, in partnership with the Port of Rotterdam. The new exchange will allow market participants to trade standard contracts in a transparent environment. Furthermore the new biomass exchange will also help to set common market standards for pellets; a series of product quality requirements for the traded goods are indeed specified. Besides quality parameters an important aspect is represented by the mandatory sustainability requirement for biomass: in order to be included in the exchange system, the delivered pellet lots will have to be accompanied with the necessary documents to prove that the product is in compliance with the guidelines as described in a range of three voluntary sustainability schemes.

2 The Wood Pellet Industry and Market in Europe

Lars Nikolaisen, Maurizio Cocchi, Jussi Heinimö, Martin Junginger, Daniela Thrän, Christiane Hennig, Didier Marchal

2.1 Sweden

2.1.1 Regulatory framework market drivers and barriers

In Sweden district heating is applied in most cities and towns. Wood pellets has been used as fuel since the 80's where many district heating plants and CHP plants were changed from oil to wood firing often in combination with coal. Today around 200 of these plants use biomass, many of them using wood pellets as fuel. In 1997 the annual consumption of wood pellets was 494.000 tons and only 39.000 tons or 8% were used in private households. The remaining 455.000 tons were used for district heating and electricity production. These figures changed dramatically over the following 13 years indeed the total consumption in 2010 was 2.280.000 tons and the use in private households was 785.000 tons or 34% of the total use.

In 1991 a general CO_2 tax on fossil fuels was introduced for thermal energy. Electricity generation and industry plants were exepted. Today the legal frameworks conditions are based on an electricity certificate system combined with renewable obligations and exemptions from CO_2taxes. For private household the biomass price is attractive due to high oil prices, increasing electricity costs, and heavy taxation on fossil fuels. These are the main drivers for small-scale users to invest in pellet boilers. The result is that the use of wood pellets in private households has increased 20 times over a 13 year period.

2.1.2 Production capacity and feedstock

The production capacity has almost doubled since 2004, namely from 1.252.000 tons in 2004 (*source: Pelletsatlas*) to 2.400.000 tons in 2010 (*source: BIOENERGI*). There are 81 pellet plants in Sweden in 2010 (*source:BIOENERGI*) and 2 of them have a capacity over 100.000 tons annually. 40 plants have a capacity below 5.000 tons annually.

The production of wood pellets has increased rapidly since 1997 reaching 1.649.000 tons in 2010. There is both import and export. SeeTable 2.1.

Year	Production (tons x 1000)	Export (tons x 1000)	Import (tons x 1000)	Total (tons x 1000)	Used by private consumers (tons x 1000)
1997	438	7	63	494	39
1998	467	13	82	536	58
1999	540	26	116	630	81
2000	549	20	157	686	80
2001	782	49	173	906	150
2002	766	36	172	902	235
2003	869	6	266	1129	297
2004	915	20	341	1236	345
2005	1287	144	330	1473	458
2006	1363	129	350	1585	609
2007	1359	54	358	1663	635

2008	1579	92	363	1850	680
2009	1576	88	430	1918	695
2010	1649	65	695	2280	785

Table 2.1: Production, import and export for wood pellets in Sweden in 1000 tons.

Source PIR: *www.pelletsindustrin.org* (the export data do not include export from non-PIR members, estimated 30 000 ton in 2010)

The largest producers in Sweden use fresh saw dust as feedstock for pellet production; as well as shavings and dry saw dust. The majority of the small-scale producers use only by-products from other activities while the large- and medium-scale producers use mainly purchased raw material. Raw material shortage is a recurring problem and several producers have difficulties in sourcing their feedstock. The reasons for such difficulties lie in the high raw material prices and intense competition.

2.1.3 Consumption

Since 2000, consumption of wood pellets has increased significantly for all sectors reaching 1,473,000 tons in 2005 and 2,280,000 tons in 2010. The sectors are private consumers, small and medium size heating plants and large scale CHP plants for both heat and electricity production.

2.1.4 Trade and logistic aspects

Since 2005 the average amount of wood pellets exported has been 100,000 tons annually mainly to Denmark and UK. The import of wood pellets has been around 365,000 tons annually on average. Early imports came from Canada and Poland, in more recent years from Russia, Finland and the Baltic States by ship to different harbours. In 2010 according to Eurostat, 695.000 tons of wood pellets were imported by Sweden. Ship size varies from small Baltic coasters up to 4,000 tons to large bulk carriers from Canada up to 50,000 tons. Ice in the harbours in December-April can cause troubles for minor ships. If not used by a power plant in the harbour, the wood pellets are transported by truck or train to the end user or to an intermediate storage for distribution. Railways are used for domestic transport of pellets. The delivery to private consumers take place in bags (16 kg), big bags (about 700 kg) and truck with blower equipment.

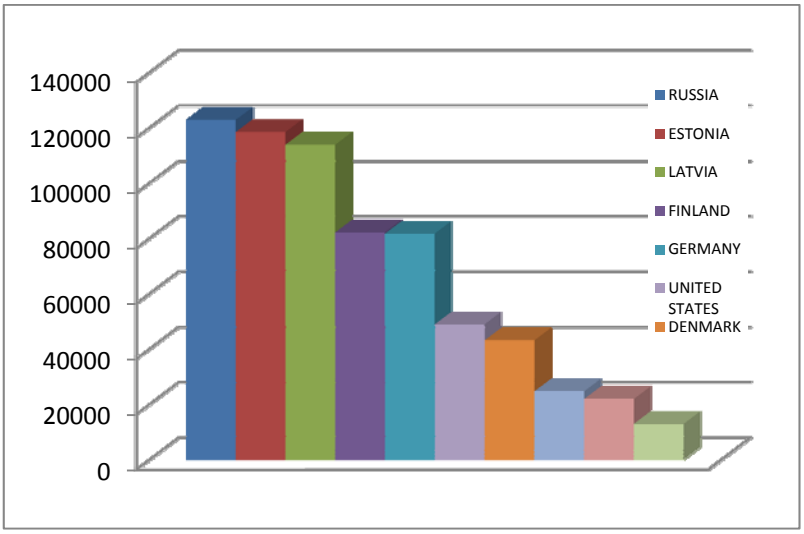


Fig. 2.1 – Import of wood pellets in Sweden in 2010 (tons). Source Eurostat

2.1.5 Pellets quality and standard

The Swedish Pellet Standard - SS 18 71 20 - was established in 1999. Nowadays the European standard EN-14061-1 is applied. (change the table below accordingly) The standard classifies the fuel into three groups (see Table 2.2). Group 1 is designed to fit the high quality needs of the small boilers for private

consumers. Group 2 and 3 are designed to fit the needs of large-scale users that do not need the highest quality. Three fourths of the pellets produced in Sweden meet the Swedish standard. Mainly small manufacturers do not follow official standards.

Property	Test method	Unit	Group 1	Group 2	Group 3
Length	Measure 10 pellets	mm	Max 4xØ	Max 5xØ	Max 5xØ
Bulk density	SS 187178	Kg/m^3	>600	>500	>500
Durability	SS 187180	fines	0,8% < 3 mm	1,5%< 3 mm	1,5%< 3 mm
Lower H_u	SS –ISO 1928	MJ/kg	>16,9	>16,9	>15,1
Ash	SS 187171	% w/w of DM	< 0,7	< 1,5	<1,5
Moisture	SS 187170	% w/w	< 10	< 10	< 12
Sulphur	SS 187177	% w/w of DM	< 0,08	< 0,08	To be stated
Chlorides	SS 187185	% w/w of DM	< 0,03	<0,03	To be stated
Ash melting	SS 187165/ISO 540	°C	Initial temp.	Initial temp.	Initial temp.

Table 2.2: Important figures from SS 18 71 20: Classification of fuel pellets

2.1.6 Price trends

Price on wood pellets has been quite stable in the last years in Sweden. The price for truck delivery to private consumers in sacks is 333 Euro/tons excl. VAT, which in Sweden is 25%. For bulk delivery the price is lower due to purchase of large amounts and due to the often lower quality (Group 2 and 3) for large scale end user. There are no price statistics from the utility companies (power plants)

End user	October 2007	October 2008	October 2009	October 2010
Private consumer (sack)	299 Euro/t	299 Euro/t	332 Euro/t	333Euro/t
Bulk delivery	261Euro/t	261 Euro/t	299 Euro/t	300 Euro/t

Table 2.3: Wood pellets delivered in sacks or bulk. Price in Euro/tons without VAT. In Sweden VAT is 25%. Heating value: 4,8 kWh/kg. Source: www.pelletsindustrin.org

2.2 Germany

2.2.1 Regulatory framework market drivers and barriers

The German pellet market has been one of the markets with fastest development in the past years and still with a significant growth potential ahead. In particular the market for pellet boilers and stoves for small- and medium-scale applications has experienced a rapid increase. Factors as the legal framework promoting the use of pellets in the residential sector and the increasing oil and gas prices gave incentives for house owners to install wood pellet heating systems. In particular, the market incentive programme (MAP) a financial support instrument and the Renewable Energies Heat Act (EEWärmeG) will give impetus for a reinforced utilization of pellets on the small-scale market. Thus, since 2000 one of the largest wood pellet markets worldwide could establish.

2.2.2 Production capacity and feedstock

The production and production capacity of wood pellets in Germany is the highest one in Europe. At the moment, 63 production plants are located in Germany with a production capacity of 3.2 million tons and a respective production of 1.7 million tons in 2010. In comparison, in 2006, only half of the pellet producers were in place in Germany with a capacity of 900,000 tons. Currently, additional production plants are in the planning process. The following figure gives an overview of the distribution of the pellet production plants.

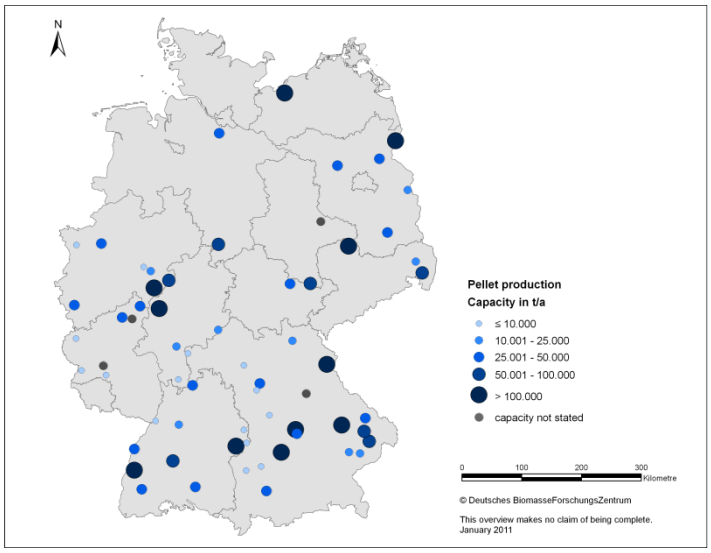


***Figure 2.2**: Distribution of wood pellet production plants in Germany 2010*

From the total production volume about 75% is intended for the heating market (certified wood pellets) and the remaining for power plants for electricity generation. The majority of the certified pellets is consumed within the country (over 90%); however, the pellets used for power generation are entirely exported. This is due to the fact that wood pellets are not used in power stations in terms of co-firing in Germany yet. In respect to the raw material used for the pellet production 70% were sawmill by-products as sawdust and 30% low quality round wood.

2.2.3 Consumption

Looking at the consumption, the figures for 2010 amount to 1.2 million tons of wood pellets consumed in the heating market. Until 2006, the coverage of the national demand was dependent on imports. Since then the amount produced and demanded broke even.

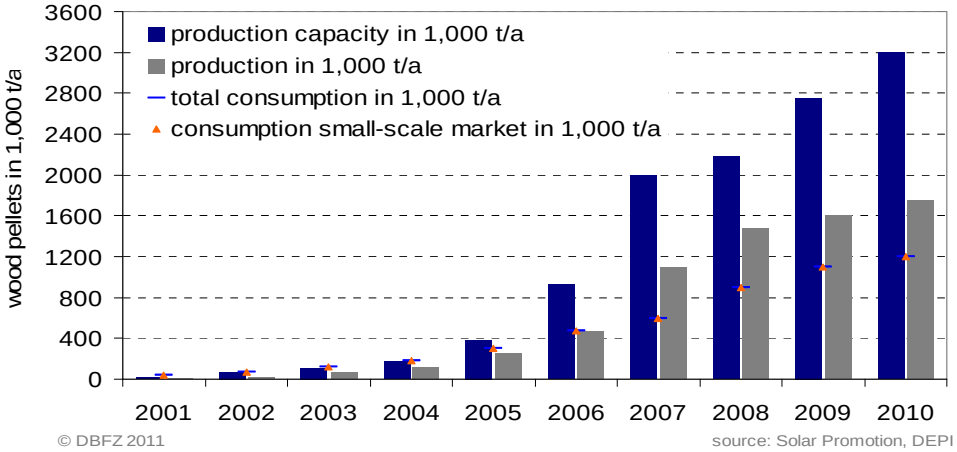


Figure 2.3: Wood pellet market development in Germany from 2001 to 2010: production capacity, production and consumption

In Figure 2.4 the development in the number of pellet heating systems – both on a yearly base and cumulative – is shown. Until 2006 a steady growth can be observed. For example, in 2005 and 2006 the sales figures increased by 60%, however after that there was a noticeable drop with a following market recovery. The reason for this development was a depletion of the budget of the promotion programme MAP in the second half of 2006 which is a significant policy instrument to promote the use of pellet heating systems. This was reflected in a rapid decline in pellet stove and boiler sales. A further disturbance of the market could be observed in May 2010 as the programme experienced a budget freeze until July. These stop-and-go measures caused uncertainties among the investors leading to a smaller number of pellet heating systems installed in 2010.

In total more pellet boilers than pellet stoves are installed, the ratio is about 65% to 35%.

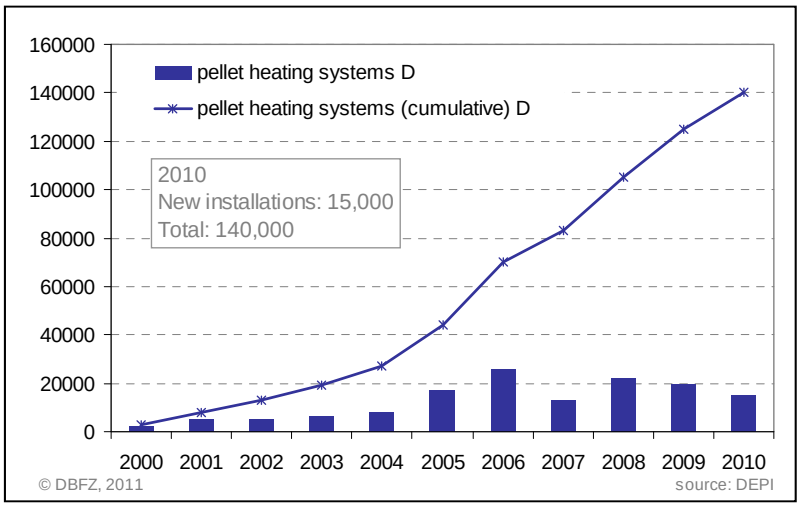


Figure 2.4: Development of installed pellet heating systems in Germany from 2000 to 2010 (yearly and cumulative)

2.2.4 Trade and logistic aspects

The main export countries for industrial wood pellets are the United Kingdom, Sweden and Denmark. With respect to the trade of certified wood pellets the main trading partners are Italy and Austria for exporting and Denmark, Russia, the Baltics and Czech Republic as well as Belarus (a rather new trading partner) for importing. In the past the trade of premium wood pellets mainly took place with bordering

countries as Austria and Czech Republic. However, imports originate increasingly from Eastern European countries like the Baltics and Belarus.

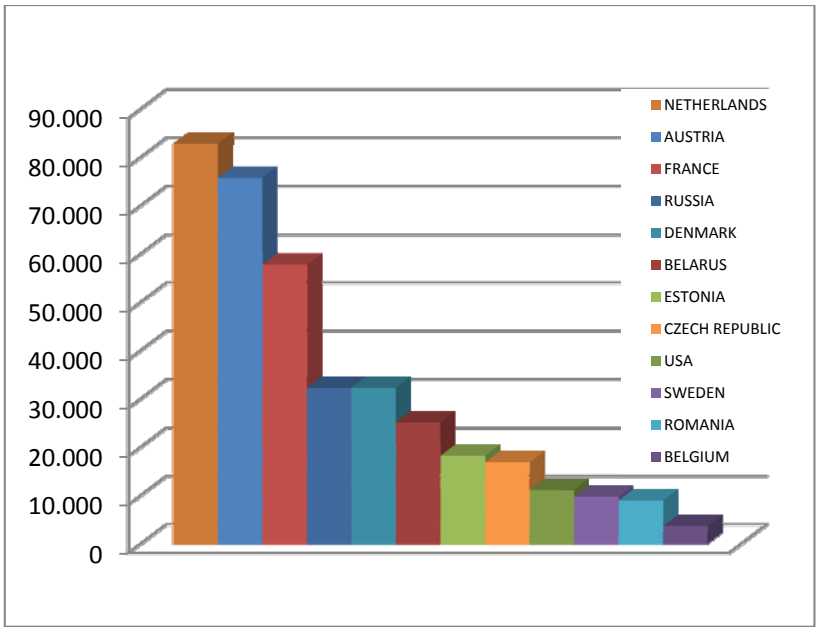


Fig. 2.5 – Pellet imports to Germany in 2010 Source Eurostat (tons)

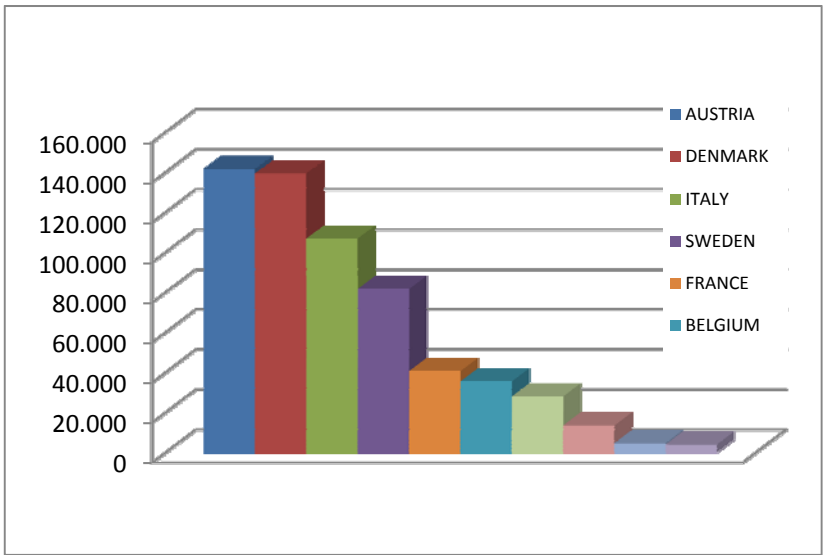


Fig. 2.6 – Pellet exports from Germany in 2010 Source Eurostat (tons)

2.2.5 Pellets quality and standard

Beginning of 2010 a new standardisation for wood pellets called EN 14961-2 has been introduced to the German market. This new standard is going to replace the existing one DIN. EN 14961-2 is a Europe-wide standard, which assures high quality pellet production and supports the harmonisation of pellet production within the different European countries. The corresponding certification system is called ENplus, which is primarily based on the specifications of the EN 14961-2 standard. Within this system three wood pellet qualities with different application purposes and thus wood pellet characteristics will be certified. These qualities are called ENplus-A1, ENplus-A2 and EN-B. So far already large and well-known wood pellet producers as German Pellets produces its pellets according to this new standard. Table 2.4 shows the quality parameters for ENplus-A1, ENplus-A2 and EN-B.

Property class	Unit	ENplus-A1	ENplus-A2	EN-B	analysis according to
Diameter	mm	6 (± 1) oder 8 (± 1) [2])			[5])
Length	mm	3.15 ≤ L ≤ 40 [3])			[5])
Bulk density	kg/m³	≥ 600			EN 15103
Net calorific value	MJ/kg	16.5≤Q≤19	16.3≤Q≤19	16.0≤Q≤19	EN 14918
Moisture content	w-%	≤ 10			EN 14774-1
Fines (< 3.15mm)	w-%	≤ 1			EN 15149-2
Mechanical durability	w-%	≥ 97.5 [4])		≥ 96.5	EN 15210-1
Ash content	w-% [1])	≤ 0.7	≤ 1.5	≤ 3.0	EN 14775
Ash melting behaviour	(DT) °C	≥ 1200	≥ 1100		EN 15370-1
Chlorine content	w-% [1])	≤ 0.02	≤ 0.02	≤ 0.03	EN 15289
Sulfur content	w-% [1])	≤ 0.03		≤ 0.04	EN 15289
Nitrogen content	w-% [1])	≤ 0.3	≤ 0.5	≤ 1.0	EN 15104
Copper content	mg/kg [1])	≤ 10			EN 15297
Chromium content	mg/kg [1])	≤ 10			EN 15297
Arsenic content	mg/kg [1])	≤ 1			EN 15297
Cadmium content	mg/kg [1])	≤ 0.5			EN 15297
Mercury content	mg/kg [1])	≤ 0.1			EN 15297
Lead content	mg/kg [1])	≤ 10			EN 15297
Nickel content	mg/kg [1])	≤ 10			EN 15297
Zinc content	mg/kg [1])	≤ 100			EN 15297

[1]) In water-free condition (wf).
[2]) Diameter must be indicated.
[3]) Maximum 1% of the pellets longer than 40 mm, max. length 45 mm.
[4]) If measured by the Lignotester, the threshold value is ≥ 97.7 w-%.
[5]) The corresponding CEN standard is currently being finalized.

***Table 2.4**: Overview quality parameters within the ENplus certification system: ENplus-A1, ENplus-A2 and EN-B*

2.2.6 Price trends

In Germany the wood pellet prices have been fairly steady with price levels of 170 to 190€/t till 2005. In 2006 prices started to rise with a peak price over 260€/t in December. In the following years such a peak did not recur and prices have been rather stable even though at a higher level. In general, seasonally variations with higher prices during the heating period and lower prices in summer can be observed. During 2010 the prices for wood pellets ranged between 218 and 234€/t. The average wood pellet prices from 2003 to 2010 are shown in figure 2.7 below.

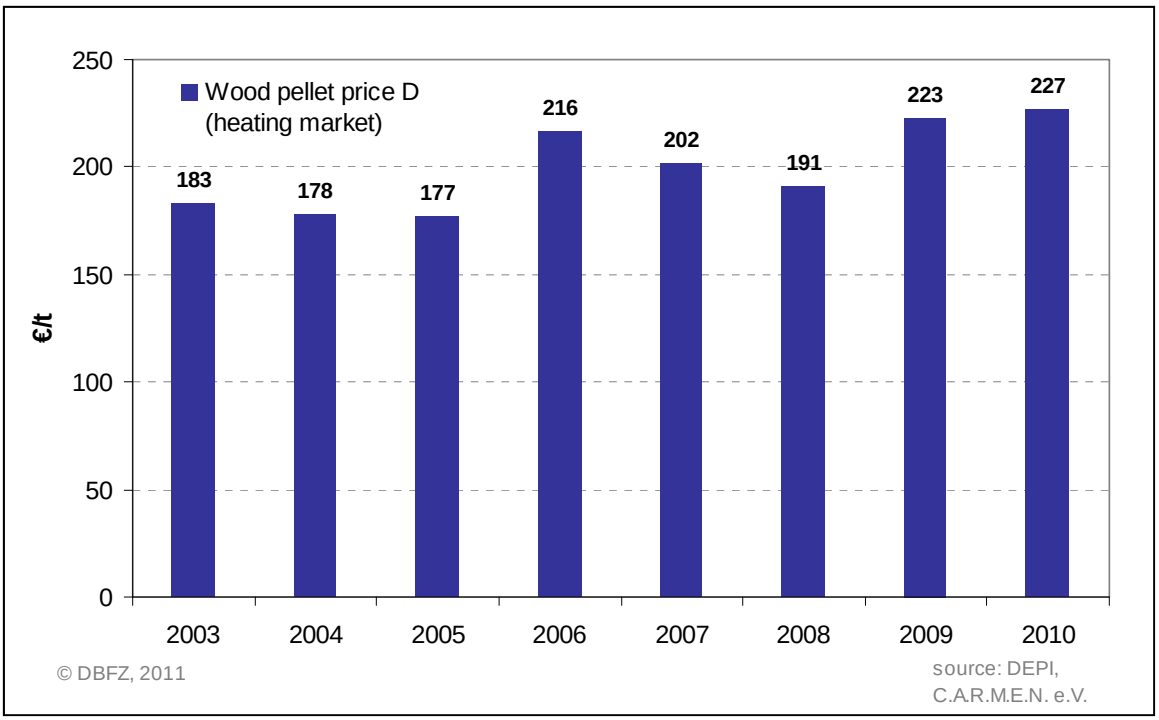


***Figure 2.7**: **Wood pellet prices from 2003 to 2010Source**: DEPI C.A.R.M.E.N. e V.*

2.3 Austria

2.3.1 Regulatory framework market drivers and barriers

In Austria wood pellets as heating fuel have been introduced to the market in the mid 1990s. Since then the usage of wood pellet primarily for residential heating has experienced a rapid growth. This success is based on the long tradition to use wood for space-heating and the related familiarity with this fuel as well as on several promotion programmes that are in place.

One important initiative is called Klima:aktiv which was launched in 2004,a programme that promotes the utilization of renewable energy sources. In total it runs until 2012 and is funded by the Lebensministerium. Within this initiative one programme is of importance for the pellet market development called “Holzwärme”. The programme ran from 2005 to 2009, which gave incentives for house owners to install biomass heating systems and increasingly pellet heating systems

Currently, financial support for installing a wood pellet system can be received within the general housing subsidy. The requirements for the funding and the respective amount can differ within the country, since it is the responsibility of the federal states. Thus, the subsidy can range between 1,400 and 7,000 Euros depending on the type of pellet heating system, if it new or replacing and in which federal state.

2.3.2 Production capacity and feedstock

In the first half of 2010, 28 production plants were located in Austria with a production capacity of 1,2 million tons and respective production of 850,000 tons in 2010. In comparison, in 2006, the production capacity was only half the amount what underlines the huge growth of the Austrian wood pellet market.

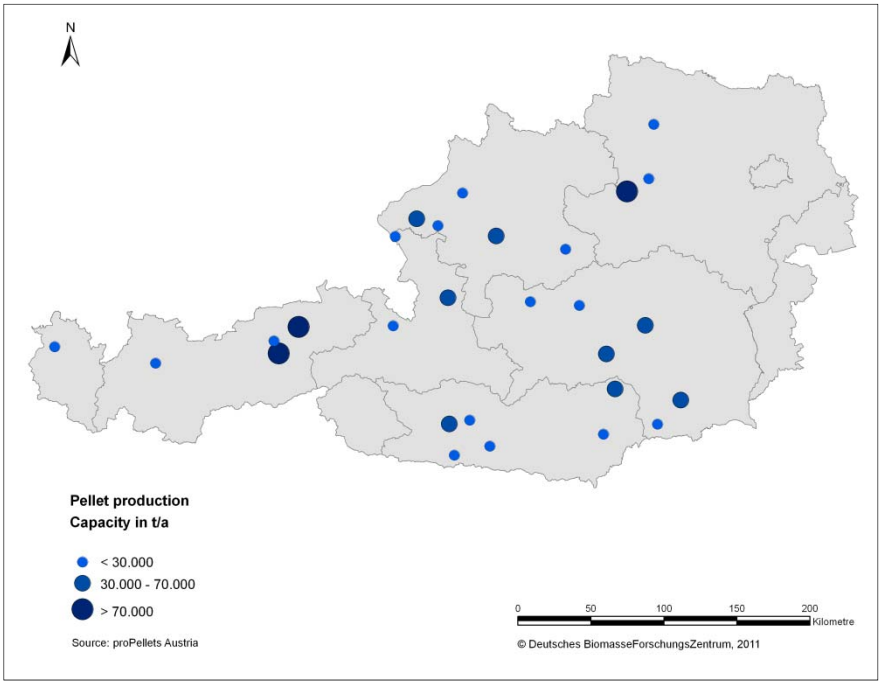


***Figure 2.8**: Distribution of wood pellet production plants in Austria 2010*

2.3.3 Consumption

In regard to the pellet consumption a steady growth with a slight drop in 2006/2007 can be observed. The wood pellet demand especially for residential heating was about 630,000 tons in 2010. In general, Austria has a higher production output than actually demanded. Currently, the production volume is 35% above national demand.

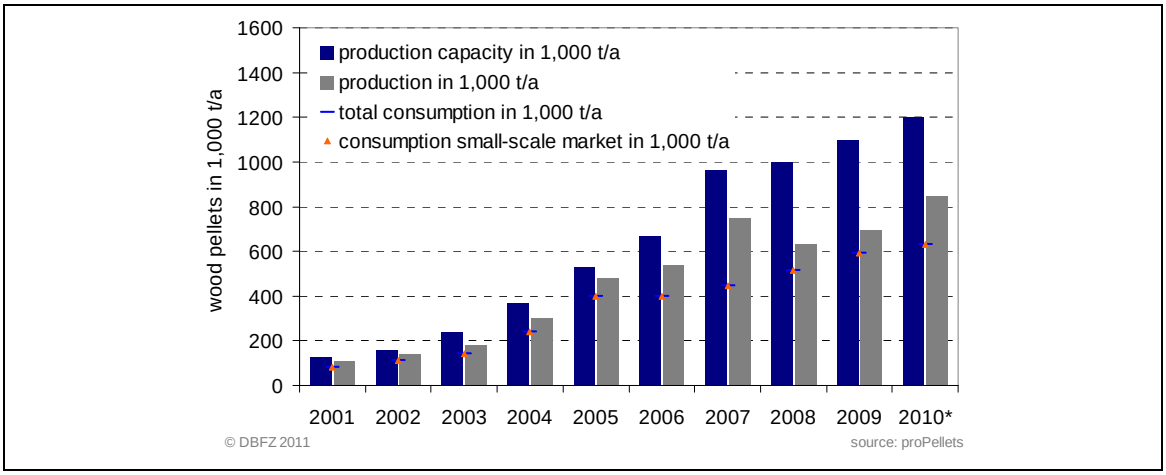


Figure 2.9: Wood pellet market development in Austria from 2001 to 2010: production capacity, production and consumption (*forecast)

The number of set up pellet heating systems rose from 425 in 1997 to a peak of more than 11,000 of yearly installations in 2008, which was mainly due to the promotion programme "Holzwärme". In 2009 the number of new installations was almost 8,450 pieces, totalling to 70,800 pieces.

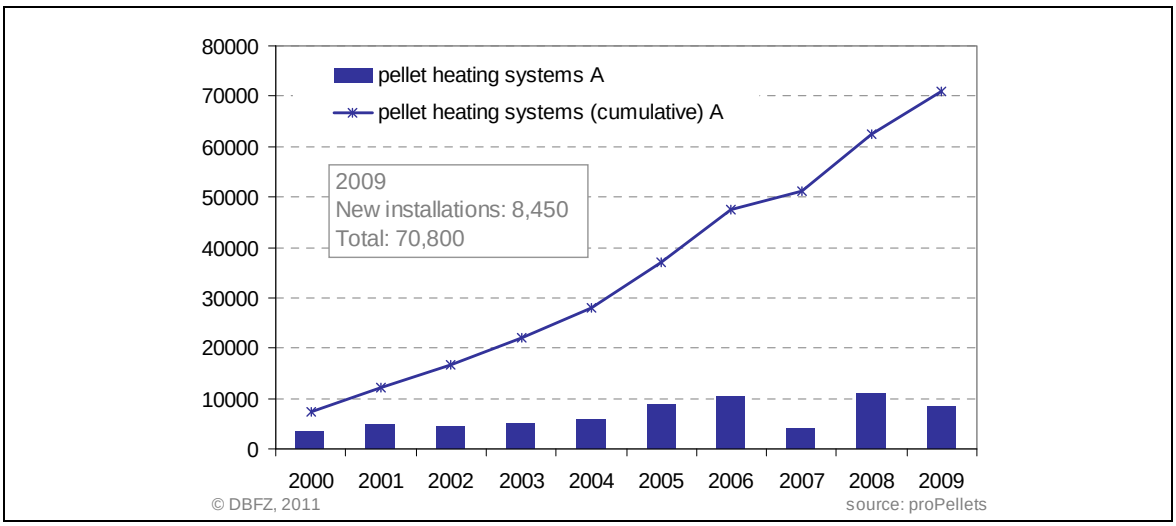


Figure 2.10: Development of installed pellet heating systems in Austria from 2000 to 2009 (yearly and cumulative)

2.3.4 Trade and logistic aspects

Austria produces mainly wood pellets for residential heating that are exported. The trade of wood pellets mostly takes place in bordering regions. Italy (226,000 t) and Germany (46,000 t) are the two main receiving countries. The imports come from Germany (80,000 t), Czech Republic (27,000 t) and Romania (22,000 t). In total the export amounts to 284,000 t and the import to 160,000 t (data 2009). Thus, Austria is a net exporting country for pellets.

2.3.5 Pellets quality and standard

In spring 2011 a new standardisation for wood pellets called EN 14961-2 will be introduced to the Austrian market. This new standard is going to replace the existing one ÖNORM. EN 14961-2 is a Europe-wide standard, which assures high quality pellet production and supports the harmonisation of pellet production within the different European countries. The corresponding certification system is called ENplus, which is primarily based on the specifications of the EN 14961-2 standard. Within this system three wood pellet qualities with different application purposes and thus wood pellet characteristics will be certified. These qualities are called ENplus-A1, ENplus-A2 and EN-B. The certification system has evolved from a collaboration of the institute proPellets Austria and German Pellets Association (DEPV). Table 2.5 shows the quality parameters for ENplus-A1, ENplus-A2 and EN-B.

Property class	Unit	ENplus-A1	ENplus-A2	EN-B	analysis according to
Diameter	mm	6 (± 1) oder 8 (± 1) [2]			[5]
Length	mm	3.15 ≤ L ≤ 40 [3]			[5]
Bulk density	kg/m³	≥ 600			EN 15103
Net calorific value	MJ/kg	16.5≤Q≤19	16.3≤Q≤19	16.0≤Q≤19	EN 14918
Moisture content	w-%	≤ 10			EN 14774-1
Fines (< 3.15mm)	w-%	≤ 1			EN 15149-2
Mechanical durability	w-%	≥ 97.5 [4]		≥ 96.5	EN 15210-1
Ash content	w-% [1]	≤ 0.7	≤ 1.5	≤ 3.0	EN 14775
Ash melting behaviour	(DT) °C	≥ 1200	≥ 1100		EN 15370-1
Chlorine content	w-% [1]	≤ 0.02	≤ 0.02	≤ 0.03	EN 15289
Sulfur content	w-% [1]	≤ 0.03		≤ 0.04	EN 15289
Nitrogen content	w-% [1]	≤ 0.3	≤ 0.5	≤ 1.0	EN 15104
Copper content	mg/kg [1]	≤ 10			EN 15297
Chromium content	mg/kg [1]	≤ 10			EN 15297
Arsenic content	mg/kg [1]	≤ 1			EN 15297
Cadmium content	mg/kg [1]	≤ 0.5			EN 15297
Mercury content	mg/kg [1]	≤ 0.1			EN 15297
Lead content	mg/kg [1]	≤ 10			EN 15297
Nickel content	mg/kg [1]	≤ 10			EN 15297
Zinc content	mg/kg [1]	≤ 100			EN 15297

[1]) In water-free condition (wf).
[2]) Diameter must be indicated.
[3]) Maximum 1% of the pellets longer than 40 mm, max. length 45 mm.
[4]) If measured by the Lignotester, the threshold value is ≥ 97.7 w-%.
[5]) The corresponding CEN standard is currently being finalized.

Table 2.5: Overview quality parameters within the ENplus certification system: ENplus-A1, ENplus-A2 and EN-B

2.3.6 Price trends

In Austria the wood pellet prices have been fairly steady with price levels of 155 to 185€/t till 2005. In 2006 prices started to rise with a peak price over 265€/t in November as it could be noticed on several central European wood pellet markets. In the following years such a peak did not recur and prices have been rather stable even though at a higher level. In general, seasonally variations with higher prices during the heating period and lower prices in summer can be observed. During 2010 the prices for wood pellets for heating purposes in the private sector ranged between 197 and 217€/t. The average wood pellet prices from 2003 to 2010 are shown in

Figure ***2.11*** below.

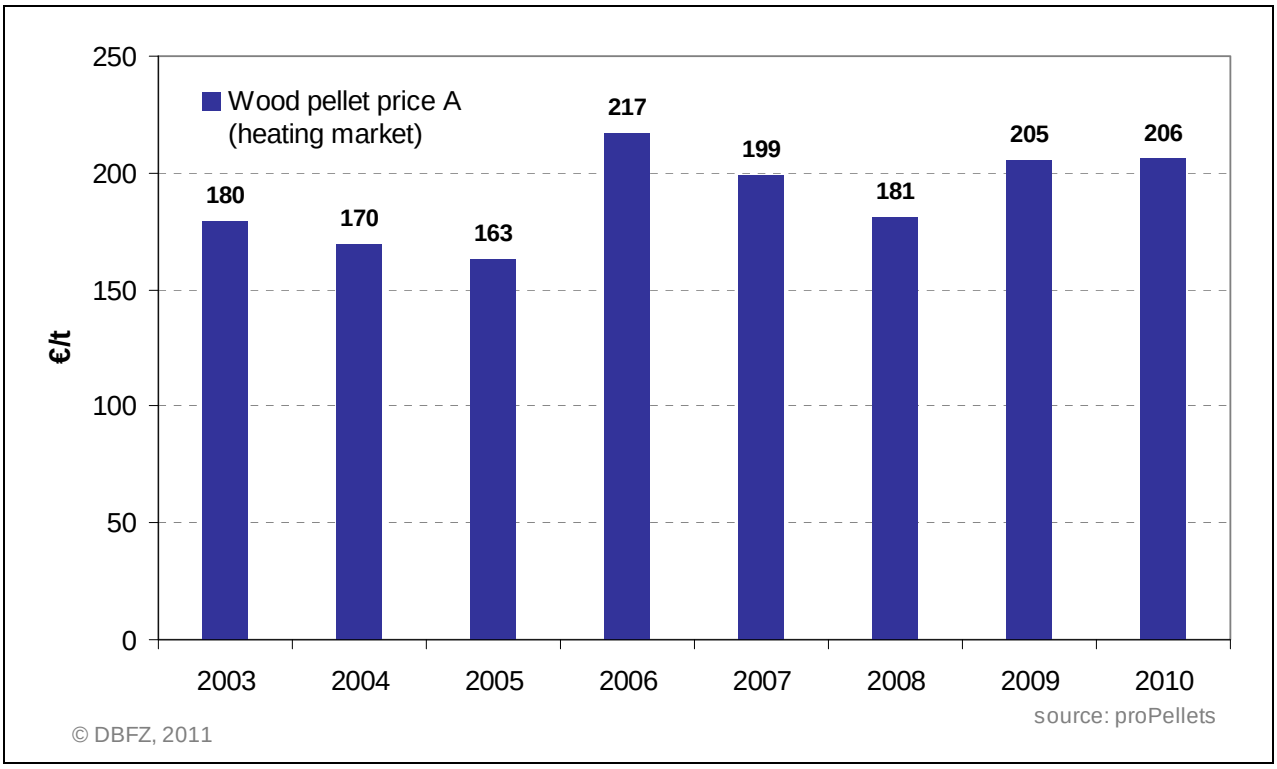


***Figure 2.11**: Wood pellet price development from 2003 to 2010 in AustriaSource: proPellets*

2.4 Denmark

2.4.1 Regulatory framework market drivers and barriers

Denmark started using wood pellets in the late 80's mainly in the district heating sector where they used to replace coal. From 1993 onwards the annual pellet use in district heating plants was about 110,000 tons. An increase in pelletconsumption in the last decades is due to an increased consumption in both power plants, publicbuildings and the residential sector.since 1998 a stedy increase in the use of pellets was observed. Since 2003 a new CHP plant co-firing with pellets (Avedøre II) started operation and increased significantly the Danish pellet consumption. The main market drivers are tax exemptions on pellets and that the utilities are forced by Government decree to use biomass in large amounts. The barriers are that the supply chain for pellets needs large investments, overseas ship transport, new storage facilities under roof and modifications for in house transport systems, milling systems and burners.

2.4.2 Production capacity

The Danish production of wood pellets reached 137,000 tons in 2010, and there has been a decreasing domestic production since 2005 where it was close to 200,000 tons. This is mainly due to lack of raw materials. There are 6 pellet plants in Denmark, but only 4 of them were active in 2010. The overall pellet production capacity is 400,000 tons, which represent less than 25% of the 2010 pellet demand in Denmark. Therefore import plays an important role in the country's pellet supply.

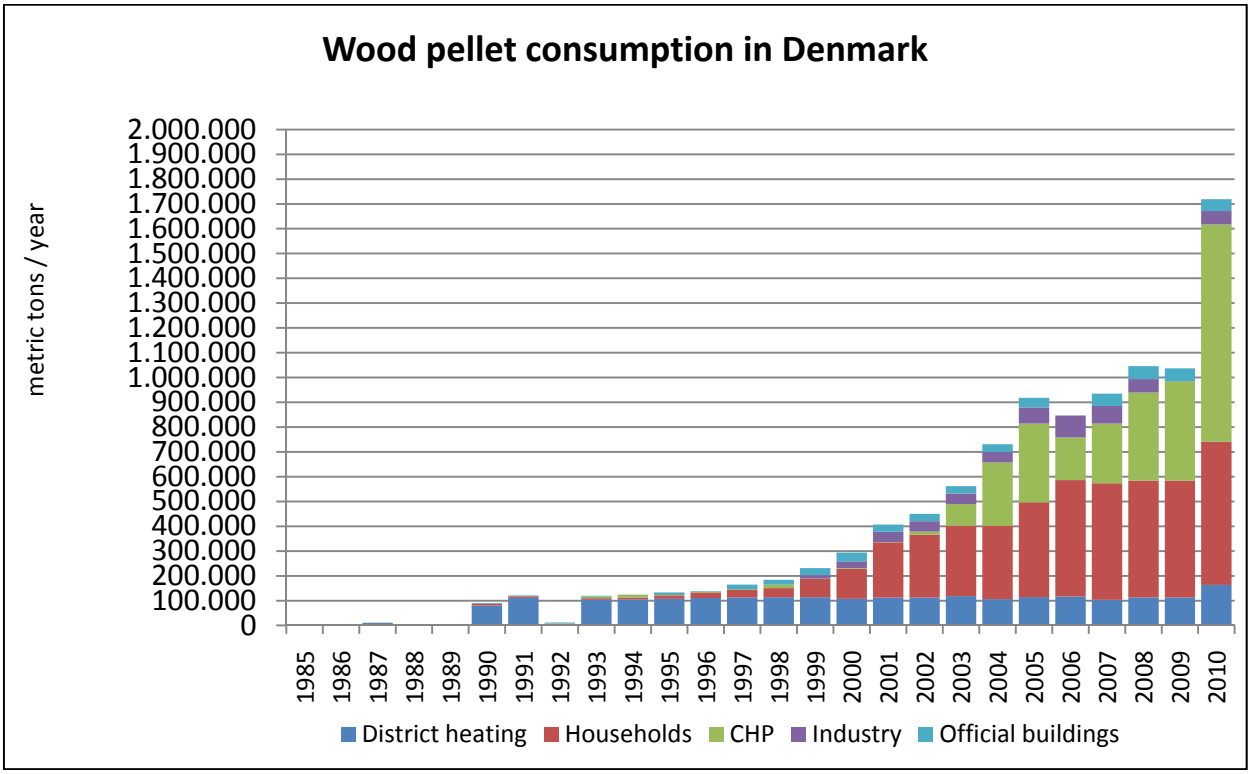


Figure. 2.12: Wood pellet consumption in Denmark 1990 to 2010. Source: Danish Energy Agency 2010.

2.4.3 Consumption

Since 2000 the consumption of wood pellets has increased significantly for both large power plants and private consumers reaching 917,000 tons in 2005 and 1,719,000 tons in 2010. The power plants (using negligible amount of pellets before year 2003) have increased to nearly 900,000 tons in 2010, the first

year to overtake the private consumers, which make up the largest market segment in 2009 with 471,000 tons. The steep increase in consumption by power plants is due almost exclusively to the establishment of Avedøre Unit 2, which consumes large amounts wood pellets (250,000 tonnes per year). Since 2003 private consumption has increased by 190,000 tons. A slight increase of 12,000 tons in industry since 2003 has taken place with a consumption of 54,000 tons in 2010 the new multi-fuel boiler (Amagerværket Unit 1) with the mixture of coal, oil, wood and straw pellets has been taken in commercial operation. The projected yearly consumption of wood pellets is 40,000 tons and 110,000 tons of straw pellets.

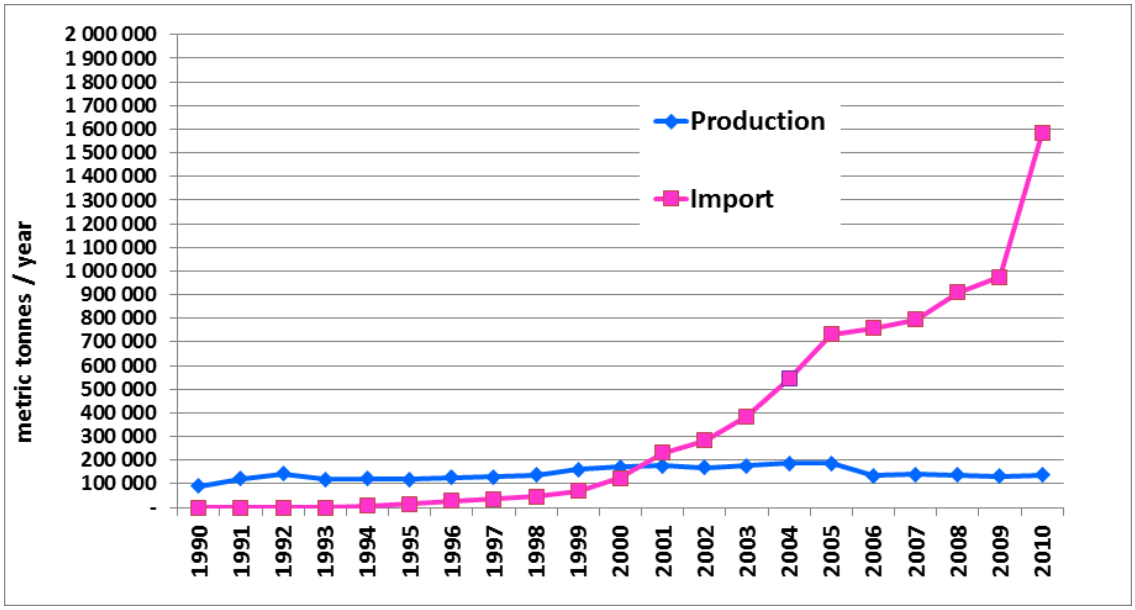


Table 2.13: Domestic production and import of wood pellets in Denmark 1990 to 2010. Source: Danish Energy Agency 2010.

2.4.4 Trade and logistic aspects

Since 2003, the amount of wood pellets imported has increased from 385,000 tons to 1,581,000 tons in 2010; an overall increase of 310 per cent. This is due to the use of pellets in power plants with an increase in the period 2003-2010 of 779,000 tons, among others Avedøre Unit 2, and private consumers with an increase of 294,000 tons in the same period. The main suppliers for the Danish market are the Baltic States, Poland, Sweden, Canada and Finland. According to Eurostat, in 2010 a significant volume of pellets was imported from Portugal. In the same year, around 100.000 tons of pellets were also exported to Germany and Sweden.

The wood pellets are imported by ships to several Danish harbors and to the harbors of the power plants themselves. Ship size varies from small Baltic coasters to large Bulk carriers from Canada. Ice in the harbors in December-February can cause troubles to smaller ships. The harbors have all unloading facilities as crane or vacuum transport systems and roofed storage for the pellets. If not used at power plant, the wood pellets are transported by truck to the end user (district heating plant) or to an intermediate storage facility for distribution to private consumers. The delivery to private consumers takes place in bags (15-25 kg), big bags (1000 kg) and truck with blower equipment. A few tons are imported from Poland by truck.

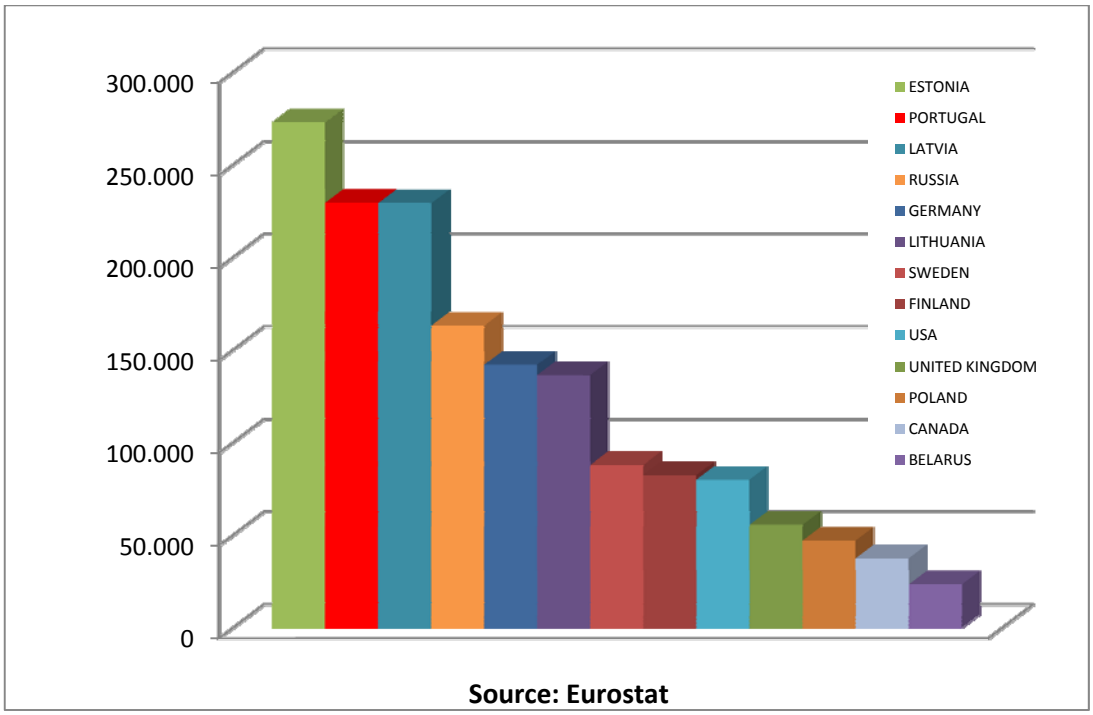


Figure 2.14:Pellets imported to Denmark in 2010

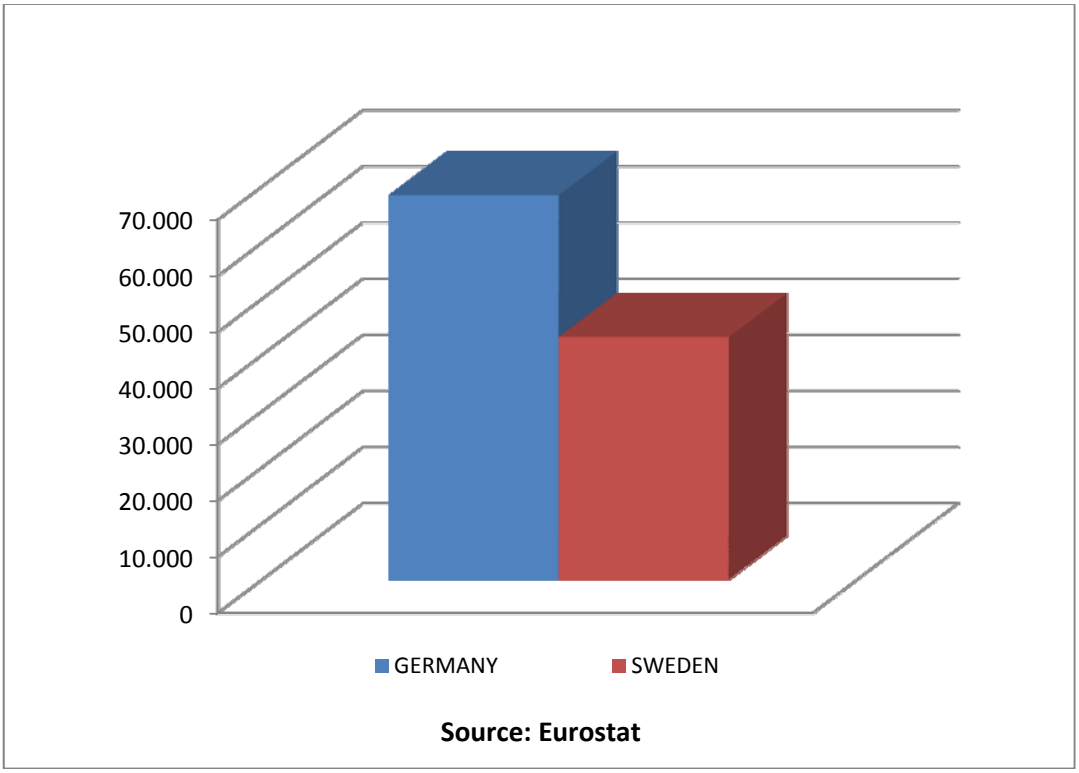


Figure 2.15 :Pellets exported from Denmark in 2010

2.4.5 Pellets quality and standard

A national standard for wood pellets is not available yet, although it is demanded by consumers and suppliers. The only legislation in thisarea is the Biomass regulation (BEK nr 638 af 03/07/1997),

requiring that wood pellets must be produced from clean wood without any kind of contamination. A maximum of 1% residues of glue (e.g. from fibre boards) is allowed, but there are no rules or demands for e.g. moisture or ash content which are important for the combustion characteristics. Labeling according to CEN/TS 14961: *Fuel Specifications and Classes* has not really been used in Denmark until now. Some producers and importers use their own labeling.

Although private consumers are the largest end users calculated in tons, pellet quality has not been so important. In general private consumers go for the best quality, when they once have tried a low pellet quality. As a substitute to the lacking national standard three quality labels from respectively FORCE Technology, Teknologisk Institut and the Danish environment label "Svanemærket" (the Swan Mark) have entered the market and offer quality certifications for pellet manufactures and suppliers.

2.4.6 Price trends

Price on wood pellets has been quite stable in the last years for district heating plants and for private consumers. The price for truck delivery to private consumers in a quantity of 5-6 tons is 214 Euro/tons excl. VAT, which in Denmark is 25%. For district heating plants the price is lower due to purchase of large amounts and due to the often lower quality compared to what private consumer purchase. There are no price statistics from the utility companies (power plants).

End user	**December 2007**	**December 2008**	**December 2009**	**December 2010**
Private consumer	217 Euro/t	214 Euro/t	214 Euro/t	216 Euro/t
District heating plant	157 Euro/t	161 Euro/t	165 Euro/t	166 Euro/t

Table 2.7: Wood pellets delivered by truck to end user in quantity over 5 tons. Price without VAT in Euro/tons. In Denmark VAT is 25%. Heating value 4,8 kWh/kg.

Source: PelletAtlas, Danish District Heating Association and private informations.

2.5 Finland

2.5.1 Regulatory framework market drivers and barriers

The RES Directive of the EU has set 38% as a target for the share of renewable energy in final energy consumption in Finland in 2020.[1] In 2005, the realised share of renewable energy was 29%.[1] The use of renewable energy in 2009 and Finnish renewable energy targets by energy source for 2020 are presented in Table 2.8.

Source of renewable energy (PJ)	Year 2009[a] (PJ)	Target level for 2020[b] (PJ)	Increment (PJ)
Black liquor	110	137	27
Solid wood processing industry by-products and residues	52	68	16
Hydropower	45	50	5
Firewood	55	43	-12
Forest fuels (in heat and power generation)	*44*	90	46
Recycled fuels	8	7	-1
Heat pumps	7	29	22
Other renewable energy (includes, e.g., solar energy and agro-biomass)	4	1	-3
Biogas	2	4	2
Wood pellets	3	7	4
Wind power	1	22	21
Liquid biofuels	7	25[c]	18
Total	338	483	145

Table 2.8 : Renewable energy consumption by energy source in 2009 in Finland and the targets for 2020

Forest biomass is the most important source of renewable energy in Finland, covering approximately 80% of the renewable energy used. Most forest-based bioenergy (over 75%) is generated from by-products of the forest industry (black liquor, bark, and sawdust). The rest of the wood energy is generated from wood biomass that is sourced from forests for energy purposes (firewood and forest chips). The proportion of wood pellets has been negligible. However, the aim of the government is to treble the domestic consumption of wood pellets to over 400 thousand tons/yr by 2020.

Past development and drivers for pellet export

The fact that the taxation of fossil fuels in energy production or subsidies for electricity from biomass have considerably higher in the main export countries (Sweden and Denmark) than in Finland has made the exportation of pellets economical. In Sweden and Denmark, the taxation of fossil fuels in heat production has been much higher than in Finland (see Figure 2.16), and wood pellets are mainly used as a substitute for coal in district heating and for oil in space heating. In the UK and Belgium, renewable energy production is strongly subsidised through energy policy measures and pellets are primary co-fired in large coal-fired power plants [4, 5].

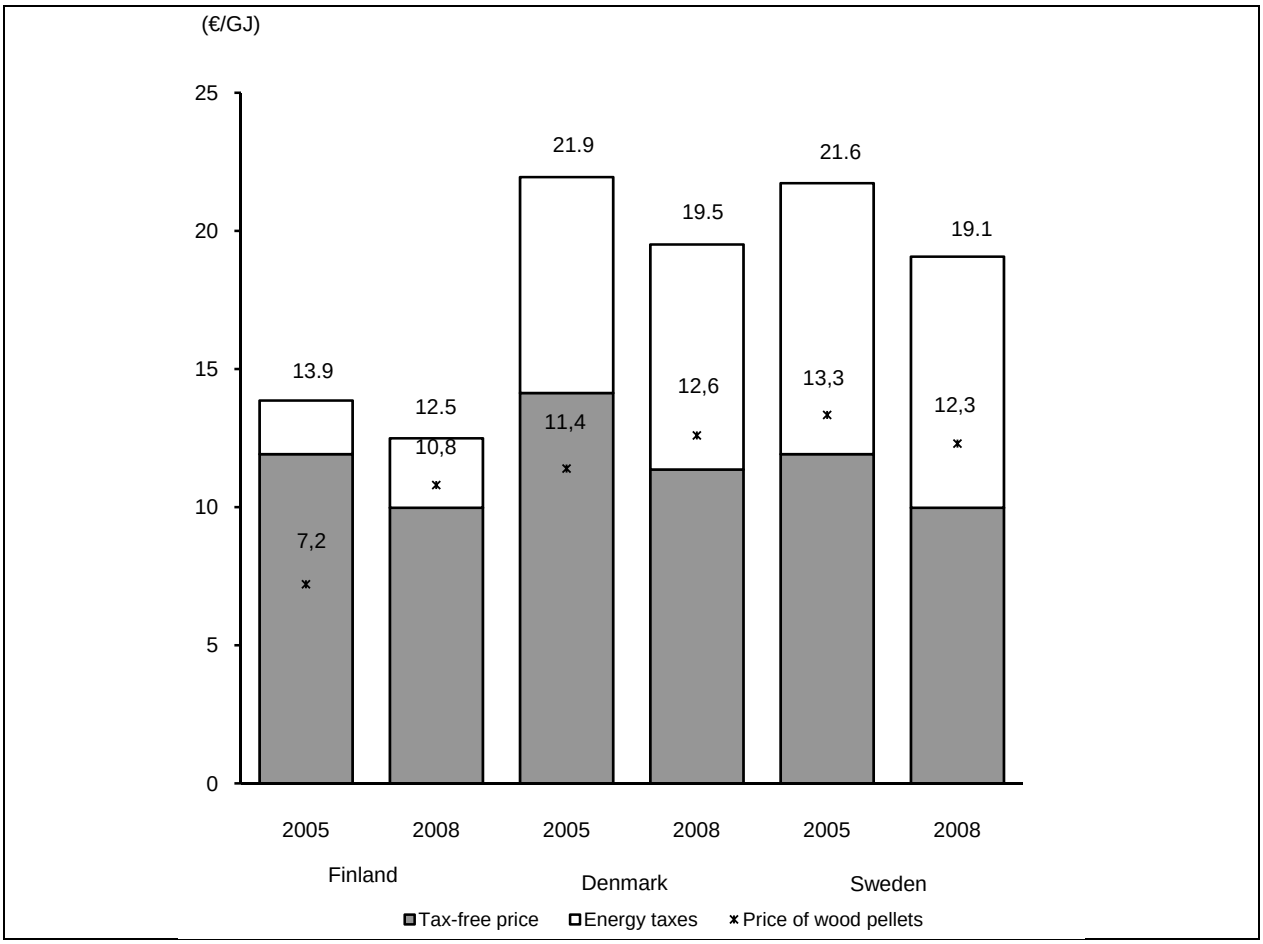


Figure 2.16. Prices of light fuel oil in heat production and wood pellets in Finland, Denmark, and Sweden at the end of 2005 and 2008. The prices exclude value added tax (22% in Finland, and 25% in Denmark and Sweden) but include energy taxes and similar fees. Prices of oil are from the [6, 7], and prices of wood pellets are from [8-10].

In 2000–2006, the market price of pellets in Finland was remarkably lower than in Sweden and Denmark. The difference in market prices of pellets between Finland and its main export countries for pellets can be considered to illustrate the transport costs of pellets. Wood pellets are exported almost totally by means of maritime transport. As bulk material, pellets are relatively easy to transport, and ports suitable for dry-cargo vessels and barges can be utilised in the export shipping. The ample underutilised port capacity that is suitable for handling and transport of pellets has facilitated the export of pellets. In 2007–2008, pellets' price in Finland increased, approaching the prices of Sweden and Denmark [10]. One explanation for the increase in pellet prices in Finland has been the rapid decline in the forest industry in 2008, which resulted in a raw material shortage in pellet mills and led to several mills' stoppages in production. The narrowing difference of pellet prices between Finland, on one hand, and Sweden and Denmark weakens the attractiveness of pellet export in Finland.

2.5.2 Production capacity and feedstock

Wood pellet production in Finland started in 1998. The Finnish pellet industry was founded on export supplying pellets to Sweden, where pellet markets were developing rapidly at the time. Since then, pellet production has increased steadily, climbing to 376,000 t (6.3 PJ) in 2008 (Figure 2.17). The majority of Finnish pellet production has been consumed abroad.

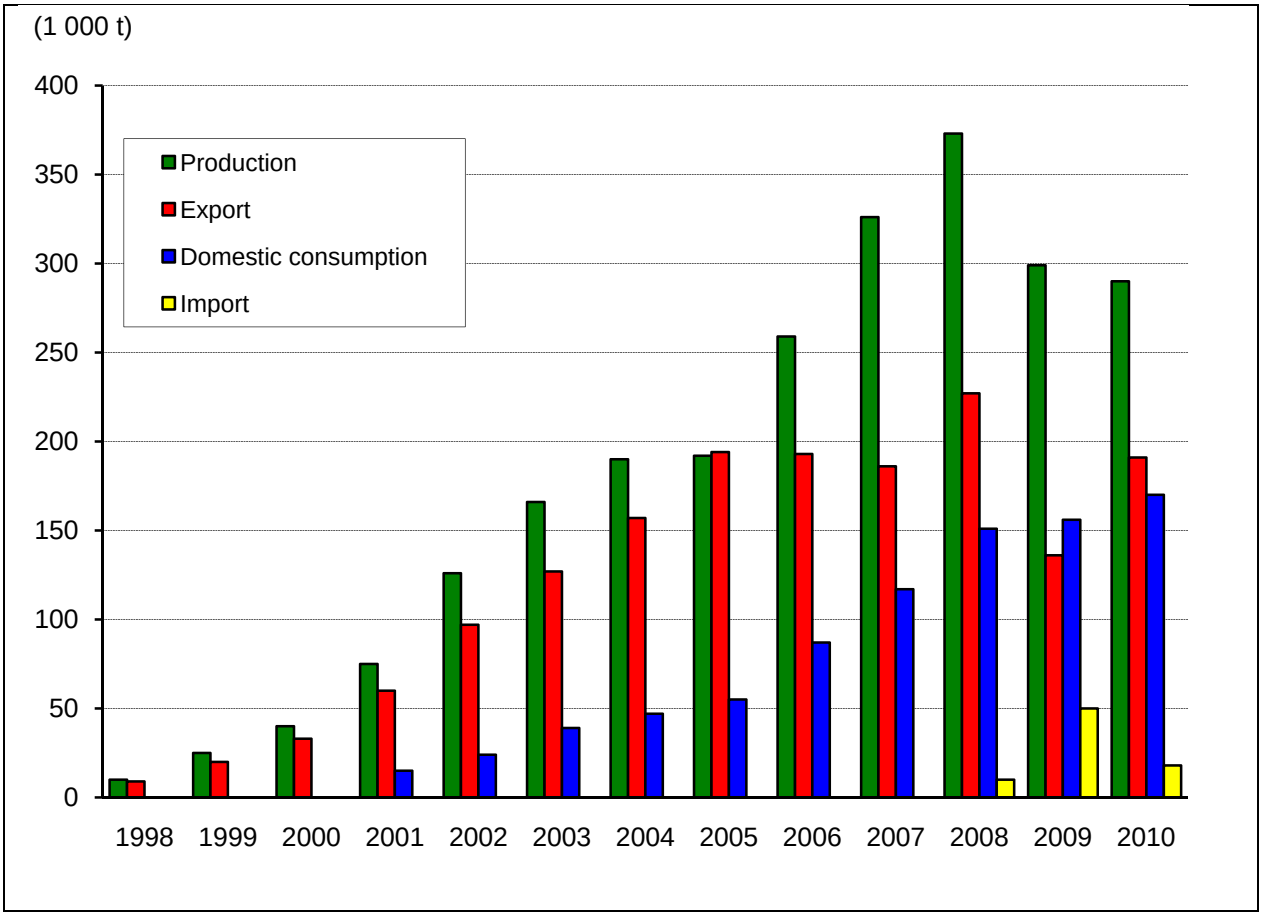


Figure 2.17. Wood pellet production, domestic consumption, and export in Finland in 1998–2010. *In 2005, the export surpassed production resulting from a change in stocks. [11-13]*

At the beginning of 2011, there were 24 wood pellet mills in operation (Figure 2.17). The total production capacity of the pellet mills is approximately 700 000 t/yr.

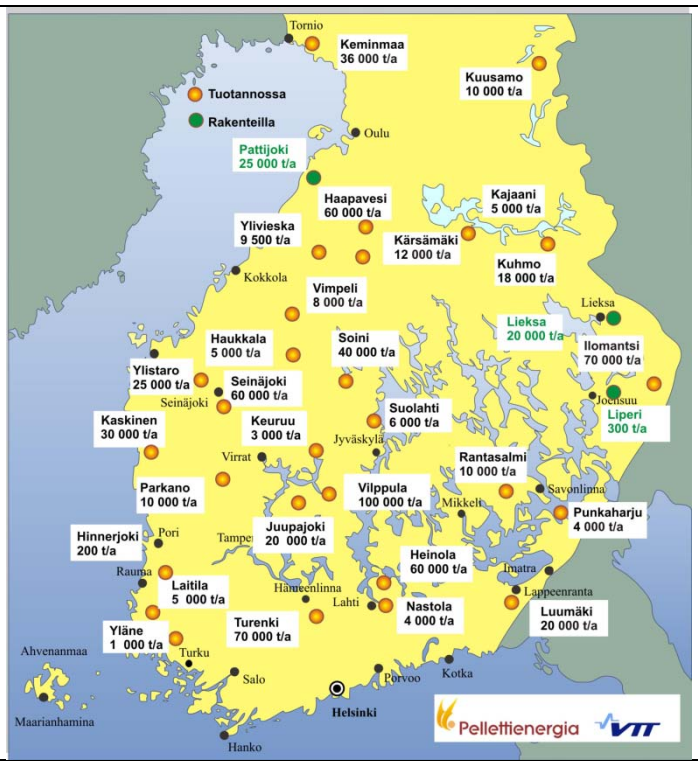


Figure 2.18. The locations and production capacities of Finnish wood pellet mills at the beginning of 2011. (brown spot = existing mill, green spot = under construction). Figure from Pellettienergiayhdistys ry.

In Finland, pellets have mainly been manufactured from dry by-products from the sawn timber refining industry. This has allowed simpler processes for manufacturing pellets, as there is no need for drying of the raw material.

In 2009, Finland was the fifth largest sawn timber producer in Europe after Germany, Russia, Sweden and Austria [14]. In 2008- 2009, global economical depression caused a remarkable (20-30%) reduction in the production of forest industry compared to past years' figures. In 2009, Finnish sawmills consumed 18.4 million solid m^3 of logs (including bark) and produced 7.6 Mm^3 of sawn timber[15]. The production of sawn timber yields approximately 12% bark and 13% of sawdust as by-products from raw wood. Sawdust and bark are moist, with an average moisture content of around 55%; therefore, they need to be dried before the pelletising process. The total volume of bark was 2.2 million solid m^3 and sawdust 2.4 million solid m^3, which would theoretically be in supply for 0.9 Mt pellet production from bark and for 1.0 Mt pellet production from sawdust. However, the bark that sawmills produce is currently consumed almost entirely in energy production in heating and compiden heat and power (CHP) plants. Sawdust is utilised partly as raw material in wood panel production and in pulp mills and partly as fuel in power and heating plants. Only a minor proportion is utilised in pellet production. The newest pellet mills in Finland are equipped with a drying process, so the use of sawdust will increase in pellet production.

In 2009, the domestic consumption of sawn timber in Finland was approximately 4 Mm^3, of which industrial use accounted for approximately 2.5 Mm^3(In this context, industrial use refers to utilisation for other than construction and packing purposes). Approximately 0.6 Mm^3, a quarter of the volume of sawn timber refined by industry, ends up as by-products, which is enough for approximately 0.25 Mt of pellet production annually. Only some of this volume can be utilised in pellet production – thus its competitive use as fuel in heating and power plants. Increasing pellet production will demand

expansion of the raw materials to include sawdust and forest chips. Furthermore, the expanding wood pellet mills will have to compete for raw material with other users of by-products.Recently established pellet mills are equipped with a drying process and utilise moist raw materials.

2.5.3 Consumption

In 2004–2009, domestic consumption of wood pellets more than trebled and is approximately half of the production. The number of private small-scale pellet users in 2009 was estimated at 20,000 [16]. In 2009, about 40% of the domestic consumption of pellets in Finland took place in small boilers whose thermal output is less than 25 kW[12, 15]. Pellets have not been competitive with heavy fuel oil or coal as fuel in heating and power plants, and they are mainly used in applications where light fuel oil is an alternative fuel, typically in the heating of dwellings and small public or industrial buildings.

The consumption of wood pellets is still at a modest level in Finland compared to the usage potential. Approximately 50 PJ of light fuel oil is consumed for the direct heating of Finnish dwellings each year [2]. Estimations have showed that the annual domestic consumption of wood pellets could be raised to 1–1.5 million tons (17.5–26 PJ) by replacing a part of the consumption of light fuel oil with the use of pellets [17]. In addition, a remarkable although less economically feasible potential use for pellets lies in substituting coal in power plants. In recent years, the average consumption of coal in energy production in Finland has been approximately 200 PJ [2]. Coal-fired power plants using pulverised combustion, e.g. in the Helsinki metropolitan area, could increase their use of pellets to even 2–3% of their fuel use without great technical changes in the burning systems if pellet use becomes economically competitive with coal. The largest Finnish coal-fired power plants are found in coastal areas with their own coal ports, which could be used for shipping pellets, if needed.

The Finnish Pellet Energy Association has set a target number of domestic pellet consumers of nearly 80,000 (75,000 single family houses and 4,000 industrial users) and a domestic pellet consumption target of approximately 1.5 Mt/yr by 2020[18]. The consumption target of Pellet Energy Association is much higher the government's target indicate in National Renewable Energy Action Plan (400,000 t/yr).

The main obstacle to increased domestic consumption of pellets has been their weak competitiveness against other heating fuels, especially light heating oil. While the direct market price of pellets has been below that of light fuel oil, the pellet heating systems' need for a bigger investment than does oil or direct electricity heating has constrained investments in pellet boilers and pellet heating systems. Domestic pellet consumers have to compete for pellets with the consumers in the export countries, and this affects the development of the Finnish pellet market – prices, production volumes, and export volumes. In addition, heating and power plants are competing for raw material with the pellet industry, which will lead to increasing raw material prices and cause pressure to increase the market price of pellets.

2.5.4 Trade and logistic aspects

Since the beginning of industrial pellet production in Finland the number of export countries of pellets has increased resulting from booming pellet markets in Europe. In addition to Sweden, Finnish pellets have been exported e.g. to Denmark, the Netherlands, the UK and Belgium.

In 2009, total pellet export form Finland was 146 thousand tons and the major export countries were [19]:

- Sweden 80 thousand tons
- Denmark 51 thousand tons
- The United Kingdom 5 thousand tons

In 2010, total pellet export from Finland was 167thousand tons and the major export countries were [19]:

- Sweden 82 thousand tons
- Denmark 72 thousand tons
- Germany 5 thousand tons

In 2008, the statistics reported the import of wood pellets to Finland (10 thousand tons) for the first time. Imported pellet came from Russia and the Baltic states. In 2009 the total import of pellets was 50 thousand tons of which approximately 40 thousand tons came from Russia. In 2010, the import of pellets declined to 17 thousands tons of which about 10 thousands came from Russia and seven thousands from the Baltic states [15, 19]The wood pellets are exported from Finland almost totally by means of maritime transport. As bulkmaterial, wood pellets are relatively easy to transport and ports suitable for dry-cargovessels and barges can be utilised in the transportations. Available indoor storage andmaterial handling equipment for dry bulk in a port facilitate the loading of pellets intothe vessel. There is plenty of underutilised port capacity in Finland available for thehandling and transportation of pellets.

2.5.5 Pellets quality and standard

Finnish wood pellet markets apply European wood pellet standards. EN 14961-2 the most important pellet standard and is so called product standard for non-industrial use of pellets. Practically, all indigenous roundwood used by the forest industry is currently certified (mainly according to PEFC system and partly FCS). Certified raw material allows wood pellets to be labelled with the PEFC or FCS logo.

2.5.6 Price trends

The evolution of consumer prices of electricity, light fuel oil and wood pellets in Finland since the beginning of 2002 are depicted in figure 2.19.

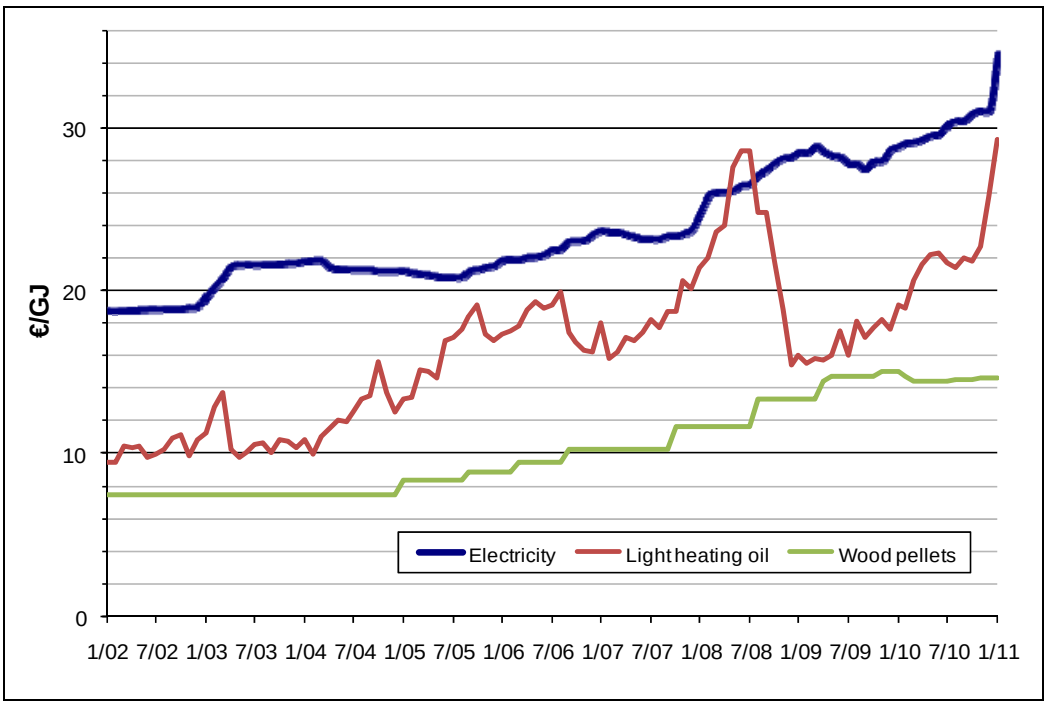


Figure 2.19. Price development of consumer prices of electricity, light fuel oil (heating oil) and wood pellets in Finland from January 2002 to January 2011. Prices are monthly prices and they include energy taxes and Value added tax (VAT). In Finland, VAT was until the end of 2009 22% and 23% since beginning of 2010. Source: Pellettienergiayhdistys ry.

2.6 Italy

2.6.1 Regulatory framework market drivers and barriers

As for most of the European members states the main policy updates and the major changes in the regulatory framework affecting the Italian biomass and pellet sectors derived by the transposition and implementation of the principles derived by the EC Renewable Energy Directive 28/2009.

The Italian target for renewable energy in the heating sector is 17.09 % by 2020 as stated in the National Renewable Energy Action Plan, a sensible increase from the 6.53% share of 2010. As a matter of fact the Italian NREAP forecasts a predominant role for solid biomass in the heating sector, with an increase from 1.6 million Toe in 2010 to 5,. million Toe in 2020.

According to the Italian NREAP in 2020 solid biomass is expected to cover 50% of the RES share in the heating sector, increasing from 2,000 kToe of 2008 up to over 5,000 kToe of 2020 (figures 2.20 and 2.21). Therefore, biomass will play a key role in meeting the Italian 2020 target particularly in the heating sector.

Figures from Italian NREAP

Gross RES heat consumption in 2008 and forecasts to 2020

	2008		2020	
	Gross production RES-H	RES production share	Gross Production RES-H	RES production share
	[ktep]	[%]	[ktep]	[%]
Geothermic	213	7%	300	3%
Solar	67	2%	1.586	15%
Biomass:	1.875	58%	5.670	54%
solid	*1.854*	*57%*	*5.254*	*50%*
biogas	*16*	*1%*	*266*	*3%*
bioliquid	*4*	*0%*	*150*	*1%*
Heat pumps	1.083	33%	2.900	28%
Total	3.238	100%	10.456	100%

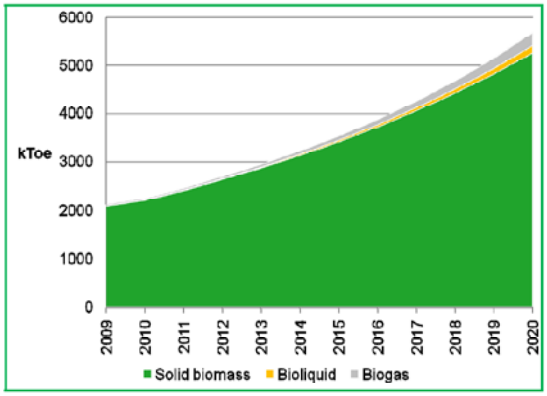


***Figure 2.20**: Gross RES heat consumption in 2008 and forecasts to 2010**Figure 2.21**: Expected trend of gross heat consumption from biomass **Source**: GSE*

In order to achieve this ambitious target, a series of support measures will have to be put in place not only to mobilize additional biomass sources, but also to stimulate the demand of biomass energy in the heating sector and promote the installation of new biomass units (boilers, district heating network, pellets stoves etc.).

The current (2010) system of support measures for biomass heating in Italy is centered on three main axes:

- **Energy efficiency certificates** (white certificates): this is a market mechanism aiming at promoting energy-saving projects in industrial, residential, services and agricultural sectors;
- **Tax relief for energy saving in buildings**: Tax relief of the 55% of total costs borne for energy efficiency improvement in buildings and/or installation of solar panels, biomass boilers and heat pumps;
- **Mandatory quota of RES for new buildings**: Minimum 50% of energy consumption for hot water production to be covered by RES in new buildings.

In March 2011 the Italian transposition law of the EU Renewable Energy Directive was adopted (Dlgs. 28 of 3 March 2011). This law introduces several major improvements in the regulatory context for biomass heating that once becoming fully operational will hopefully boost the adoption of biomass heating systems including pellet stoves and boilers.

Some of the main innovations introduced by the law are:

- Mandatory integration of RES systems in new buildings or old buildings subject to major renovations (art. 11);
- Simplification of authorization procedures for new heating and RES systems;

Introduction of mandatory "district heating and cooling plans" to be developed by municipalities with more than 50.000 citizens;

- Introduction of a loan guarantee fund for the installation of district heating networks;
- Introduction of incentives for RES heating and energy efficiency in small scale applications (to be further specified and regulated by ministerial decrees);
- Measures for the modernization of the system of energy efficiency certificates (white certificates).

According to estimates of the Italian Association of Wood Energy (AIEL) in 2009 over 22 million tons of biomass in various forms were consumed for energy purposes, with an overall market value of nearly 2,300 million euro. Among the various solid biofuels, firewood still holds the highest market share (83%) and is used in many stoves and fireplaces still present in many households and country homes especially present in rural areas of Italy. As a matter of fact Italy is one of the largest importers of firewood in the world. Around 3-4 million tons of biomass mainly in form of woodchips are consumed by biomass plants (54 operating in 2009) and district heating plants (around 200 mainly distributed in Northern Italy). Wood pellet consumption was estimated between 1,000,000 and 1,200,000 tons in 2009 therefore accounting for around 5% of the total woody biomass consumption and covering a share of more than 10% of the European pellet market.

The demand is almost exclusively generated by the consumer market for space heating in residential buildings. The main driver is therefore represented by the market of pellet stoves and boilers that has been growing steadily since 2003 and accounted for over 1,200,000 units in 2010, most of them being pellet stoves with average installed capacity of 7-10 kWth and a much smaller share being pellet boilers of slightly higher power capacity (14,000-15,000) units. Forecasts for 2011 predict more than 1,400,000 units installed.

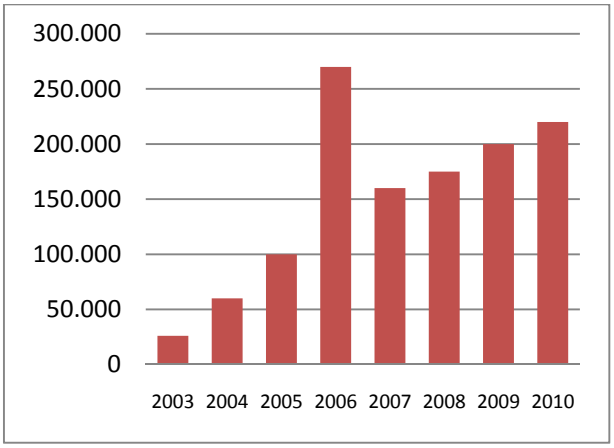


Figure 2.22: Sales of pellet stoves in Italy – source: Politecnico Milan

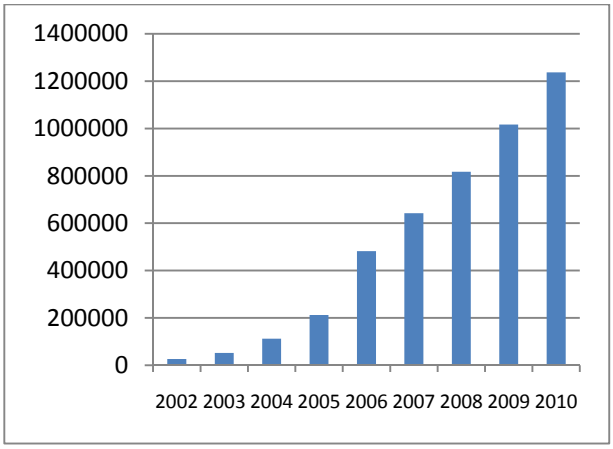


Figure 2.23:Cumulative sales of pellet stoves in Italy – Source: Politecnico Milan

According to a report published in 2011 by the Energy Strategy Group of the Politecnico di Milano, the market of pellet stoves has experienced a steady growth of 10% per year since 2008. Over 220,000 new pellet appliances were installed in 2010 (+ 20% compared to 2009).

There are several drivers behind the expansion of this market such as:

- The economic competitiveness of wood pellet versus other fuels such as LPG and heating oil that are still the main fuels used in several decentralized rural areas not served by the natural gas grid network;
- The availability of tax incentives (55% tax relief as specified in the above paragraph) and grants especially for rural areas;
- The presence of a mature and dynamic sector of stove manufacturers providing a wide range of solutions from entry level to high design products.

The relative cost competitiveness of pellet heating is therefore the main driver behind market expansion. As a matter of fact, despite the increasing trend of pellet prices, the annual costs of a pellet stove are still as competitive as a traditional natural gas boiler.

2.6.2 Production capacity and feedstock

In 2008 and 2009 the cumulative pellet production of Italian manufacturers was estimated around 800,000 tons, increasing since 2007 when it was around 650,000-700,000 tons.

In 2010 between 70 and 80 producers were operating, most of them declaring a small production capacity in the range of 15,000-20,000 tons per year. Over 70% of the production is located in the northern regions, due to the relatively higher abundance of raw material and a more developed wood industry in these areas. Several manufacturers are companies involved in the wood industry as primary activity, (sawmills, furniture manufacturers), that produce large quantities of sawdust and therefore produce pellet as secondary activity.

Raw material used in pellet production are mainly constituted by residues of the wood industry with 65% of sawdust, 19 % of shavings, 5% of rough discards, whereas chips and other residues represent 11%.

In the last 2-3 years several manufacturers experienced difficulties in sourcing feedstock at competitive prices, due to the rising competition of other manufacturing activities such as that of fiberboards and furniture, but also to the increasing competition of a growing number of biomass plants, that in some cases have led to a concentrated demand of feedstock in some local areas.

Despite the steady growth of pellet demand, the sector is currently affected by strong market dynamics that have led some large producers to close their plants in 2009-2010 due to the economic crisis and to strong difficulties in ensuring a competitive supply of feedstock. At the same time some large players entered into the market, i.e. Italiana Pellets, that started its activity in May 2010 and has aproduction capacity of 60,000 tons per year.

As a consequence of such difficulties, during the last 2 years an increasing number of operators shifted their main activity from the production to the distribution of imported pellets.

Company	Location – Region	Capacity (tons/y)
Italiana Pellets	Corana – Lombardia	60.000
Energy Pellets	Treviso – Veneto	100.000
Fiul - Pellet	Captiva – Friuli Venezia Giulia	40.000
IT-Fire	Sassocorvaro - Marche	40.000
Sitta	San Giovanni Natisone – Fiuli Venezia	30.000

	Giulia	
Rossikol	Sambuceto - Abruzzo	30.000
Elle - BI	Cerreto Guidi – Friuli Venezia Giulia	30.000
Pe.Pe	Azzana Decimo – Friuli Venezia Giulia	30.000
Italtrucciolo	Bologna – Emilia Romagna	30.000
Segatifriuli	San michele de Piave di Cimaldolmo - Veneto	25.000
Del Curto	Verderio Inferiore - Lombardia	25.000
Produttori Sementi Verona	Caldiero – Veneto	25.000
Braga	Casalmaggiore - Lombardia	23.000
Biocalor	Romans D'Isonzo – Friuli Venezia Giulia	20.000
Ecologic Fire	PIetrabbondante - Molise	15.000
Priant	Vazzola - Veneto	25.000
Bordignon Giuseppe	Selva del Montello - Veneto	15.000
Geminati	Brescia - Lombardia	15.000
Imola Legno	Imola – Emilia Romagna	15.000
Melinka Italia	Verona - Veneto	15.000
Mallarini	Savona - Liguria	10.000

Tab. 2.8 : Major Italian Pellet Producers. Source: PoliMi and AIEL 2011

2.6.3 Consumption

The demand for wood pellet has increased steadily since 2003, led by the growth of the pellet stoves sector. A sensible increase in the pellet market was observed in 2007, when the volume of pellets distributed reached over 1,000,000 tons, from around 650,000 tons in 2006.

In 2009 the consumption of pellet reached over 1,200,000 tons, and in 2010 it was estimated well above 1,400,000 tons, thus confirming Italy as one of world's biggest and dynamic markets for high quality pellet.

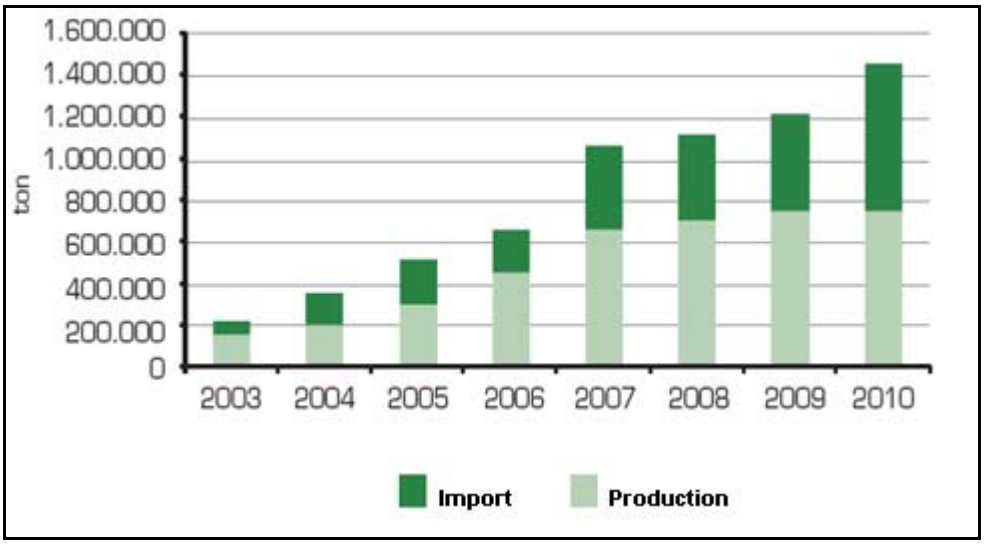


Figure 2.24*: Evolution of the Italian Pellet Market, from 2003 to 2010.Source: Politecnico Milan.*

In Italy the large majority of pellets are used for space heating in the residential sector;it is estimated that 90% is consumed in stoves and the remaining 10% is used in boilers. The potential for growth in the domestic market is still quite high, and lies in the possibility of replacing old and inefficient traditional wood heating systems with modern stoves and boilers. Indeed according to recent estimates there are over 15 million traditional systems (fireplaces, wood ovens, boilers etc.) still operating in Italy with very low efficiencies.

2.6.4 Trade and logistic aspects

The increasing demand in the Italian market cannot be satisfied by domestic production and a large share of the market is currently covered by imports.

The estimated amount of imported pellets in 2010 varies between 680.000 tons (source: Polytechnic of Milan) and 1,054,000 tons (source: Eurostat 2011). This represents a market share between 48% and 72% respectively.

According to Eurostat in 2010 Austria remained the largest exporting country to Italy with nearly 400,000 tons delivered. Other important partners were, Germany (147,000 tons), France (85,000 tons), Romania (76,000 tons), Slovenia (66,000 tons) and Lithuania (52,000 tons).

For the first time in 2010, small volumes of imports were also recorded from overseas countries such as U.S. (3,500 tons) and Canada (12,000 tons). This is an evidence that Italy is being increasingly seen as an export market by countries that had so far looked almost exclusively towards Northern EU markets for industrial pellet.

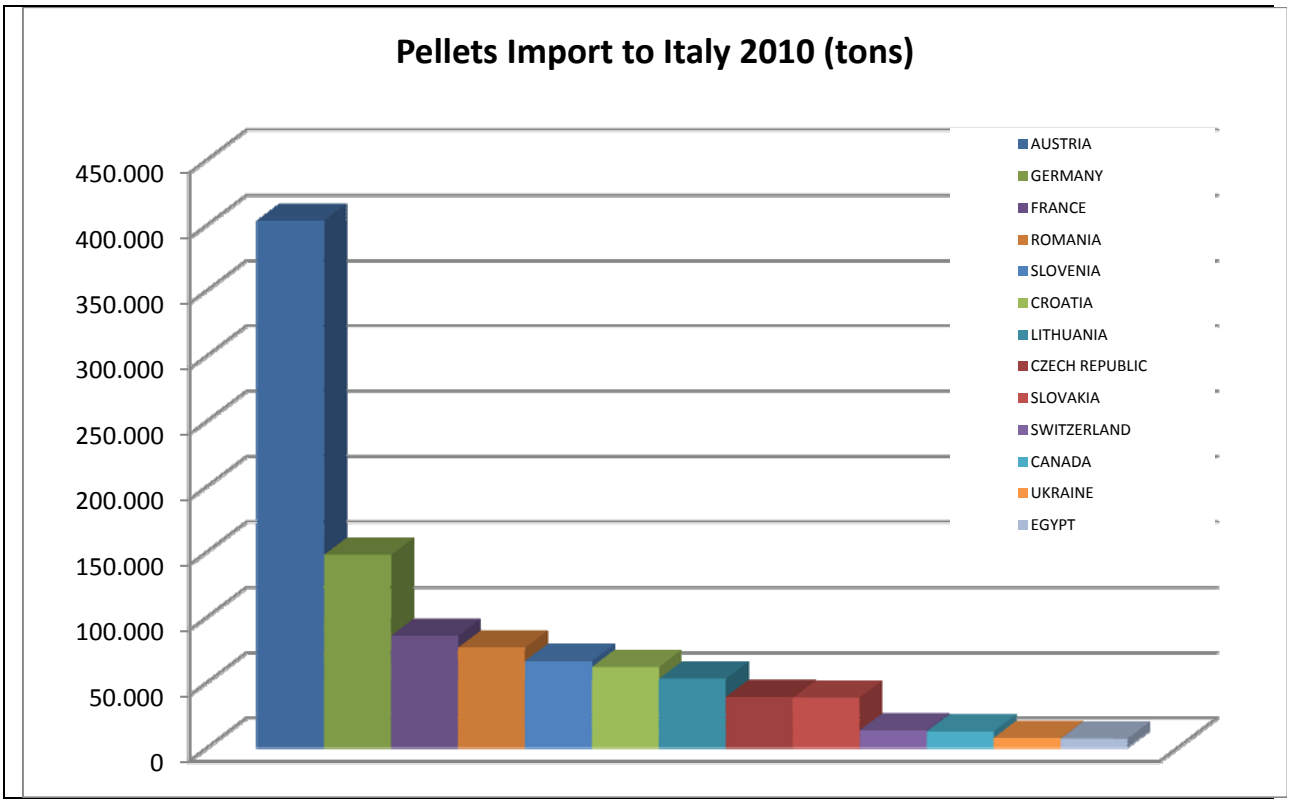


Figure 2.25:Pellets imported to Italy in 2010 source Eurostat

Wood pellets are distributed to final consumers through 3 main channels: direct sale from producers, sale through stove and boiler providers and sale through wholesalers and retailers.

Over 70% of pellets are distributed through wholesalers and retailers.

The large majority of pellets are sold in bags of 15-20 kg.

In some regions of Northern Italy, pellet is also delivered in bulk with tank trucks mainly to owners of biomass boilers.

2.6.5 Pellets quality and standard

Since the only use of wood pellet in Italy is that of space heating in small-scale units, product quality has become an essential parameter of competitiveness in the Italian market. As a consequence of that, standards and certification assume an important role in ensuring and communicating quality to final consumers. As a matter of fact, until 2010 one of the most acknowledged quality assurance systems in Italy is the Pellet Gold label. Active since 2006, Pellet Gold is a third party voluntary system based on **CEN/TS 14961**, **DINplus**, **ÖNORM M** 7135 norms and on the limits introduced by the America Pellet Fuel Institut (PFI).The chemical-physical quality limits required by Pellet Gold are shown in Table 2.9.

Parameter	Measure unit	Limit	Tolerance
Moisture content	% Fresh matter	< 10	-
Ashes	% Dry matter	<=1	+0,05
LHV	MJ/kg	>=16,9	-0,2
Nitrogen (N)	% d.m.	<= 0,3	-
Chlorine (Cl)	% d.m.	<0,03	-
Sulphur (S)	%d.m.	<0,05	-
Lead (Pb)	mg/kg	<10	Maximum total concentration of the 4 metals <= 20 mg/kg f.m.
Mercury (Hg)	mg/kg	<0,05	
Cadmium (Cd)	mg/kg	<0,5	
Chromium (Cr)	mg/kg	<8	
Steric mass	Kg/m3	>600	-
Mechanical durability	%	>97,7	-
Formaldehyde	mg/100g	<01,5	+0,5
Radioactivity	Bq/kg	<6	-
Binding agents	<2%		-

Table 2.9: chemical-physical quality limits required by Pellet Gold***Source: AIEL***

A major help for the standardization of the sector will derive from the introduction and application of the new European norms EN 14961 and the relative certification system EN-Plus, as well as the introduction of the norm EN 15234-1 for the traceability of the supply chain, that will constitute an important tool to guarantee transparency and uniformity of labeling. In July 2011, AIEL (The Italian Association for Wood Energy) has obtained the license for this certification system.

2.6.6 Price trends

Since 2009 the Chamber of Commerce of Milan keeps track and publishes the prices of wood pellets and other solid biofuels. Prices are updated every 4 months and are referred to the wholesale price of 15kg bags of quality pellet. The price trend since January 2009 is shown in fig. 2.26. As can be seen the prices show a seasonal variability, with higher prices in winter season and lower prices in spring-summer. In October 2011 the price of a 15 kg bag was reported at 4.10 € VAT included, corresponding to 273 €/ton.

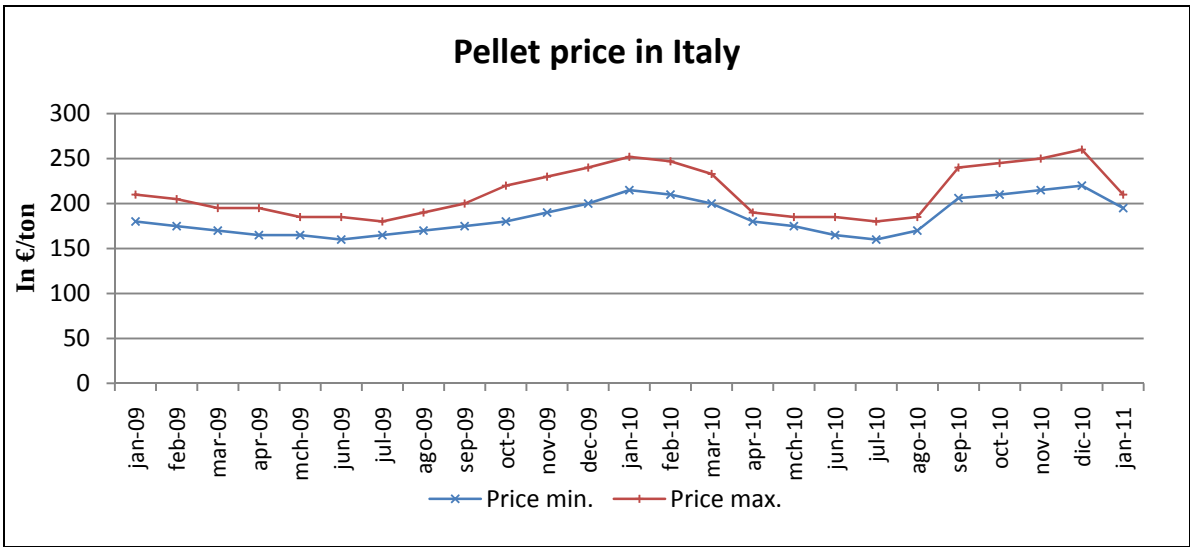


***Figure 2.26: Italian pellet price evolutionSource**: Chamber of Commerce of Milan*

2.7 Belgium

2.7.1 Regulatory framework market drivers and barriers

The Green Certificate Scheme (GEC) in Belgium contributed to stimulating the demand for solid biofuels, including pellets, to generate electricity in (co)combustion, which in Belgium is largely satisfied by pellet imports (1 GEC = 1 MWhe). The guaranteed minimum value of a certificate is based on a 'financial gap' analysis, which identifies the extra cost in production with reference to the use of fossil fuel. The guaranteed value for biomass was 80 €/GEC As of 2010 it is 90 €/GEC. However, starting 2010, co-combustion plants will receive only 50% of the GEC they were given before. For dedicated plants the certificates issued remain at 100%. The support system is not only for pellets in particular but for RE in general, but it creates opportunities for pellets as well.

In the residential heating sector, there is a fiscal reduction of approximately 2,800 € for home-owners who install a pellet boiler in a newly built house.

Enterprises as well benefit of a fiscal reduction (FED); those who invest in renewable energy can in fact deduct 14% of their investment from their taxes.

Moreover, supports for ecological investments (FI Reg) also exist: small and medium enterprises receive an additional 40% of the extra cost in comparison to standard technology, while large enterprises receive 20%. The extra cost is defined as 50% for biomass electricity or combined heat and power and as 80% for biomass heat production.

In 2020, wood pellets are estimated to account for 8-15% of the total green heat production and for around 20-25% of the biomass-related green heat production.

2.7.2 Production capacity and feedstock

Pellet production in Belgium has experienced a large growth since 2005, increasing from a production capacity of 18,000 tons to 500,000 tons in 2009, 470,000 of which from the region of Wallonia and 30,000 from the region of Flanders. The growth in the production capacity from 2008 to 2009 was of 50,000 t/year, below the average for the last 4 years.

The pellet production capacity in December 2009 was estimated at 544,000 tons.While in the region of Flanders there is only 1 pellet plant with a capacity of 20.000 tons, Wallonia has 7 factories, whose output is about 286,000 tons/year(Pieret, 2011). Preliminary data for 2011 indicate a production of 300,000 tons.

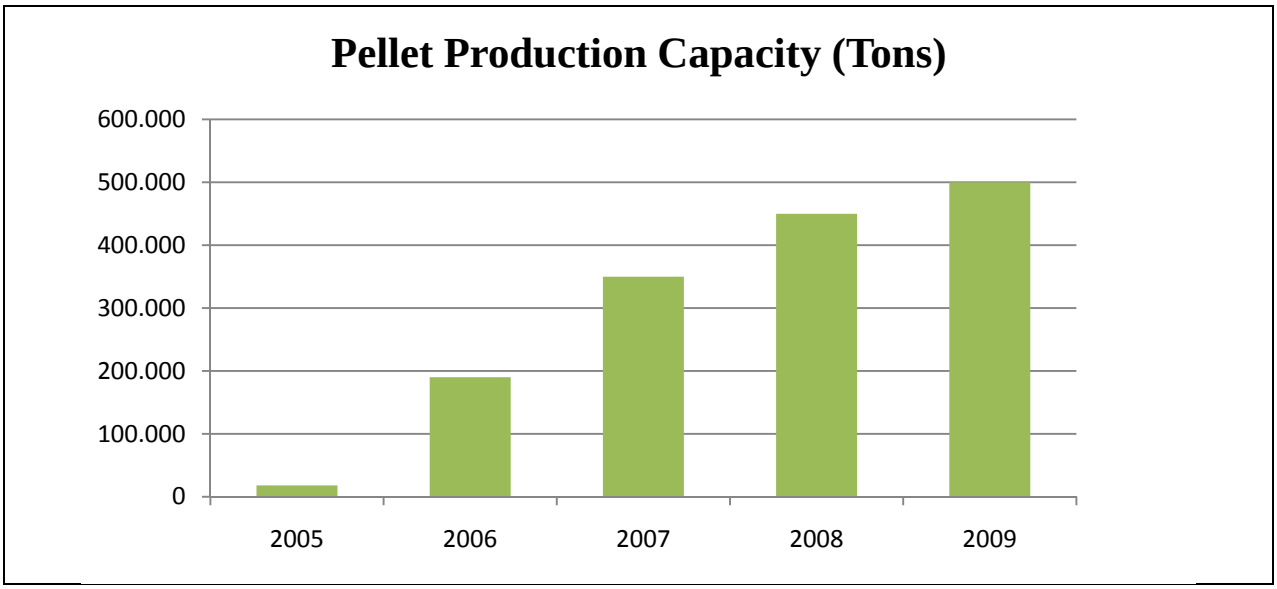


***Figure 2. 27:The evolution of pellet production capacity in Belgium.Source**: ETA – Florence.*

The availability of domestic forest resources in Belgium is limited. The country has one of the smallest percentage of forested areas per inhabitant in Europe. Most of the forests are found in Wallonia (the Ardennes) where 30% of the area is covered with forests while only 12% of the area in Flanders is covered with forests.

2.7.3 Consumption

The consumption of pellet shows regional differences: in Wallonia 79,500 tons were consumed for domestic use in 2010, 4,000 for district heating and 400,000 for co-firing in the Les Awris power plant (Pieret, 2011). This means that in this region the annual consumption amounted to approximately 483,500 tons and that the current Wallon production can satisfy the domestic demand for Wallonia.

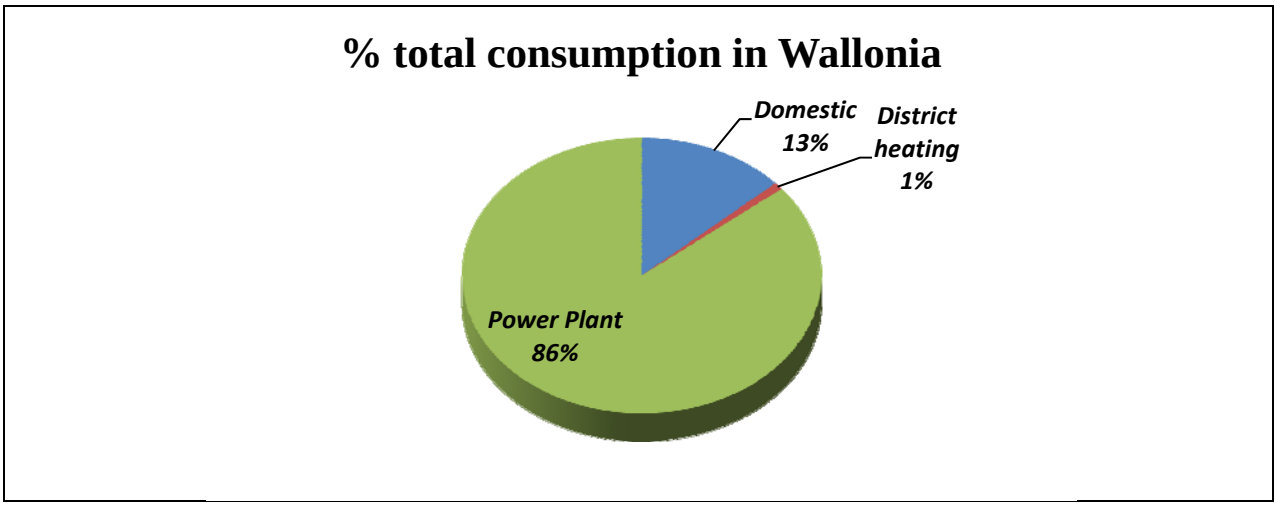


***Figure 2.28:% of total pellet consumption in the region of Wallonia in 2009.Source:** ValBiom association, 2009.*

In the region of Flanders, in 2010 the industrial sector used 50,000 tons, 18,000 tons in the residential sector, and 1,000 tons in the tertiary sector,and generate electricity in a power plant with 400,000 tons. This means that in this region the annual consumption amounted to approximately 470,000 tons.

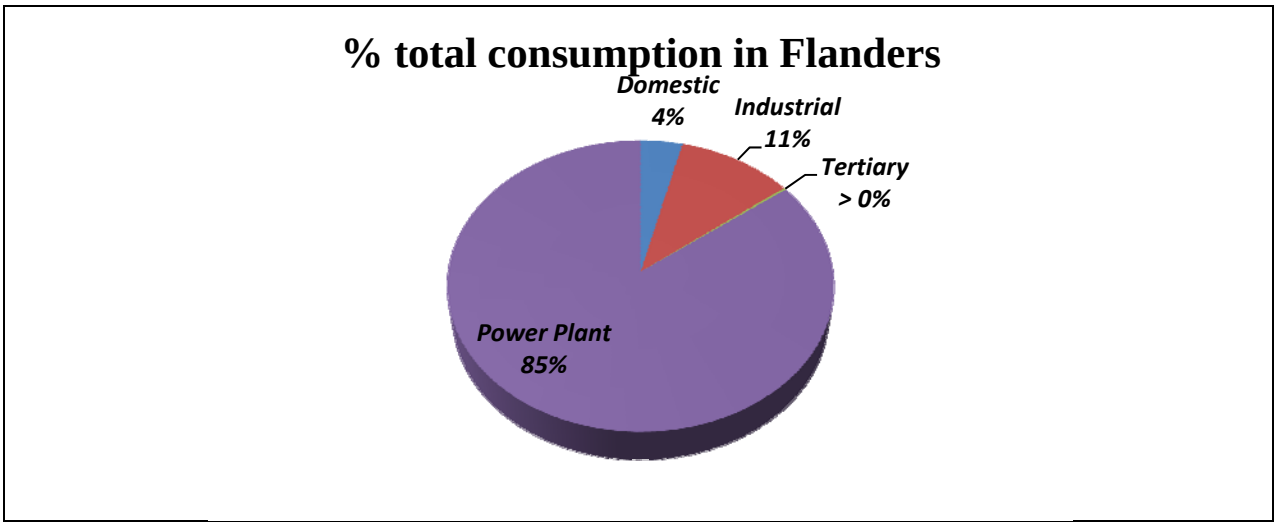


Figure 2.29:% of total pellet consumption in the region of Flanders in 2010.Source: *Ruben Guisson. "The Flemish pellet market situation and its importance in realising the 2020 targets."*

Therefore, the demand for pellet in Belgium in 2010 amounted to approximately 940,000 tons.

2.7.4 Trade and logistic aspects

The domestic pellet production in Belgium is not able to satisfy this huge demand. It is noteworthy that in Flanders about 90% of the pellet used in the region comes from abroad. In Wallonia, more than the half of the pellets used is from outside.Power plants import almost all of pellets needs. They principally come from Canada, U.S. and Germany.

2.7.5 Pellets quality and standard

As European standards EN 14961-1 and EN 14961-2 were adopted at the European level, Belgium has to adapt its national standards. In the case of pellets, a Royal Decree will soon be adopted. On the other hand, the ENplus certification system continues its development. Up to now, pellets produced in Belgium generally fulfill the foreign standards (e.g. German DIN plus). Pellets imported in Belgium also fulfill general quality standards.

2.7.6 Price evolution

Figure 2.30 shows the trend of pellet prices compared do other fossil fuels for heatig in Belgium.

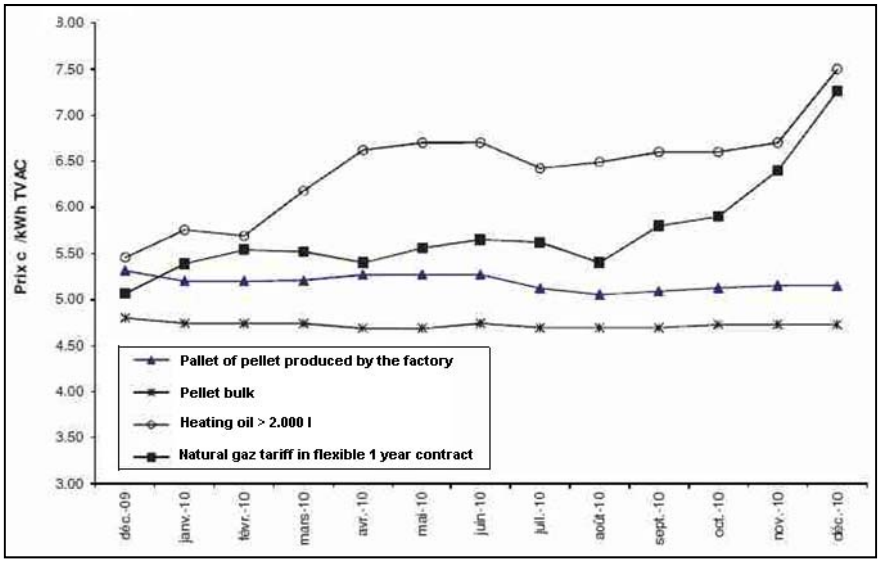


Figure 2.30.Price of pellet and fossil fuels for ehating in Belgium per kWh produced, VAT incuded

2.8 France

2.8.1 Regulatory framework market drivers and barriers

The public strategies implemented in the last years on wood energy focused on improving wood log uses by householders and on the development of heating or cogeneration units burning wood chips. Wood pellet benefited of some tax relief for high efficiency stoves and boilers, however the direct support measures at national level for the promotion of pellet use were relatively few compared to other countries. Locally, some regional support to the wood pellet sector is available but it is not yet part of an integrated national plan.

A survey performed by the Propellet France Association in 2010 on a sample of 1,000 people revealed that the common awareness of French citizens about pellet heating is still relatively low, although it has grown sensibly in the last years. In 2009 only 42.5% of the people interviewed declared to be aware of pellet heating systems, whereas in 2010 this share had increased to 50%.

Pellets are more popular in the East and North regions and more in provinces than in urban areas. 74% of people having a traditional wood heating system declared to be aware of pellet whereas only 47% of those using natural gas or electricity were familiar with pellets.

According to this survey the main limiting factor perceived by over 55% of French consumers for the use of pellet is the high purchase price of boilers and stoves. Despite this, 75% of those declaring to know pellets see this fuel as comfortable, economically competitive and environmentally friendly.

The French pellet market has an important potential both in terms of production and consumption. Its growth is continuous but relatively slow in comparison with some other neighbouring countries. The potential availability of raw material is high, despite the fact than sawmills are small and sawdust resources are dispersed in a large territory. A factor causing a relatively slow development of the French pellet market can be identified in the he prices of other sources of energy like gas and electricity, which are cheaper than in many other European. As the French electricity production is mostly from nuclear origin, its costs did not show any strong variations in these last years and electricity is promoted in France as having very low impact on greenhouse effect.

2.8.2 Production capacity and feedstock

The volume of pellet produced by French manufacturers has grown steadily since 2005 as shown in figure 2.31; in 2010 over 460,000 tons were produced.

Around 40 producers are active in France, with a production capacity between 10,000 and 30,000 tons per year and the majority of them working well below the full load capacity.

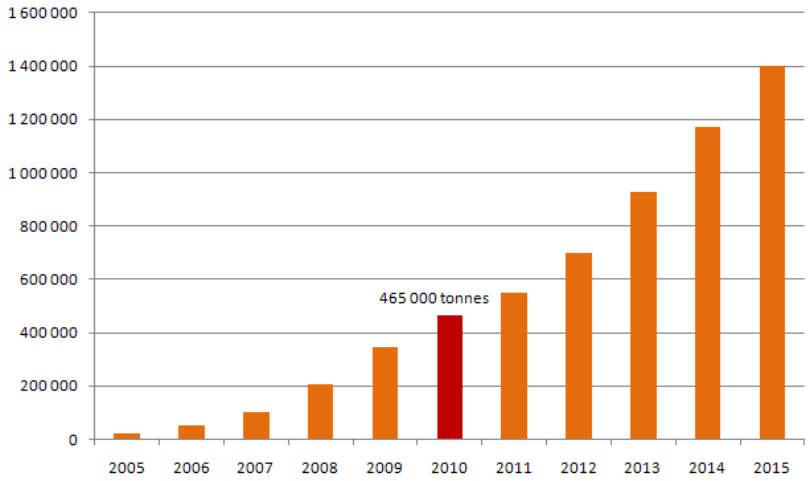


Figure 2.31: Pellet producers and distributors in France in 2010Source: *Propellet France.*

According to "Bioenergy International", in January 2011 the countries production capacity reached 1,040,000 tons.

The production is almost entirely represented by wood pellets for residential heating.

As far as feedstock is concerned as in most other producing countries a shift from sawdust to alternative feedstock is observed: some producers already use up to 70% of different resources such as roundwood or forest residues.

There are around 180 bulk distributors of wood pellets, as shown in figure 2.32

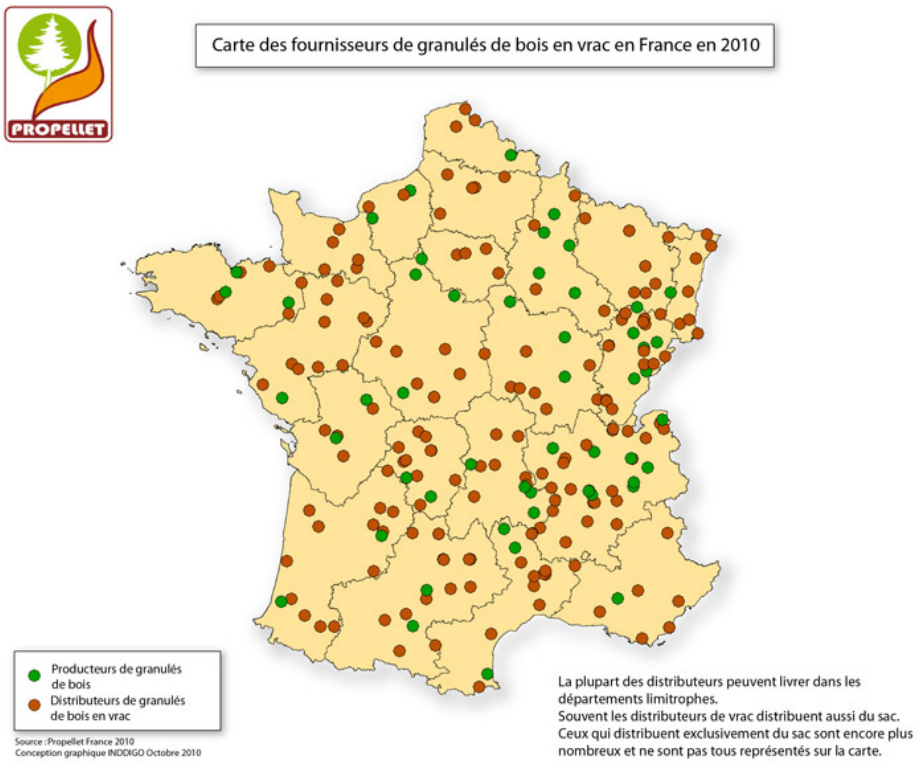


Figure 2.3: Distributors of wood pellets in France. Source Propellets france

The production of industrial pellets could take place in the future, especially in some paper industry factories requiring re-engineering or diversification.

2.8.3 Consumption

In 2009 the consumption of wood pellets was 305,000 tons, whereas in 2010 more than 405,000 tons were consumed (source: Propellets France).

France shows a variety of climate conditions, which in turn offers opportunities for pellets usage both for stove and boilers. The North-East part of France has a continental climate with long and cold winters and a strong tradition in wood energy similar to the one of the neighbouring countries like Germany and Switzerland. The development of pellets consumption was faster in these regions than in others, with a good balance between boilers and stoves sales. In the Southern and Western parts of France where winters are less cold the use of wood for heating is limited, especially in urban and suburban areas. Pellet stoves have more success than boilers as they are mostly used to complement a central oil fuel heating system or an electric heating installation.

The trend in pellet consumption is directly related to the trend in the sale of pellet heating systems.

The market of pellet stoves is experiencing a rapid growth, whereas the sale trend of boilers is more stationary. Around 4,500 boilers are sold each year, representing less than 1% of the market share.

On the other hand, around 25,000 pellet stoves were sold in 2009, representing nearly 5% of the market share. For 2010, Propellet estimated a 20%increase in the sale of pellet stoves.

The French ADEME agency recently performed a study on the perspectives of development of residential biomass heating by 2020. The most likely scenario of this study indicated that in presence of

strong and constant public support measures, a sale of 136,000 pellet stoves and 87,000 biomass boilers (with the majority of them being pellet boilers) per year by 2020 would be achievable.

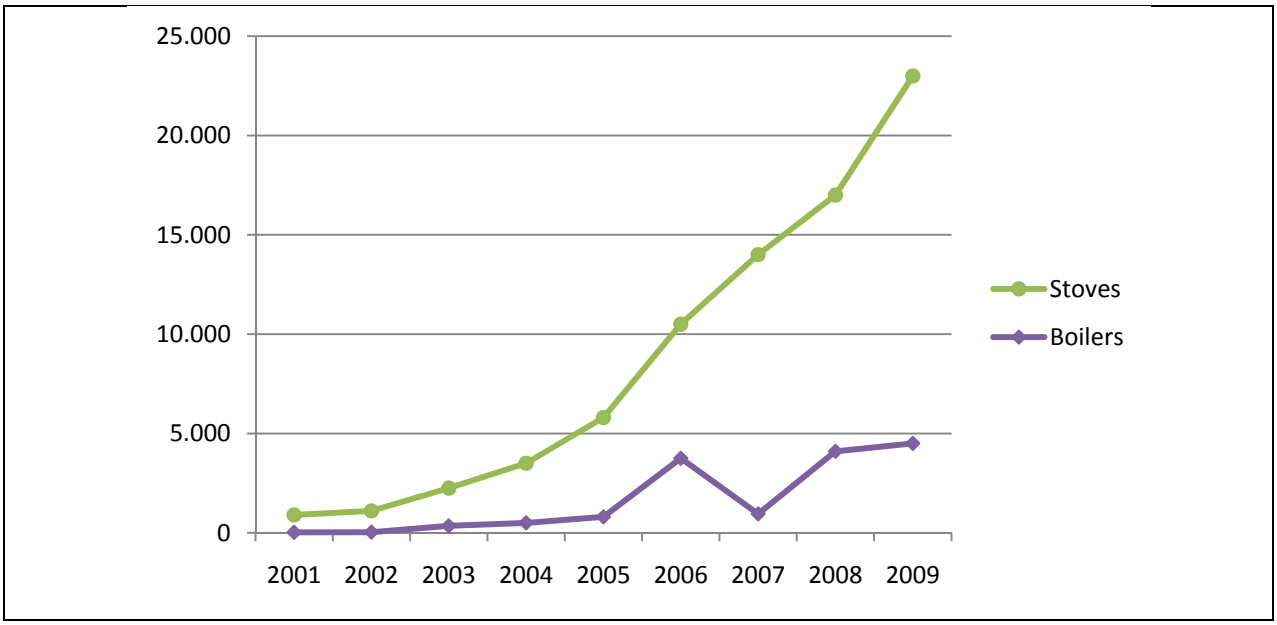


Figure 2.33: *Evolution of Annual sales of pellet heating system.**Source:** Institut des Bioenergies (Itebe).*

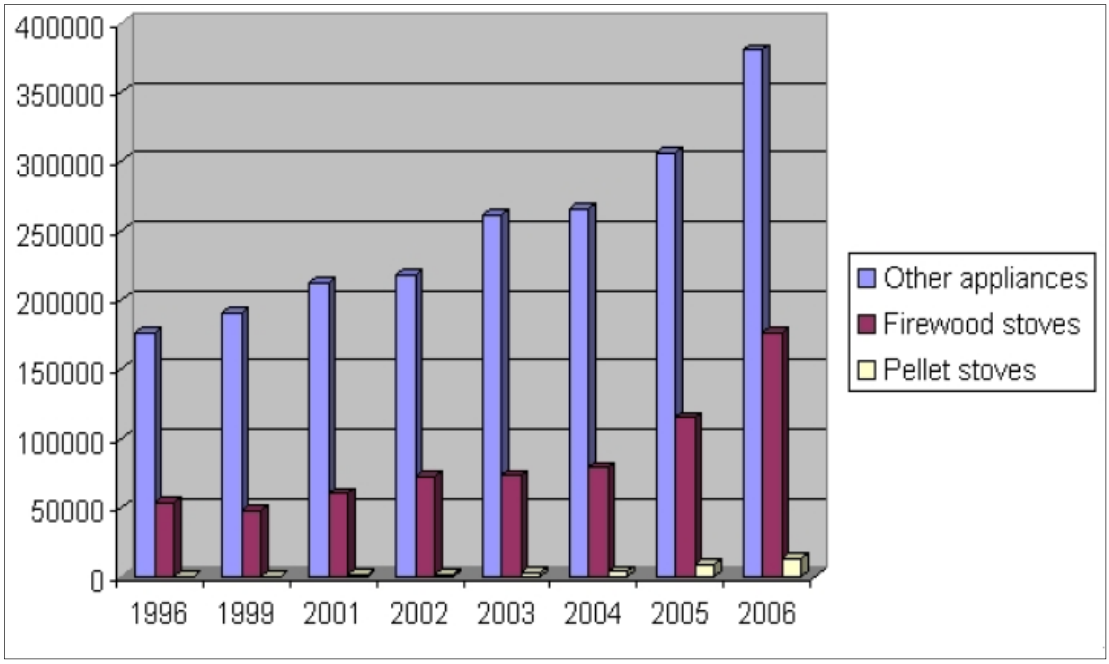


Figure 2.34: *Sales of domestic wood heating appliances in France.**Source:** Institut des Bioenergies (Itebe).*

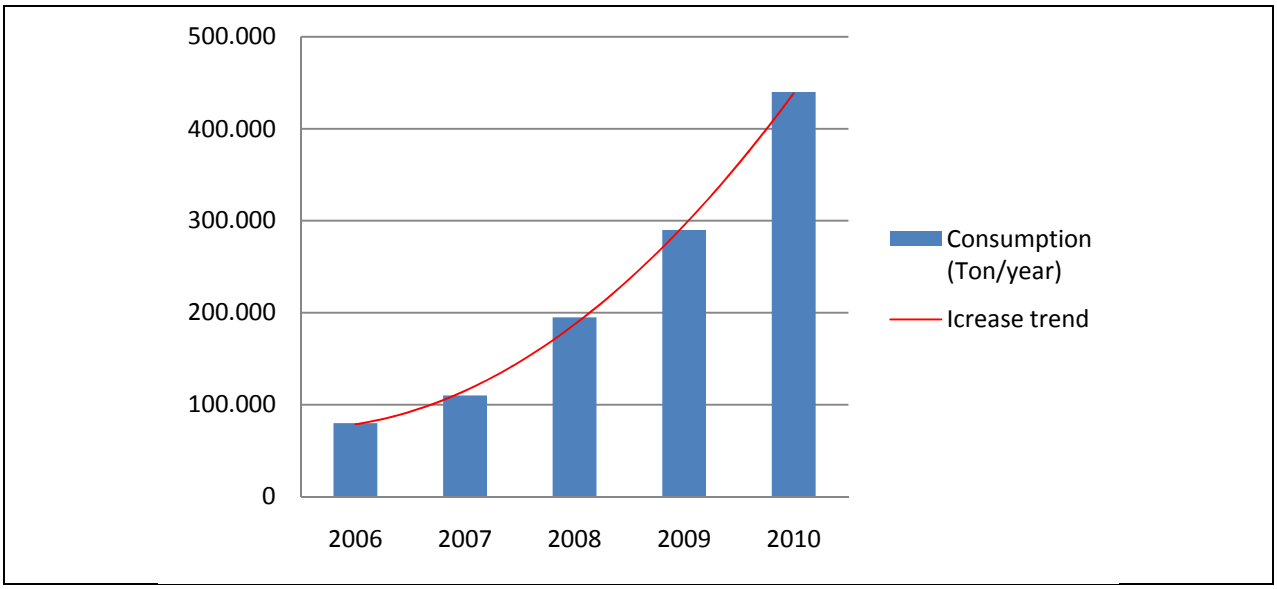


Figure 2.35. *The evolution of pellets consumption in France.**Source**: ETA – Florence.*

2.8.4 Trade and logistic aspects

Back in in 2008 France imported around 20,000 tons of wood pellets (mainly from Germany and Spain) and exported around 35,000 tons to Italy, UK and other countries (Source Pellets@las).

According to Propellets France in 2010 imports were unvaried at 20,000 tons, while exports grew to 80,000 tons mainly to Italy, Belgium, Germany and Switzerland.

2.8.5 Pellets quality and standard

The quality of French production was heterogeneous in the past. In more recent times many producers have acquired a certification of quality according to different standards.

The two main certifications used are NF Granulé Biocombustible QHP (Norme Française), active since 2009 and the German DIN+.

According to the Syndicat National des Producteurs de Granulés de Bois (SNPGB), in 2009 the quality of pellets produced in France was divided as follows:

1. 34% without certification.
2. 32% DIN Plus
3. 35% NF Granulés Biocombustibles QHP.

Since 2011 the procedure for the introduction of the new ENplus certification has been started and should be managed by Propellets France.

2.8.6 Price trends

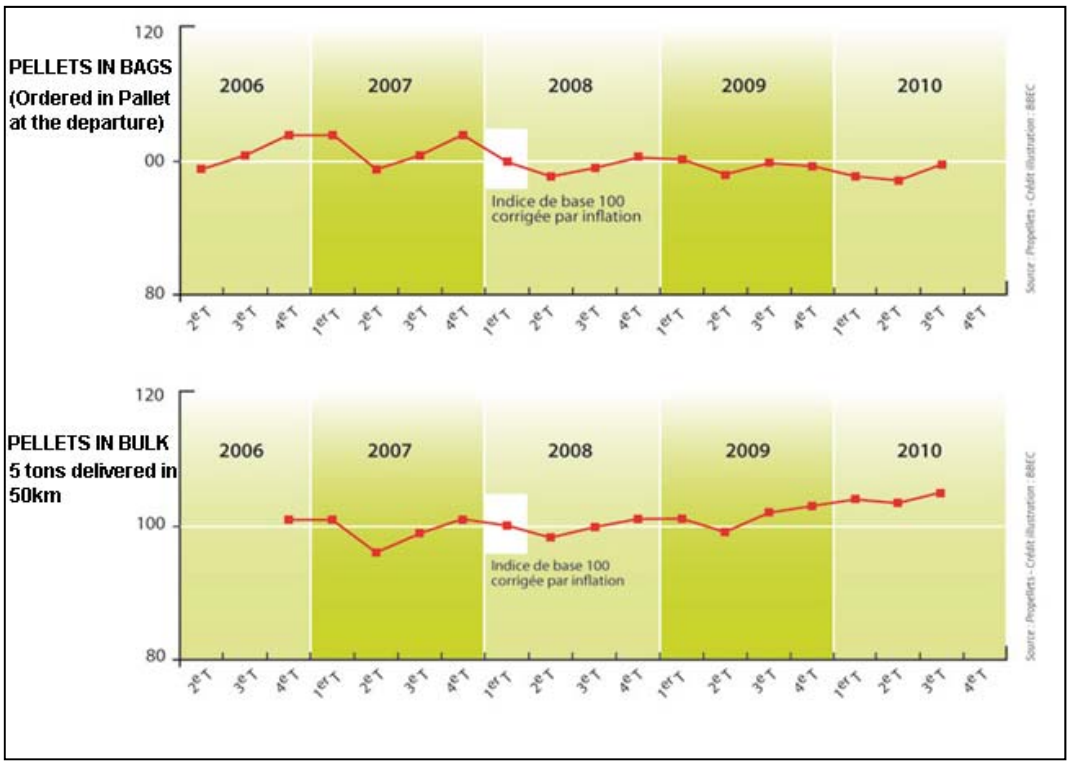


Figure 2.36. The price evolution of French Pellet with inflation-adjusted.Source: *Propellet France.*

2.9 The Netherlands

2.9.1 Regulatory framework market drivers and barriers

The most important driver for the use of solid biomass for electricity production by power utilities was the financial support for electricity generated on biomass, initiated in 2002. The feed-in premium provided by the national government under the so-called MEP-scheme (Milieukwaliteit ElectriciteitsProductie) was 6-7 €ct per kWh electricity produced from woody biomass. After 2006, no new projects were allowed to apply for the feed-in premium. The successors of the MEP subsidy are the SDE and SDE+ support schemes, which exclude large-scale power plants for financial support. The SDE and SDE+ support schemes focus on small-scale electricity production (co-)fired by solid, liquid or gaseous bioenergy. The current schemes under the MEP will continue up until 2012-2014.

In June 2011, the Netherlands government has made clear its intent to eventually mandate cofiring of biomass at all coal-fired power stations, and has indicated it will begin with cofiring obligations on power producers with possible obligations on power suppliers eventually. The cofiring mandate for all coal-fired power plants was announced in the Dutch government's Energy Report. A figure of 10 percent cofiring for producers has been discussed, but the terms and conditions have yet to be agreed upon in consultation with the energy sector (BiomassMagazine, 2011). Most likely, a producer obligation could enter into effect on the short term, whereas from 2015 onwards, a more generic renewable electricity supplier's obligation may enter into effect.

Another driver for the use of (imported) solid biomass was the coal price, which reached over 4.5 €/GJ in mid—2008, but has declined to about 2 €/GJ in 2009. In 2010-2011, coal prices fluctuated between 100-135 €/tonne.In the same period the wood pellet price fluctuated between 6-8 €/GJ. Finally, also the price of CO_2 makes use of biomass more attractive, as the Dutch utilities fall under the emission trading regime, and can use biomass to reduce their GHG emissions. However, at current coal, pellet and CO_2 prices, the use of wood pellets is not economically feasible without the feed-in premium.

Basically no major barriers have existed regarding the trade of wood pellets in the past years. Apart from the long-term financial support for wood pellets in the past 8 years, also the general regulatory framework has supported the use of wood pellets for co-firing. Also the view of NGO's and other societal actors has been neutral or positive towards the use of wood pellets.

2.9.2 Production capacity and feedstock

The Dutch wood pellet production capacity is small, consisting of two plants (Energy Pellets Moerdijk and Plo-Span Bio-energy) with a combined capacity of approximately 130 ktonne/year, with a typical utilisation of 80-90%. This production capacity has been constant for the past few years, and given the limited availability of the main feedstock for wood pellets (sawdust from wood processing industry), no further increase in domestic production capacity is expected. The pellets are manufactured in accordance with 'DIN 51731' quality standards.

2.9.3 Consumption

After Sweden, Germany and Italy, the Netherlands are the fourth-largest wood pellet consumer in Europe, with a steadily increasing consumption that reached about 1250 ktonne in 2009. Almost 100% of all wood pellets are used for co-firing in large-scale coal fired power plants:

- RWE Essent accounts for more than 80 percent of the total co-firing volume in the Netherlands. In the past years, the amount of wood pellets has been steadily increasing, and has reached more than 800,000 tonnes in 2009. Typically, about 20% co-firing is carried out. However, in 2010, RWE Essent for the first time co-fired more than 50 percent of biomass in the Amer-9-

plant. The test demonstrated that co-firing 50 percent of biomass is technically feasible, for short periods of time.

- In April 2010, the co-firing capacity of biomass in the Gelderland plant, plant 13 of Electrabel (GDF Suez) was increased from 44 MW_e to 180 MW_e. As a result, the plant is expected to co-fire 470,000 tons of wood pellets per year. The conversion involved an investment of more than 40 million Euros (AgentschapNL, 2011).
- Substantial amounts of wood pellets are also co-firing in the coal power plants of Borssele (owned by EPZ) and Maasvlakte (owned by E.On).

Overall, it is anticipated that in 2011, the Netherlands may consume well above 1.5 million tonnes of wood pellets.

In contrast, there is basically only a negligible amount of wood pellets used in the residential sector. No official statistics exist, but consumption is probably below 10,000 tonnes per year.

Due to the fact that almost only industrial wood pellets are used in the Netherlands, there is no demand for high-quality wood pellets meeting quality standards as required for the residential sector. While such pellets may be used occasionally (e.g. if supply of industrial pellets is short), typically the utilities focus mainly on a few parameters such as heating value and content of chlorine and other elements that may cause problems in their boilers. However, as coal power plants are used to high ash contents in their fuel, the ash content is of much less importance than for the residential use.

2.9.4 Trade and logistic aspects

Given the large demand and very limited domestic supply, more than 90% of all wood pellets consumed in 2009 were imported. Imported wood pellets for co-firing are mainly imported from Canada and the United States of America. Other, minor wood pellet streams originated in Western Europe (mainly Portugal), the Baltics, North-West Russia, South Africa and Australia (see also figure 2.37). As can be seen in figure 2.38 in the past years, the Netherlands have also (re-)exported wood pellets, but this trend is declining. In total, the net internationally sourced wood pellets amounts to 20.7 PJ, which corresponds roughly to 1.15 Mtonne in 2009. Figure 2.38 shows an overview of estimated wood pellet production, consumption and trade in between 2007 and 2009 in the Netherlands, while figure 2.39 shows the (estimated) growth of the net import (i.e. gross import – exports) of wood pellets from 2003-2009. All numbers should be considered estimates and used with care.

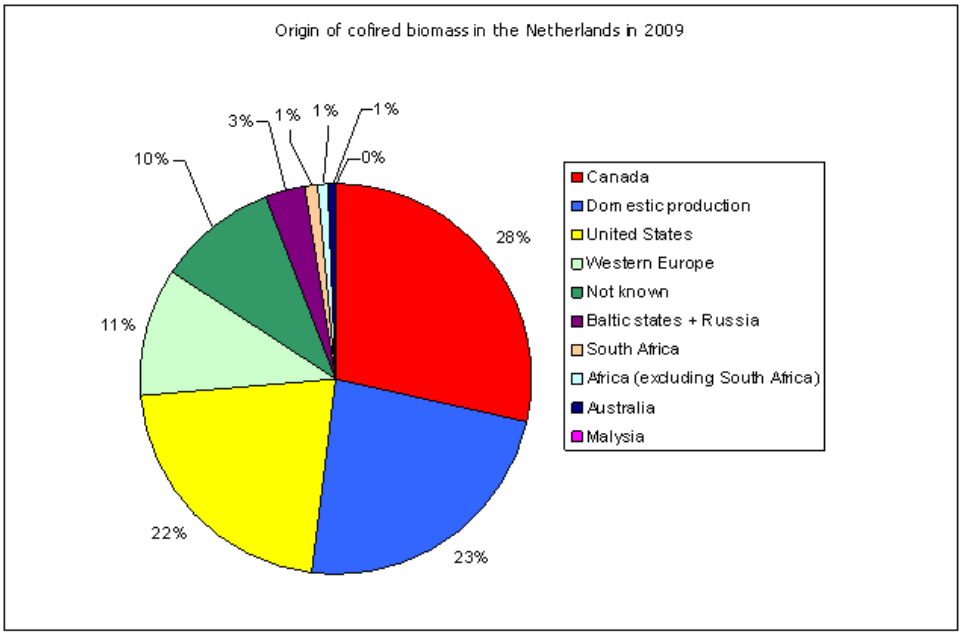


Figure 2.37. Overview of the origin of co-fired solid biomass in the Netherlands in 2009 (Jonker and Junginger 2010). While the domestic biomass consists of various different kinds of solid biomass, more than 95% of the imported solid biomass are wood pellets.

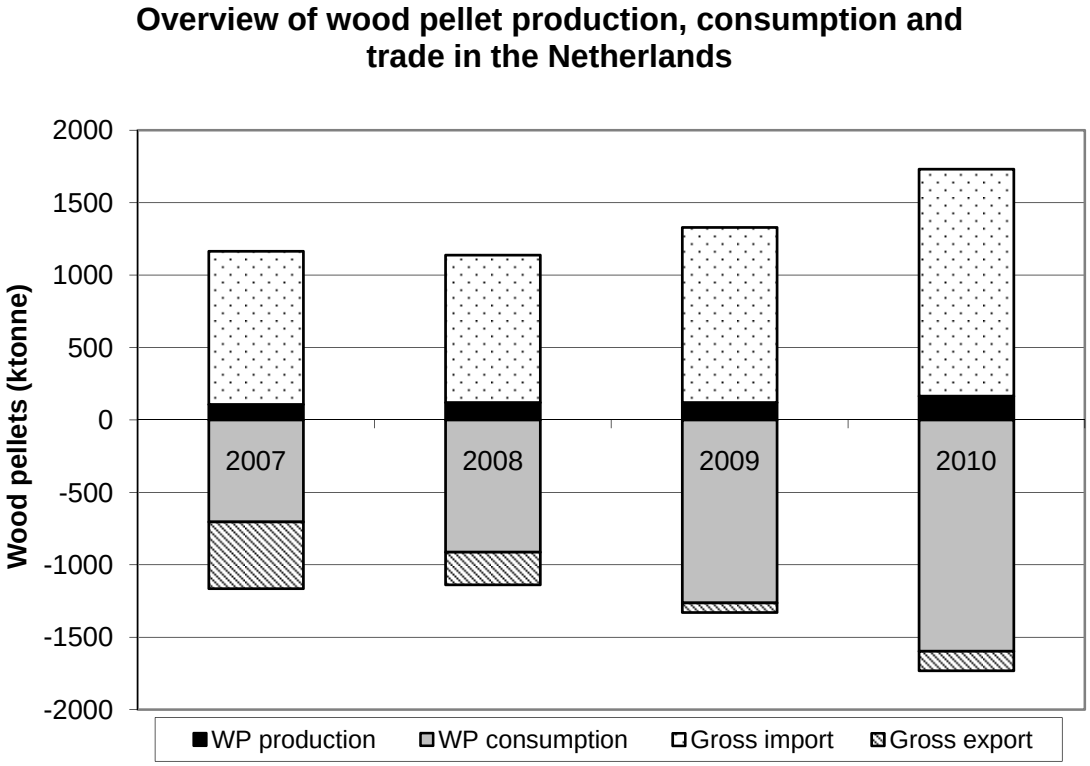


Figure 2.38. Overview of estimated wood pellet production, consumption and gross trade flows between 2007 and 2010 the Netherlands, based on Eurostat trade statistics and own data collection. In some cases, these two data sources did not match. Therefore, all numbers should be considered estimates.

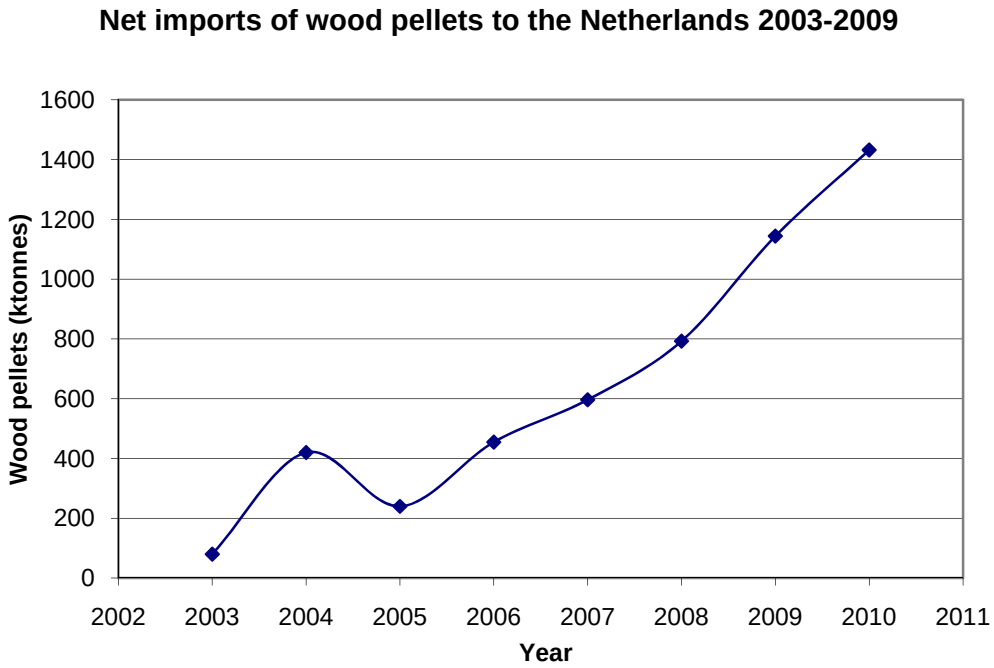


Figure 2.39. Estimated net imports of wood pellets to the Netherlands 2003-2010

Wood pellets are transported almost exclusively by ship both to and in the Netherlands. Handymax-sized vessels typically arrive in either the Rotterdam harbour or other harbours (e.g. Amsterdam and Flushing), and are there transhipped to smaller vessels. The single-largest user is the Geertruidenberg power plant, situated about 50 kilometres from Rotterdam harbour. Barges are used to transport the wood pellets from Rotterdam to Geertruidenberg, where they are unloaded and stored in dedicated silos (see fig. X.5).

Figure 2.40 Dedicated quay at the RWE-Essent owned Amer coal power plant to unload wood pellets. It is situated at Geertruidenberg, roughly 50 km from the Rotterdam harbour. Source: Afval online (2011)

2.9.5 Price trends

The spot pellet prices for Dutch power plants have been fluctuating between 112 € per tonne in July 2008 to above 140 € per tonne at the beginning of 2009 (see figure 2.41). The average price between July 2007 and September 2011 was 125.7 €, with a standard deviation of 7.3 €. Price data should be handled with care, as the large majority of the wood pellets is traded under long-term bilateral contracts at fixed (unknown) prices. Also, the limited number of traders and end-consumers makes it difficult to obtain an accurate price indication.

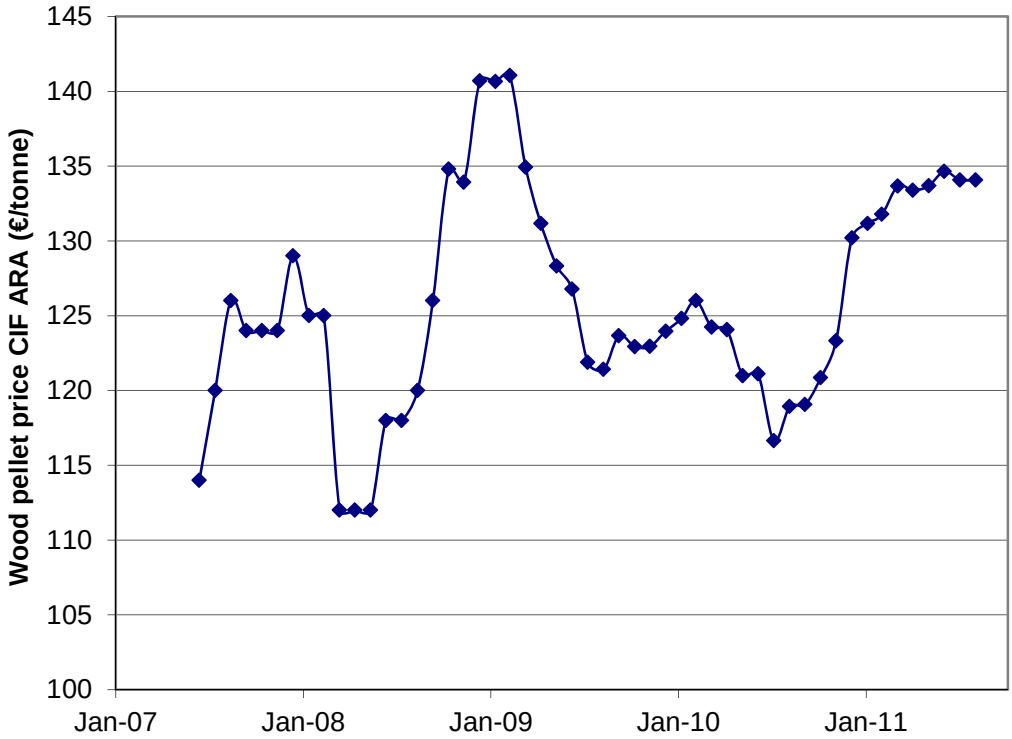


Figure 2.41. Development of the wood pellet price CIF-ARA between July 2007 and September 2011. (**Source: Pellets@las data and APX-Endex**).

In the past few years, the net import of wood pellets have shown a clearly increasing trend, from about 80 thousand tonnes in 2003 (Junginger et al. 2006) to more than 1.4 million tonnes in 2010 (Jonker and Junginger 2010). Continuation of this growth will depend on future policy support. As stated above, the use of (imported) wood pellets for co-firing is depending on financial governmental support. However, the contracts under the MEP-scheme will expire of the period 2012-2014. If no new governmental support system is put into place, it is quite likely that the amount of imported wood pellets for use in the Netherlands will decline strongly. As at the time of writing (April 2011), the Dutch government had (yet) not announced whether and how it will support large-scale co-firing for biomass, the outlook for future wood pellet imports is highly uncertain. However, as the Dutch renewable energy targets are almost impossible to achieve without solid biomass import, it is deemed likely that sooner or later, a new support system will be put in place. Whether this will be again in the form of a feed-in premium or e.g. a quota for renewable electricity production is yet to be seen.

In case the wood pellet demand in the Netherlands will continue to grow, it is likely that the origins of future solid biomass imports will further diversify. In the past decade, wood pellet were mainly

imported from East and West-Canada, and from several European countries. From 2009 onwards, the South East of the United States have started to produce and export large quantities of wood pellets towards North-Western Europe (i.e. Belgium, the Netherlands and the UK). Also, new wood pellet production facilities are being built in Australia, Latin America and South Africa. Thus, it is likely that the trade in wood pellets will further globalize.

Whether imports from these countries will also reach the Netherlands, may also depend on the fact whether their product is sustainably produced or not. The European Commission will take a decision at the end of 2011 whether or not to introduce mandatory sustainability criteria fro solid biomass (similar to the one for liquid biofuels). Also the Dutch government may decide to link any future subsidy scheme to compliant with sustainability criteria, such as the NTA 8080/8081 (see Jonker and Junginger (2010) for more details).

For solid biomass, compliance with sustainability criteria is currently voluntary for producers and consumers and is not related to any subsidy or investment schemes or involved in obtaining legal permits. Therefore, no official statistics exist on how much of the imported biomass was produced sustainably, and how this was guaranteed.

However, the single-largest user of solid biomass RWE Essent (formerly Essent) developed a voluntary certification scheme: the Green Gold Label (GGL). The GGL is nowadays registered and owned by the independent Green Gold Label Foundation. According to the GGL criteria, the solid biomass consumed by Essent/RWE, approximately 70-73%, was certified as sustainable in 2009, and an estimated 85% in 2010 (Schouwenberg, 2011). As biggest Dutch end-consumer, this provides an indication on the overall status of the sustainability of solid biomass imports.

2.10 Norway

2.10.1 Regulatory framework market drivers and barriers

In Norway there is a relatively small market for wood pellets compared to the vast wood resources and the number of inhabitants. Norway has based the electricity production on hydro power and the oil and gas production as about ten-fold the domestic energy consumption. In 2009 electricity (96% hydro) made up 51% of the net domestic energy consumption, fossil fuels 42% and biomass 7% (Statistics Norway 2011). Residential heating mainly is based on electricity in combination with wood stoves. The pellets consumption of around 40,000 tons annually, is used in pellets stoves and in central heating. The main barriers for pellets consumption in Norway is no co-firing due to no coal plants, relatively high share of wood stoves that are used in combinations with electric heating and/or heat pumpsin residential heating and preferences for wood chips in a relatively small market for district heating.

The climate change targets in Norway are to reduce the annual greenhouse gas emissions by 15–17 million tons of CO_2-equivalents by 2020, including the carbon taken up in forests. In order to reach the bioenergy target, Norway wants to increase the use of biomass for heating and the government has proposed an increase of 14 TWh (50 PJ) in the use of bioenergy by 2020, which is a doubling of the current consumption. Implementation of the EU directive regarding the use of energy from renewable resources (RED) will force Norway to increase its renewable share from 62% to 67.5% by 2020(EU, 2009). A joint green certificate market with Sweden is planned to increase the renewable electricity production with in Norway by about 10% towards 2020. Wind power and small-scale hydro power will be the most important technologies for increased electricity production. Other strategies for fulfillment of the RED will be increased energy efficiency, district heating based on biomass and increased use of biofuels in transport. A concern is that increased power production caused by green certificates will give lower electricity prices and reduced incentives for reduced energy consumption and transfer from oil to renewable including wood pellets.

2.10.2 Production capacity and feedstock

There are currently 9 producers of pellets in Norway, ranging from small plants based on dry feestock such as the large plant Biowood Norway at Averøy at the west coast with an annual capacity of 450,000 tons. The production of wood pellets has increased from 39,000 tons in 2004 to 54,000 tons in 2010. There is both import and export (Table 2.10). The production at Averøya will influence the figures from 2011 onwards but is mainly targeted on export.

The feedstock for this new plant will be mainly imported from foreign countries including Canada. So far there isalmost no logistics to supply such large amount of domestic wood in Norway.

Year	Production (tons)	Export (tons)	Import (tons)	Sold in Norway (tons)
2004	33567	5566	672	22055
2005	42339	17980	2392	19497
2006	51340	29003	0	30184
2007	44827	15672	0	31868
2008	35115	7800	9080	39791
2009	46424	5796	4849	42943
2010	45100	755	14014	58505

Table 2.10: Production, import and export for wood pellets in Norway in tons. Source: NOBIO. Markedsrapport 2010. Available on www.nobio.no

The production of briquettes was 31.255 tons in Norway in 2010 and the domestic consumption 48,071 tons.

2.10.3 Trade and logistic aspects

As for most small and medium scale European pellets producers, the pellets production in Norway is mainly targeted on domestic consumers. Most trade exchanges occur cross border with Sweden. The new mill at Averøya will increase the export from Norway significantly. The annual wood use in this large plant will be about 1.2 mill m^3 – imported from Canada, Western Africa and the Baltic countries. Their major market will be European electricity generators and industrial companies (Source: Kristian Rørstad and Birger Solberg "WP2 - Biomass fuel trade in Europe. Country report: Norway").

According to Statistics Norway (www.ssb.no), the stationary consumption of petroleum products in household and service sector was 16TWh/57 PJ and represents the main potential for biomass energy including wood pellets. A recent study (Trømborg et al 2011) predicts an increase in the biomass use in central and district heating of 3-5 TWh (11-18 PJ) depending on energy price developments towards 2020. Wood chips seem to be preferred in district heating due to lower fuel costs and business opportunities for local forestry. Wood pellets will take a share in central heating, but the market share will depend on electricity prices, technical development iof larger heat pumps and the price of wood pellets. Increase demand for cooling will also favour heat pumps.

The use of wood pellets in pellet stoves and small-scale boilers for single houses has stagnated in Norway. Even if hydronic heating distribution is common in new houses, the systems are rarely designed for biomass heating. Direct electric heating or air-to-air heat pumps in combination with wood stoves on colder days is the most common system in detached housed. The Norwegian Association for heat pumps in Norway, reports that more than 600 000 heat pumps are installed in Norway (www.novap.no). Air to air heat pumps are most common, but heat pumps linked to water based heat distribution is becoming more common.

Lower electricity prices, caused by increased production of renewable electricity will imply stronger competition for biomass heating. Increased transmission capacity between Norway and the European continent will also influence the price level and seasonal structure for electricity prices in Norway. Lower price during the heating season when the demand is high and higher from spring to fall when demand is low and production of hydro power is a possible scenario.

Statistics Norway started to report on trade of wood pellets for energy production from 2009. Table 2.11 shows traded volumes for 2009 and 2010.

	2009			**2010**		
	Others	**Sweden**	**Denmark**	**Others**	**Sweden**	**Denmark**
Import	446	2 194	1	1 367	16 027	16
Export	0	593	2829	63	2 291	1236

Table 2.11. Export and import of wood pellets in tonnes. Source: www.ssb.no/

2.10.4 Pellets quality and standard

In Norway quality standards are as follows: (*source: Pellets@las*)

Cylindrical pellets of pure wood -Classification and requirements

- NS 3166 Edition 1, 1999, Biofuel - Determination of mechanical strength of pellets.
- NS 3165 Edition 1, 1999, Biofuel -

The standards match the Swedish pellet standards. Table 2.12 shows the criteria.

Property	Test method	Unit	Group 1	Group 2	Group 3
Length	Measure 10 pellets	mm	Max 4xØ	Max 5xØ	Max 5xØ
Bulk density	SS 187178	Kg/m^3	>600	>500	>500
Durability	NS 3166	fines	0,8% < 3 mm	1,5%< 3 mm	1,5%< 3 mm
Lower H_u	ISO 1928	MJ/kg	>16,9	>16,9	>15,1
Ash	SS 187171	% w/w of DM	< 0,7	< 1,5	<1,5
Moisture	SS 187170	% w/w	< 10	< 10	< 12
Sulphur	SS 187177	% w/w of DM	< 0,08	< 0,08	To be stated
Chlorides	SS 187185	% w/w of DM	< 0,03	<0,03	To be stated
Ash melting	ISO 540	°C	Initial temp.	Initial temp.	Initial temp.

Table 2.12: Important figures from NS 3165: Classification and requirements

2.10.5 Price trends

Table 2.13 show the producers pellets prices in Norway, at producer factory, as reported by to the Norwegian Bioenergy association (www.nobio.no)

	2004	2005	2006	2007	2008	2009	2010
Exchange rate	8,37	8,01	8,05	8,02	8,22	8,73	8,01
Small bags	182,8	189,4	213,8	232,9	239,4	232,1	298,2
Large bags	156	163,2	181,6	192,3	203,1	195,8	241,7
Bulk	136,7	140,1	163,3	14,2	184,7	171	203,5

Table 2.13 Pellets prices in Norway – producer prices delivered mill gate. All prices in Euro/tons excl. VAT at pellet factory

The volumes and prices for international trade in 2009 and 2010 are shown in Table 2.14.

	2009		2010	
	Volume	**Price**	**Volume**	**Price**
Import	2 641	190	17 410	191
Export	3 421	197	3 590	191

Table 2.14. Export and import of wood pellets in tonnes. Source: www.ssb.no/

No central pricing information is available for consumers, but the consumer prices seems to be about 20% higher than the producers prices reported above.

2.11 Russian Federation

2.11.1 Regulatory framework market drivers and barriers

Russia is one of the largest producers and exporter energy in the world. According to IEA Statistics in the year 2008, total energy production reached approximately 52.4 EJ(total primary energy supply in 2008 was around 28.7 EJ) [1]. According to different sources, renewable energy represents around 1% of the totally produced energy. Undeveloped infrastructure, low-density of population and relatively low prices for fossil sources of energy (gas, oil and coal) are reasons for low utilization of renewable energy.

In Russia, the use of renewable energy sources (excluding large hydropower, > 25 MW_e) is negligible. Annually, with the use of renewable energy sources Russia produces no more than 8.5 TWh of electrical energy (excluding hydropower stations with installed capacity of over 25 MW). The installed electricity production capacity from renewable energy sources is less than 2,200 MW (excluding large hydropower stations) [2].

Biomass/biogas (61.8 % of total electricity production) around 5.2 TWh and small hydro power (33.3 % of total electricity production) around 2.8 TWh are the most important renewable sources of electricity in Russia. Almost the same situation is with heat power generation; only 3% (≈0.25 EJ in 2008) of common heat is generated with renewable energy and bioenergy sources usage. It is worth noting that the major part of the heat power produced with renewable energy sources is manufactured at private (decentralized) boiler stations. By the end of 2008, the municipal (centralized) boiler-stations produced 0.02 EJ of heat power with renewable energy using [3]. This figure illustrates distribution of heat energy generation by different renewable sources.

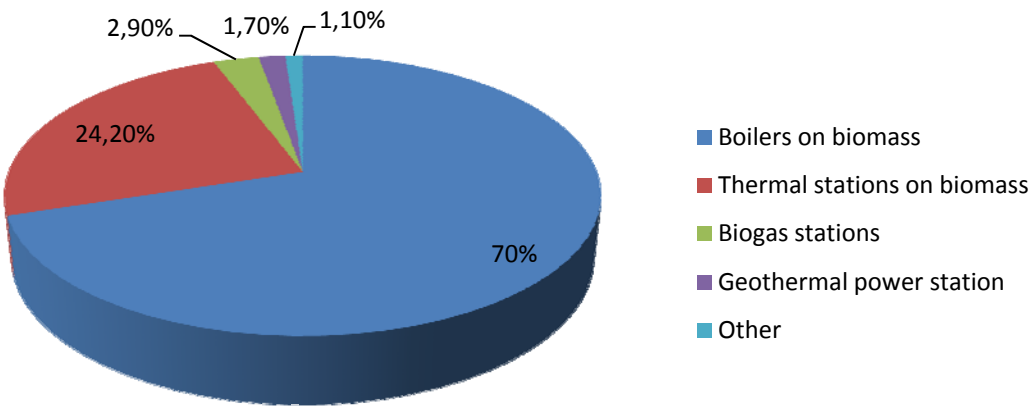


Figure 2.42*Distribution of heat energy generation by different renewable sources (Research Techart)*

Based on data Research Techart, 2010 [3]

Generally, utilization of renewable energy in Russia is still in the initial phase.

Referring to a number of studies, most perspective directions for Russian renewable energy development would be wood based bioenergy pellets, small hydro stations and wind power. Also the tidal power development is very promising.

The government resolution established a goal to increase the share of renewable sources for electricity energy production in Russia (exclude large hydropower > 25 MW) to 1.5 percent in 2010 2.5 percent in 2015 and to 4.5 percent in 2020, which represents approximately 0.3 EJ(80 billion kWh). Production of thermal energy generated from renewable sources will increase from current ≈0.25 EJ to ≈0.5 EJ in 2020. Electricity production generated at hydro power stations with capacity over 25 MWth will go up from ≈0.6 EJ (168 billion kWh) in 2010 to ≈1.02 EJ (284 billion kWh) in 2020 [4].

Wood pellet production in Russia is on the increase. Recently several pellet mill projects have been launched. The largest on-going project is the "Vyborg Cellulose" (Leningrad oblast). The plant will be launched in several stages. The full capacity will be reached in 1-1.5 years. The plant will use 2.5-3 million cubic meters of timber annually. The company has already received a number of leased forest lands in the Northwest Federal District. Also the possibility of using timber from the flooded woods due to creating hydropower reservations is considered [5]. Furthermore, the enterprise is building its own terminal for pellet shipment. According to the project, the terminal will allow loading simultaneously two vessels with the volume from 3,000 tons to 8,000 tons each; the length of the quay wall will be over 300 m. The terminal will be able to transport the plant's own export (1 million tons per year). The production will start in the first quarter of 2011 [6]. Nowadays, Russian pellet producers reconsidered the approach to the capacity of new pellet plants. While previously main focus in pellet plants organization was on small-capacity mills, today most installed plants have capacity around 50,000 tons per year. Around 50 new plants are expected to be established in few years time.

Recently the new project was announced. It involves the group of companies "Region- Russian Wood Pellets". According to this project, it is planned to build a network of plants in 13 regions in Central and North-West part of Russia with total capacity about 3 million tonnes of pellets per year.

At the first phase, several plants will start in Pskov oblast (the first stage 70,000 tons per year), Novgorod oblast (the first stage 125,000 tons per year), Tver oblast (125,000 tons per year), Kirov oblast (the first phase - 125,000 tons per year), and Nizhny Novgorod oblast (100,000 tons per year). Feasibility studies for construction and business plans are completed; constriction sites are chosen [7].

Main drivers for pellet production development in Russia are huge amount of cheap rawmaterial and consequently comparative low production prime cost. In the same way accrescent demand for wood pellets in European Union is promoting pellet production increase. In addition, pellet production, especially in North-West region, allows delivering big amount of product to consumers with low transport cost, because of geographical closest of this region to EU.

2.11.2 Production capacity and feedstock

The first wood pellet manufacturer in Russia, LCC Biofuel was founded in the year 2001 and is located in the Leningrad region. It was a very small enterprise –in fact, it was an experimental workshop, which didnot run up to a high level of development.

However, this enterprise gave a start to wood pellet industry in Russia. In 2003, five pellet manufactures were operating in Russia. They were equipped with second-hand equipment and their total production was near 8 thousand tons a year [8]. In 2006, there were about 50 pellets manufactures, which didnot have good and high-quality equipment.

Currently there are about 150 wood pellet mills, with a total installed annual production capacity of about 1.9 million tonnes. Unfortunately, many of them are off-line or produce a negligible quantity of pellets, which does not affect statistics. Trade sources report that construction of additional 50 wood pellet facilities is likely to occur in the near future [4]. In 2009 year nine leading manufactures produced 75% of overall production.

Presently main producers and exporters of wood pellets in Russia are the two plants: DOK Yenisei (Krasnoyarsk Kray) and Lesozavod 25 (Arkhangelsk oblast). They are closely followed by the plant "Taleon Terra"(Tver oblast), "Biogran" (Karelia), "Green Power" (Leningrad oblast), "Setles" (Karelia), "Meidger" (Vologda oblast), and "Mir granul"(Leningrad oblast). Also on the list of major exporters there was "Vologdabioexport "(Vologda oblast) which was reported on preservation at the end of 2010[9]. Considering the fact that Russian manufacturers are working for export and Europe's need for pellets is growing, one can assume that production of pellets will increase. Presently, not all pellet plants in Russia are in full operation. In the table below (table 2.15) the description of installed capacity of major Russian pellet plants in 2009 is presented. The description of major pellet plants is presented in table 2.15.

Name	Installed capacity (ton/year)	Real capacity (ton/year)	Location	Web-site
Biogran	40 000	35 000	Republic of Karelia	http://biogranpellets.ru/ (English)
Green Power	30 000	30 000	Leningrad oblast	N/A
Vologdabioexport	50 000*	20 000	Vologda oblast	http://www.vologdabioexport.ru/ (English)
DOK "Yenisei"	130 000	120 000	Krasnoyarsk Kray	http://www.dok-enisey.ru/en/index.html (English)
Lesozavod 25	130 000	120 000	Archangelsk oblast	http://en.sawmill25.ru/
Meydzer	24 000	24 000	Vologda oblast	
TaleonTerra	80 000	60 000	Tver oblast	http://www.ultralam.com/uk/
Setles(Stora Enso)	25 000	25 000	Republic of Karelia	www.storaenso.com
Bioenergetichskaya	50 000	8 000	Vologda oblast	N/A
Ug Rusi	130 000	120 000	Rostov-na-Don	
Yantamoye	70 000	30 000	Saratov Region	
AlTBiot	60 000	1 000	Krasnodar	http://www.altbiot.com/eng/
Severo-Zapadniy holding	50 000	4 000	Leningrad oblast	N/A
Setnovo (Stora Enso)	25 000	21 300	Novgorod oblast	http://www.storaenso.com
EFKO	80 000	40 000	Belgorod Region	
Novoenseisky LPH	40 000	8 000	Krasnoyarsk Kray	http://www.novo-lhk.ru/ (Russian)
Ekoles	30 000	20 000	Tver oblast	N/A

Mir Granul	30 000	30 000	Leningrad Oblast	N/A
Bange SNG	70 000	60 000	Moskow and Belgorod Region	
Biotech	60 000	20 000	Leningrad oblast	
In total	900 000	795 000		

Table 2.15 Major Russian pellet producers in 2010

froze their production in late 2010* ***Source**: Rakitova, 2010 [10]*

As it is mentioned above, the majority part of pellet mills is located in North-West Federal District. According to statistics, this region is a leader in pellet production. Based on official production numbers, Archangelsk oblast is the leader in North-West Federal District; it is followed by one of the largest pellet plants in Russia, "Lesozavod 25" in Leningrad oblast.

In a little while in Leningrad oblast the biggest plant in the world "Vyborg Cellulose" will be launched which establishes North-West District leadership in pellet production. Next to North-West Federal District's comes Siberian Federal District. The largest mills here are "DOK Yenisei" and recently started operation "Novoeniseysky LPH".

Russia is the wood-richest country in the world. Russian forest area is around 800 million hectares. It constitutes around 20% of all world forest resources [11]. The majority of forest industry in the country is located in European part of Russia, where most of the timber has been already cut. The main timber resources are located beyond the Urals, where timber-processing industries are very weakly developed, except for some regions. [12] The utilization rate of Russian forests is low. Forestry enterprises use less than one quarterof harvesting potential of timber cutting funds; according to various sources the implementation level of the economic potential in the industry ranges from 7 to 10% [13]. One of the main problems is the lack of wood-transporting roads.
It is proved that logging becomes unprofitable if the haul distance on wood-transport roads is more than 50 km. Low density of railroads and public roads in Russia makes millions of cubic meters of timber inaccessible [14]. Today there is only 1.2 km of forestry roads per 1,000 ha forest land.

The potential for biofuel rawmaterial from waste timber in Russia is very high. According to the Federal Forestry Agency, annual forest waste in Russia composes at least 100 millon cubic meters (loose) [15]. From this raw material potential it is possible to produce around 20 million tonnes of pellets (at the rate 5 cubic meters for 1 ton of pellets). Sawdust cost depends from some factors like moisture content, species of wood and region. Approximate cost is 3.75-7.5 euro (150-300 RUR) per one cubic meter. So, to produce tone of pellets it is necessary to use 5-7 cubic meters of sawdust. Consequently, raw material expenses will be around 22.5-45 euro per ton of pellets.

The Northwest contains 60% of forests in the European part of the Russian Federation; 17% of all Russian timber is concentrated in this region. Approximately half of the pellet mills are located in the Northwest region.

The undeniable advantages of placing pellet manufacture in the Northwest are:
presence of rich wood resources
closeness to the main European commodity markets and seaports

Wood resources of the Russian Federation are presented in the three basic categories:
Coniferous (pine, cedar, spruce, fir, larch) (71%)

Soft-wooded broadcasting(birch, aspen, linden, poplar) (17%)
Hard-wooded broadcasting(birch stone, oak, beech, ash-tree) (2%).

2.11.3 Trade and logistic aspects

The wood pellet production in 2009 was around 900 thousand tones. The major part of Russian pellets is exported to EU countries. Export data are different in various sources. According to Eurostat, in 2009 Russia exported 380,000 tons of pellets and 310,000 tonnes of briquettes to EU countries. According to other research agencies and experts, export in 2009 was approximately 500,000-600,000 tones. The internal wood pellet consumption is growing; recent data from different sources range from 100,000 to 250,000 tones annually. Major internal consumers are private customers, but recently some municipal boiler-houses have been transferred from gas to pellets. Figure2.43 presents average data of production volume and export of wood pellets in recent years.

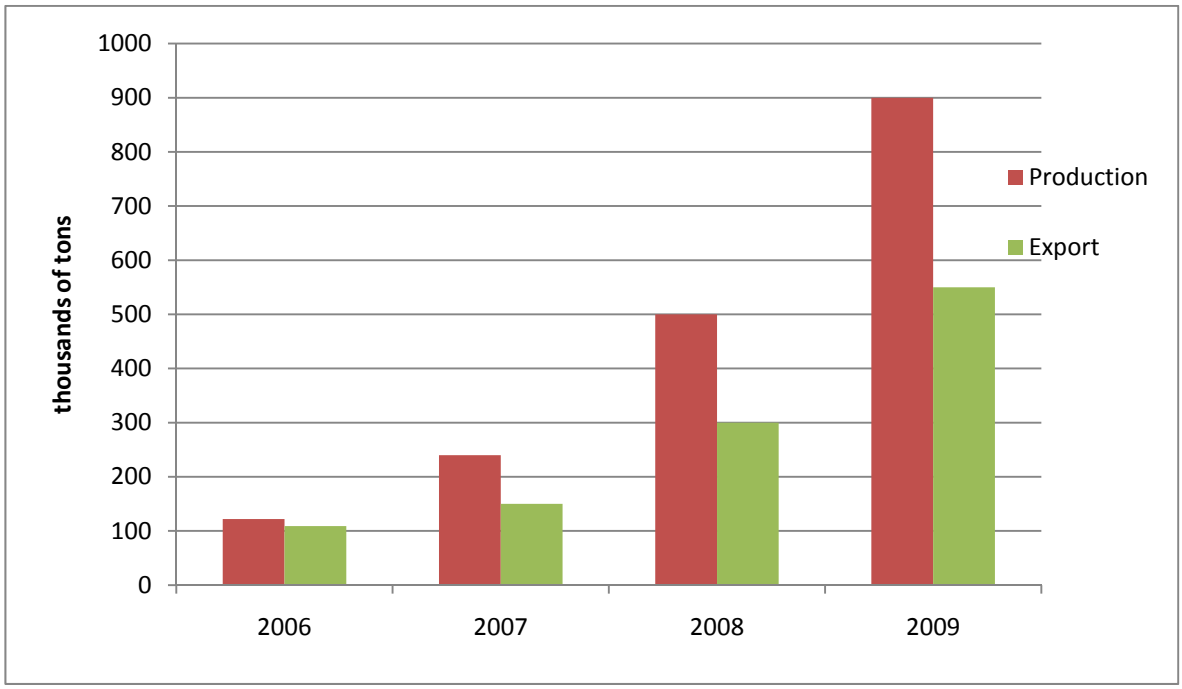


Figure 2.43. Wood pellets production and export in Russia in 2006-2009.

***Source**: based on averaged data from Alexandrova (2008)[16],), Portal Wood-Pellets.com,(2010)[17], Research.Techart, 2010 [18]*

According to experts export volume in 2010 was around 500 thousand tones. [19] Actually, in 2010 two major pellet plants DOK "Yenisei" and "Lesozavod 25" manufactured and exported almost half of total exported volume. All Russian pellet producers work through traders. The main buyers of Russian pellets are:

S. Syr. Pedersen AS - Norwegian trader
Lantmannen Agroenergi - a Swedish company, manufacturer and trader

The Russian pellet export in 2009 is shown in figure 2.44

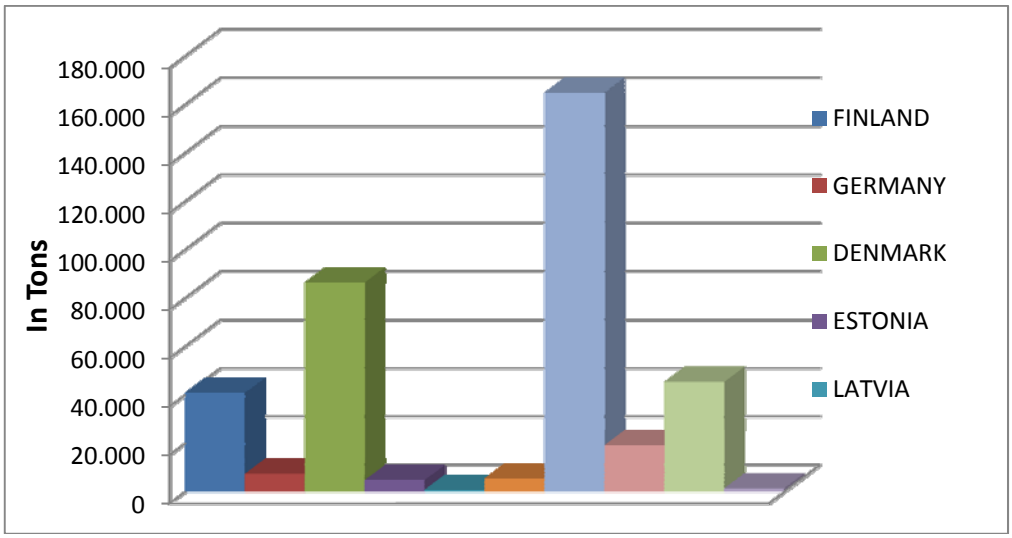


Figure 2.44*Volumes of Russian pellet export in 2009****Source****:Eurostat, 2011*

The major part (more than 50 %) of Russian pellets is exported from the North-West Federal District. The main harbours for pellet export are St.Petetsburg, Ust-Luga, Petrozhavodsk. Some pellets are exported though Baltic ports: Tallinn (Estonia), Sillamae (Estonia), Klaipeda (Lithiania), Liepaya, Vetspils (Latvia), and Paldiski (Estonia)[20]. One of the main problems hampering growth of pellets production in Russia is the lack of specialized cargo handling capacity and consequently, a high cost of transshipment.The cost of pellet transhipment is different. For example, in Podporozhie port, it costs 5 € per tonne, in Ust-Luga (December 2009) 9 € per ton, in the St. Petersburg Port this operation is cost about 12-13 € per tonne [21].

2.11.4 Pellets quality and standard

Presently, there is no standard for pellet production in Russia. Since major part of Russian pellets is exported to EU countries, Russian producers are guided by the standards of the importing countries. Until recently, the main standard it was DIN plus. But in 2010 pan-European pellets standard ENplus 14961-2 was introduced. Thisstandardisimportantforprivateconsumers of pellets, but the major part of Russia's traders and consumers (Denmark, Sweden, and Belgium) use industrial pellets, which should have EN-B standard certification.

2.11.5 Price trends

Wood pellet prices are liable to variation. The average prime cost is 50-60 € per tonne. Export prices vary from 100 to 115 € per ton (on FOB condition). Table 2.16 presents the dynamics of bulk industrial pellet prices (FOB and CPT condition) in euro per tonne (Port Saint-Petersburg).

	2003	2004	2005	2006	2007	2008	2009
FOB St.Petersburg	85-90	90-95	95-105	110-125	90-100	95-105	105-120
CPT St.Petersburg	70-80	75-80	75-90	80-105	75-85	85-95	95-100

Table 2.16 Dynamics of bulk industrial pellet prices in euro per tonne in Port Saint-Petersburg

Source: Rakitova O., 2010[22]

2.12 Spain

2.12.1 Regulatory framework market drivers and barriers

In Spain at national level one of the most recent support measures for the development of the pellet sector is represented by the program BIOMCASA of IDAE, the national Energy Agency. This program promotes the use of biomass for heating by ESCOs, with incentives up to 350,000 €/project. Eligible projects must ensure a minimum 10% cost savings for the final user.

As of April 2011, 52 ESCOs have joined this programme. The public support achieved 4.91 M€ and the heating capacity has reached 13.4 MW.

Pellets are the first source by type of biofuel, covering a 36% of the share of the supported projects (2,824 t/year).

Some regional governments provide various support measures indirectly promoting the use pellets such as:

Funding of installations, typically 20-30% of the eligible costs.

- Specific soft loans for companies.
- Taxes reduction in the investment for companies in the “Companies Tax”.

The Real Decreto-Ley 6/2010 introducing measures for the promotion of economic recovery and employment provides tax deductions for several energy efficiency measures in private households. As of May 2011 the installation of new biomass and pellet stoves is recognized as an eligible measure and private house owners can therefore benefit of such tax deductions until 2012.

2.12.2 Production capacity and feedstock

The Spanish pellets market started developing in 2005, especially after the results ofthe European project “propellets” that led to the creation of three new plants with aproduction capacity of approx. 30,000 tonnes/year.

In 2006 the pellets production capacity was 75,000 tons and the final production was 30,000 tons. Since that time the capacity of the Spanish pellet industry has grown sensibly; in 2009 the production capacity was 577,000 tons, and the actual production around 150,000 tons, whereas in 2010 the production capacity increased again to 651,000 tons.

The production plants can be classifiedas:

11 small-scale (<30,000 tons/year),

6 large-scale (>70,000 tons/year).

In general terms, the capacity range of the plants is 15,000-40,000 t/year.

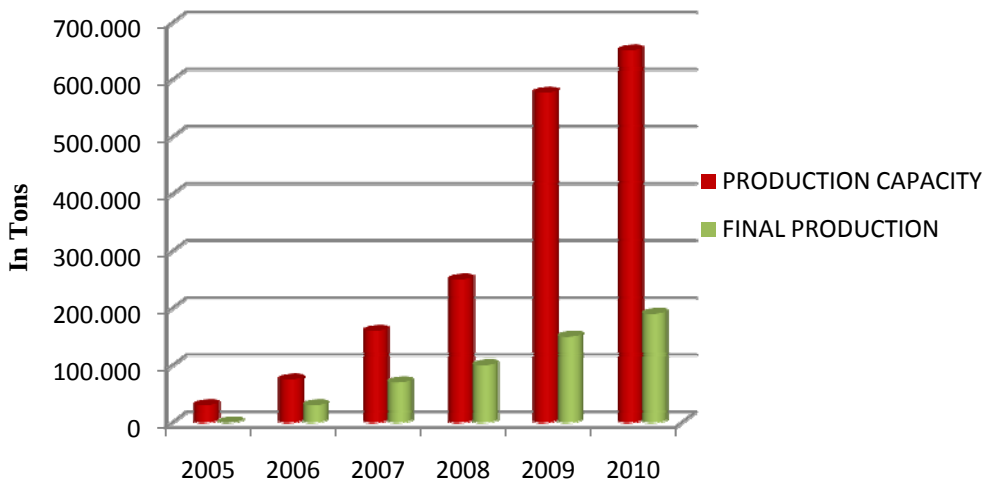


Figure 2.45:*Evolution of pellet production in Spain.****Source****: ETA – Florence.*

According to AveBiom, the pellets production in 2020 could reach 1,5 millions of tons.

Currently in Spain the focus is on associating pellet plants to biomass cogeneration facilities in order to recover part of the waste heat produced by the cogeneration plant, as the reuse of excess heat is supported by the Royal Decree 661/2007 setting tariffs for renewable electricity.

The main feedstock used is sawdust. Until some years ago, this raw material was abundant; nowadays feedstock supply has become a limiting factor The current trend is in using the wood available in each local area also in form of alternative feedstock such as shavings, woodchips and also round wood from forest management.

According to the Spanish National Renewable Energy Action Plan PANER 2011-2020, in Spain there are more than 27 million ha of forests (more than 50% of total surface).

2.12.3 Consumption

Despite the rapid expansion of the production capacity the domestic demand for pellet is still relatively small. The use of pellet is almost negligible compared to other Europeancountries; approximately. 10,000 tons were consumed in 2010 mainly in small-scale applications for heating.

At the end of 2007 the number of pellet heating systems installed in Spain was about600-700 units. These generally are small and medium scale boilers for a total powerof 25-35 MW.

The use of pellets per capita in Spain is one of the lowest among all European countries, as shown by table 2.17

Country	Per capita consumption in 2008 (tons)
Sweden	230
Denmark	190

Austria	60
Germany	11
Italy	15
Netherlands	54
Belgium	87
UK	14
Poland	3
Spain	0,2
France	3

Table 2.17: Use of pellets per capita in Europe countriesSource: Graanulinvest via Bioplat - 2010

2.12.4 Trade and logistic aspects

Given the limited domestic demand Spain exports every year its almost entire production.

According to Eurostat data Spain exported 153,089.9 tons of pellets in 2010. The main importing partnes were Portugal and France, followed by Belgium, Sweden, Italy and Germany.

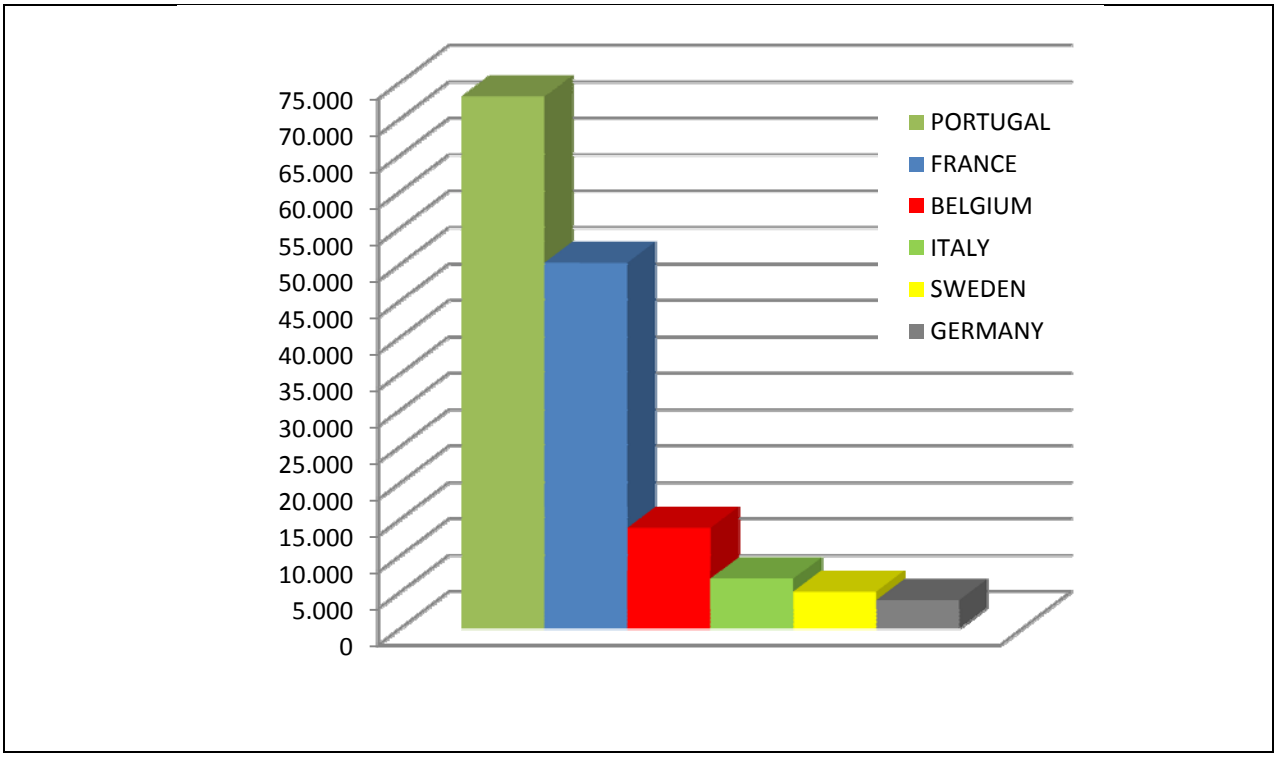


Figure 2.46: Volume of wood p*ellets exported by Spain in 2010 (tons).* ***Source****: Eurostat. Elab Etaflorence*

2.12.5 Pellets quality and standard

The pellets produced in Spain are generally good quality from the standpoint of chemical composition and energy content, however an improvement of some physical aspects such as durability and fines content seems necessary.

A recent project named “Capeles”, performed by CEDER in 2010 aimed atanalyzing the quality of pelletsavailable in the Spanish market, by evaluating 10 quality parameters according to the European standard EN 14961-2 and other 7 parameters based on the German DIN standard.

The results of the analysis conducted showed that only 4 out of 21 samples were actually compliant with the quality requirements of DINplus standard. If contrasted with EN 14961-2 standard only 3 samples ranked A1 and A2, the remaining samples ranked in class B or outside the quality requirements, mainly due to high fines content above 1% and more that 95.5% lower durability.

Since 2011 the AVEBIOM association, as a member of the European Pellet Council is accredited for the development and management of the ENplus certification in Spain.

2.12.6 Price evolution

The pellets price is lower than the average prices in Europe. It was quite steadyduring the last two years. It slightly decreased from 125 € in summer 2007 to 122€/ton in the autumn of 2008.

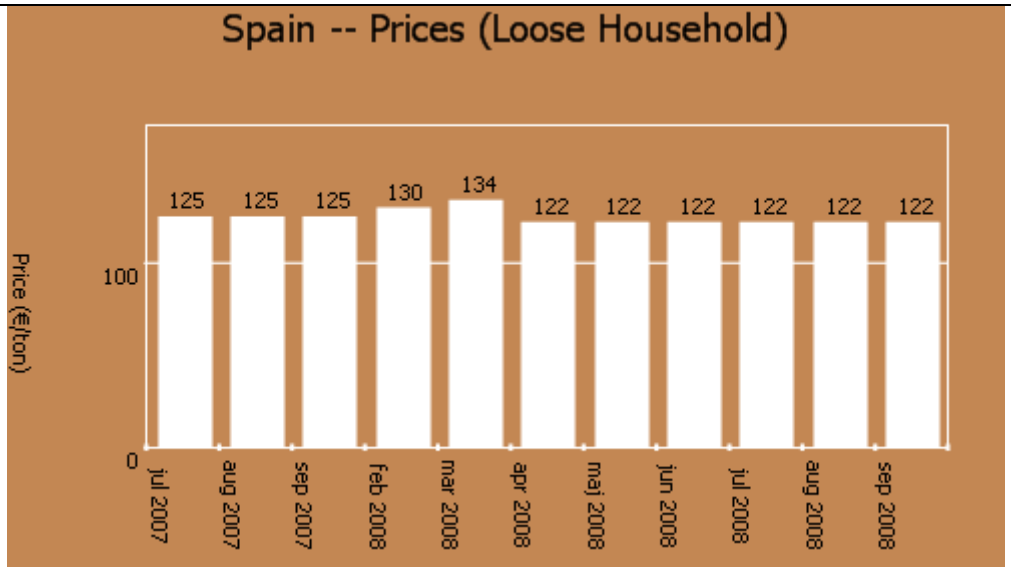


Figure 2.47:*Price evolution pellets in Spain.****Source****: ETA – Florence.*

2.13 Portugal

2.13.1 Regulatory framework market drivers and barriers

The Portuguese pellets market started developing around 2005 and is still in an initial stage; the large majority of the production is exported and the domestic consumption is extremely scarce; despite the sale of pellet appliances is growing.

Some support measures for the promotion of the domestic market were introduced, such as tax deductions for the purchase of renewable energy appliances by private citizens (i.e. pellet stoves/boilers). On the other hand, a commonly acknowledged barrier for the development of the sector is the VAT regime for biomass feedstock, including pellets, that is still at 20% whereas natural gas and electricity are subject to a reduced tariff of 6% and fossil fuels for heating benefit of a 13% tariff.

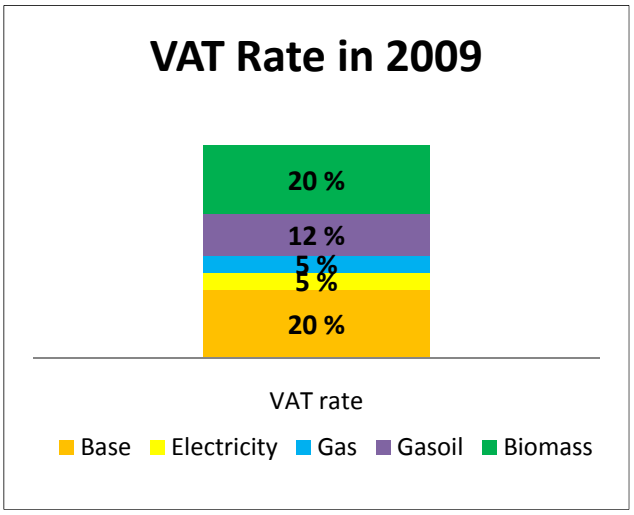


Figure 2.48:*Type of VAT for Portuguese Energy.*

2.13.2 Production capacity and feedstock

According to Portuguese national pellet association in 2010 16 plants were active, with a total capacity of 700,000 tons per year, while the actual production amounted to 500,000 tons.

Sawmill residues and sawdust from industrial semi-finished wood, wood furniture factories, carpentry and other woodworking industries are the main feedstock used for the production of pellets in Portugal.

Company	Location
Jungle Power	Lousada
PeletesPower	Mortagua
PeletesPower2	Alcàcer do Sal
PineWells	Arganil
Enermontijo	Pegões
Enerpellets	Pegrogão Grande
NovaLenha	Oleiros
Briquetes Raro	Vila Nova de Gaia
Vimasol Pellets	Celorico de Basto
CMC Biomassa	Alcobaça
Biobranco II	Vila Velha de Rodao
Soltotal	Carapinheira

Biomad	Lousada
Ambipellets	Povoa de Lanhoso
Castro & Filhos	Guimares
Stellep	Chaves

Tab. 2.18 Portuguese pellet producers in 2010

Source ANPEB

2.13.3 Consumption, Trade and Logistic Aspects

Only 1% of the national production of pellets amounting to around 5,000-10,000 tons is consumed in Portugal, the vast majority of pellets are exported to other EU countries. Both industrial and residential quality pellets are produced in Portugal, DINplus is commonly used for the qualification of this latter product.

The Eurostat data for 2010 show a significant volume of exportsestimated 695,683.32 tons of pellets exported by Portugal, mainly to the United Kingdom (291,365 tons), Denmark (246,626.3 tons) and Sweden (105,417.8 tons).

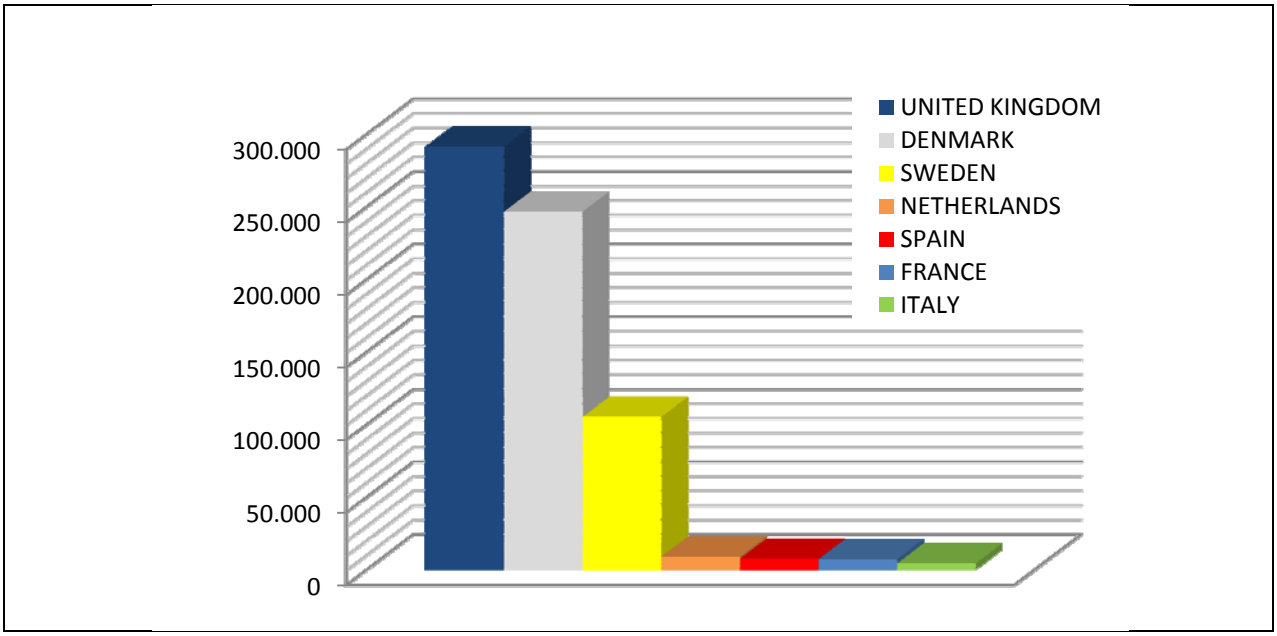


***Figure 2.49: Pellets exported by Portugal in 2010.Source**: ETA – Florence.*

2.14 Poland

2.14.1 Regulatory framework market drivers and barriers

Green certificates for electricity produced by RES have an approximate value of 250 zl/MWh, while “red certificates” issued for cogeneration have a value of 120 zl/MWh for small plants < 1MW.

Recent changes in legal regulations promoted the use of agricultural biomass (energy crops, agricultural residues and residues coming from food processing industry) to the detriment of residues from forestry and their processing, thus increasing the interest in MBP.

The new regulation published by the Ministry of Economy on 14 August 2008, Dz.U. 156, Poz. 969 states that power plants using biomass with power output exceeding 5MW, have to assure that the agricultural biomass weight ratio (energy crops, agricultural residues and residues coming from food processing industry) is at least:

4. 5% - in 2008
5. 10% - in 2009
6. 25% - in 2010
7. 40% - in 2011
8. 55% - in 2012
9. 70% - in 2013
10. 85% - in 2014
11. 100%- in 2015

Power plants exceeding 20 MW, have to assure that the agricultural biomass weight ratio (energy crops, agricultural residues and residues coming from food processing industry) is at least:

12. 5% - in 2008
13. 10% - in 2009
14. 20% - in 2010
15. 20% - in 2011
16. 20% - in 2012
17. 25% - in 2013
18. 30% - in 2014
19. 40% - in 2015
20. 50% - in 2016
21. 60% - in 2017

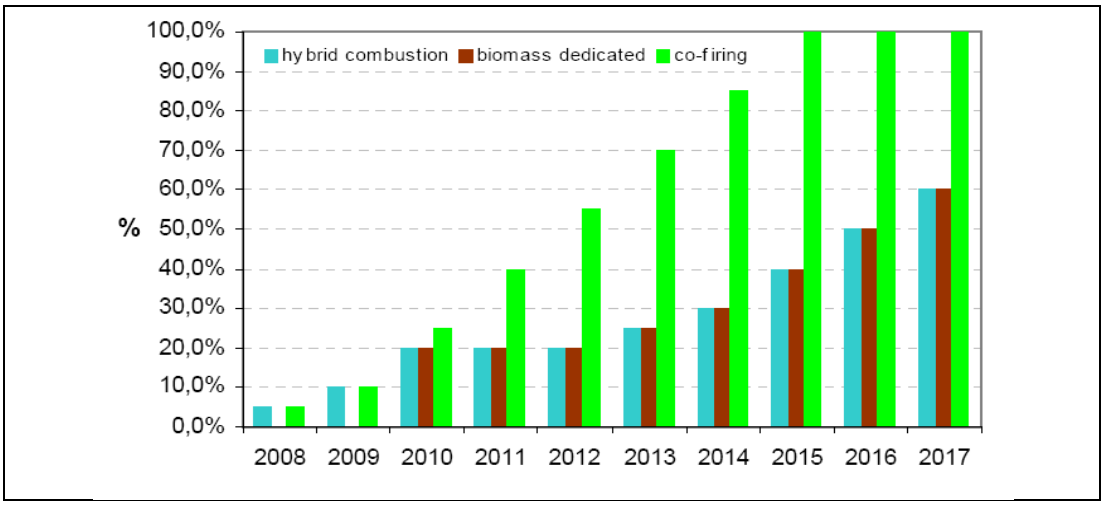


Figure 2.50 minimum use of agricultural biomass in different technologies according to Dz.U. 156, Poz. 969

Source: www.4biomass.eu

The Polish energy market is mainly coal-based. For decades coal was the main energy carrier, exploited by power plants, district heating systems and individual heating systems. Private households without any access to district heating network are equipped with either coal, gas or oil installations. These are mainly rural areas where biomass is used in the form of log wood, fired in old, inefficient installations.

The Polish pellets market is still very young: production activity has only started in 2003, but its rate of growth is very fast. A large portion of the production volume is exported every year, but this trend is recently changing with the growth of domestic consumption.

Due to rising prices of fossil fuels, as well as the risk of unstable deliveries, more and more people show their interest in pellets. Also, large consumers like CHP plants started to co-fire biomass with coal, thus resulting in a major rise in pellets production which occurred in 2008. Therefore, no wonder that biomass is the most commonly used renewable energy source (its share in RES exploitation in 2007 was equal to 91.3%).

2.14.2 Production capacity and feedstock

A rapidly growing interest in pellets as an alternative to oil and natural gas has led to extensive investments in pellets production within last years. In 2008 21 companies were active in the production of wood pellets, while in 2010 the number of producers had already increased to 30 units.

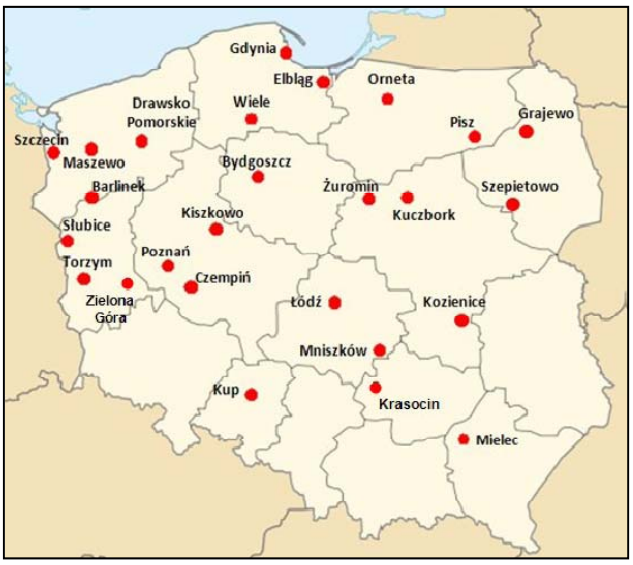


Figure 2.51: *Location of wood pellet plants in 2008.**Source:** Pellet@las Poland Country Report.*

The majority of pellet plants have a production capacity below 30,000 t; however they are characterised by a high utilisation rate. They are small or medium-size companies that buy their raw materials from wood processing industries in their vicinity and which operate their own regional distribution system.

In 2010 only 2 plants had a production capacity above 100,000 tons/y and one around 80,000 tons/y

Company	Production (tons)	Capacity (tons)
Agropellet	1.500	1.500
Arno-Eko	50.000	50.000
Barlinek	135.000	135.000
Biopal I	60.000	60.000
Brytpol	9.000	9.000
EMG Szepietowo	50.000	50.000
Eko-Orneta	12.000	30.000
Eko-Pellets	5.000	5.000
Ekopal	4.500	4.500
Ekoplex	18.000	18.000
Enbio	12.000	12.000
Fabich	36.000	36.000
Fu-Wi	5.800	5.800
Furel	15.000	24.000
Grenerg		78.000
Inwestycjia	10.000	10.000
Libero	10.000	18.000
M&M pellets	3.600	7.200
Motowerk	6.000	6.000

Ostrowski	10.000	10.000
PBH Zaubski	20.000	36.000
Stelmet	60.000	140.000
Sylva	12.000	12.000
Tarkak	54.000	54.000
Task	12.000	13.000
Vapo	36.000	80.000
Biopell	3.840	3.840
Drewankryw	5.000	6.000
Saleko	-	-
TOTAL	656.240	914.840

Tab. 2.19 – Pellet producers in Poland in 2010: Source – Bioenergy International

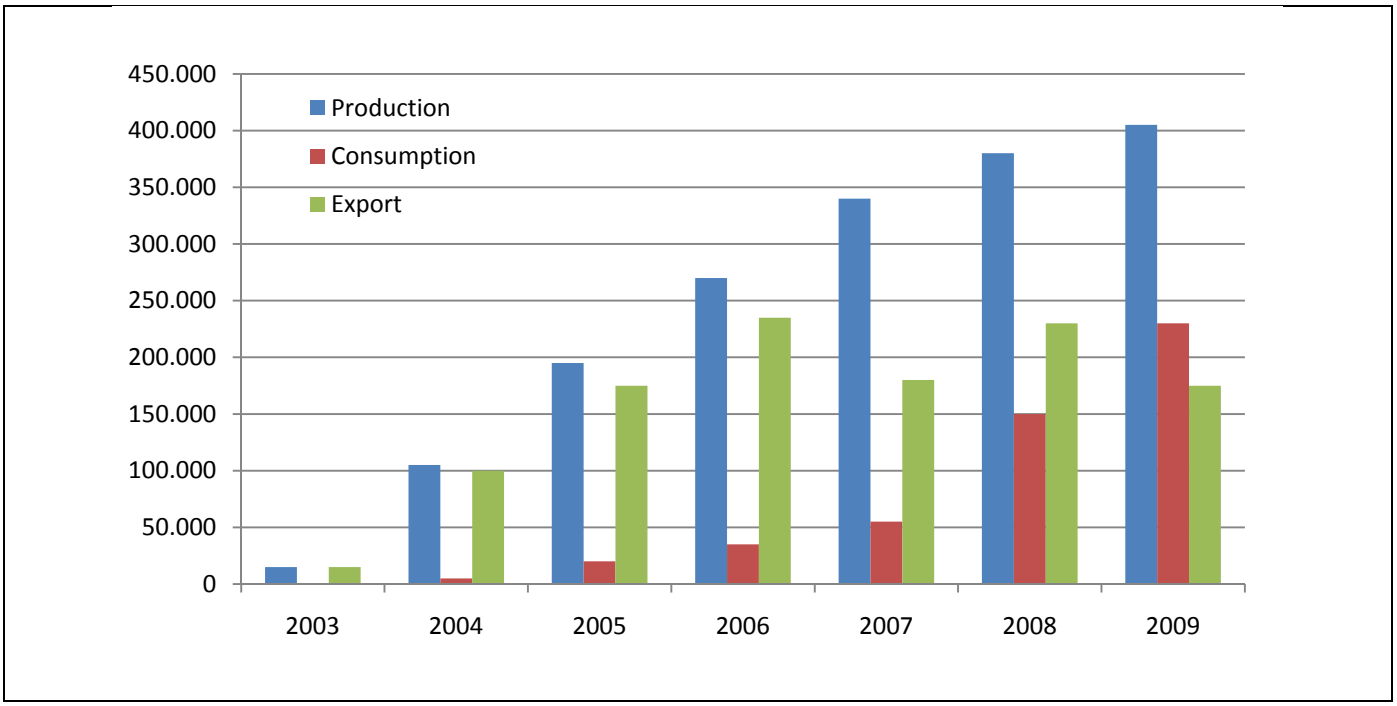


Figure 2.52: The Polish market evolution of Pellets. Source: *Węcek R. 2010.*

In 2010 the pellet production capacity of Poland was 914,840 tons while the actual cumulative production of was 656,240 tons (Source: Bioenergy International, 2011).

Forests cover 28.8% of the area of Poland (8.9 mln ha). National forests cover the area of 7.4 mln ha and a further increase in the forestation is planned, until they cover 32% of the country in 2020. The technical potential of forest wood, that may be used for energy purposes, equals 6.1 mln m^3, which is sufficient to produce 42 PJ of energy. The technical potential of wood residues from wood processing industry and other sources equals 58 PJ (8.3 mln m^3).

Wood shavings and saw dust are the raw materials mainly used for pellet production. The quality of the raw materials originating from furniture or construction industry is good. Saw dust from small sawmills may be contaminated with bark and sand, or even with larger pieces of wood, and therefore must be sieved before the pellets production process begins. Wood chips are used in tiny amounts so far.

2.14.3 Consumption

The existing legal duties concerning the compulsory production of green energy result in the increased interest of both district heating companies and CHP plants in biomass utilization, in order to co-fire it with coal. In 2009 about 80,000 tons of pellets were consumed for residential heating and over 150,000 tons were used for co-firing with coal in power plants.

2.14.4 Trade and logistic aspects

In 2010 the quantity of pellets exported was estimated around 130,000 tons, mainly to Denmark (104,834.3 tons), and to a lower extent to Italy and Germany.

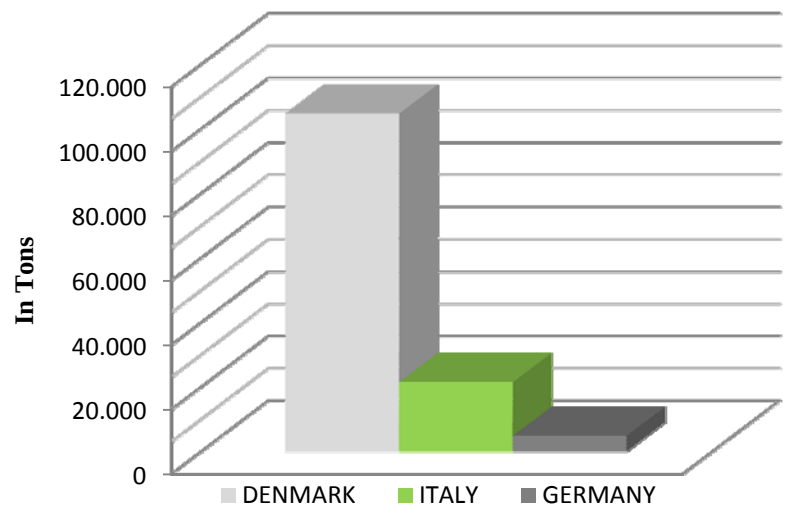


Figure 2.53: *Pellets exported from Poland in 2010 according to Eurostat.**Source**: Eurostat, elab. Etaflorence*

Imports in 2010, reached around 43,000 tons, mainly from Ukraine (25,380 tons), thatequals to more than half of the imports. Other trade partners were Germany (7,461 tons), Russia (3,620.04 tons), Belarus (2,333.64 tons), Romania (2,192.4 tons) and Lithuania (1,792.32 tons).

2.14.5 Pellets quality and standard

There is no national standard for the quality control of pellets.

Some pellets meet the requirements of the German standard DIN 51731 and their quality is certified. Producers often claim that their pellets meet the requirements of the Austrian standard ÖNORM M 7135, or of the German DIN Plus, but have no certificate to prove it.

2.14.6 Price trends

In the period 2006 to 2009 an average 10% increase of biomass prices was experienced due to increasing demand increasing transport costs form longer distances.

In 2010 the cost of biomass delivered to power plants was 25 zl/GJ. The reasons for this growth were: increasing competition between the power plants and increasing distances of biomass transportation.

While smaller consumer can source biomass from local suppliers, large power plants must shoulder long distance transports and this often reflects on 10-20% additional costs for biomass delivery.

As far as agricultural biomass is concerned, sunflowers husks pellets have been imported from the Ukraine with an offered average price of 28 PLN/GJ (16MJ/kg).

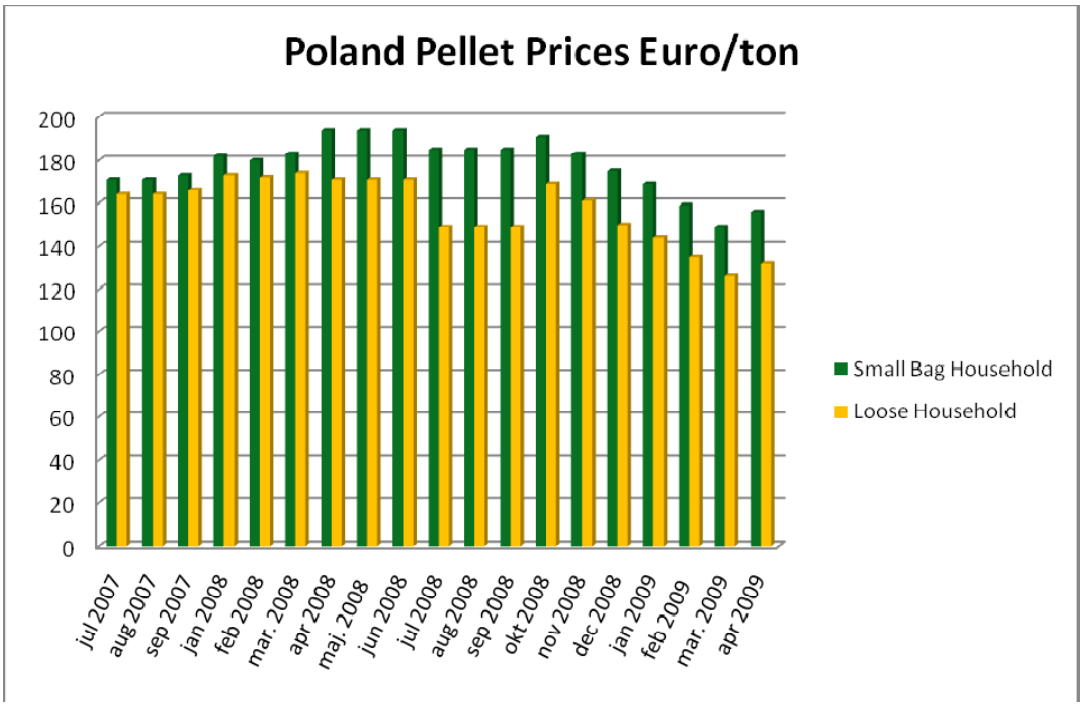


Figure 2.54: *Pellets price evolution in Poland.**Source:** www.4biomass.eu*

2.15 United Kingdom

2.15.1 Regulatory framework market drivers and barriers[4]

The UK provides various incentives to generate electricity from biomass such as the Renewable Obligation, the Electricity Market Reform and the Feed in Tariff, briefly discussed here. It is expected that by 2020 biomass could contribute up to a total of 6 GW, compared to 2.5 GW capacity in 2010 (DECC, 2011a). To achieve these objectives the electricity market needs significant institutional support.

The UK government is currently drawing up legislation to address these issues, namely: long-term contracts for both low-carbon energy and capacity as well as institutional arrangements to support electricity from biomass, continued grandfathering, and supporting the principle of no retrospective change to low-carbon policy incentives within a clear and rational planning cycle; and to create a market that allows existing energy companies and new entrants to compete on fair terms. In 2010 the UK government decided to provide further support to feedstock and energy waste plants from the RO and there also plans to review the RO for further technological development up to 2013. The new Renewable Obligation will come into force in April 2013 and will pay particular attention to waste use e.g. by setting up new landfill regulations on waste wood use (DECC, 2011a).

Policies on co-firing have changed over the past or so decade. A ROC review came into effect in October 2011 which could have a significant impact particularly on co-firing and hence on bioenergy use. Coal-fired + biomass generation currently provides security of supply benefits in terms of availability, reliability and flexibility. Hence, unlike any other large-scale renewable technology, biomass-fired generation can respond flexibly and quickly to changes in electricity supply or demand and can provide large scale, reliable, and predictable power.

In addition, conversion and enhanced co-firing biomass plant will also reduce the need for transmission investment, which, depending on the location, can be significant. A recent study (Arup, 2011) has considered a range of different options for biomass usage, including dedicated biomass plants as well as existing coal plants in a variety of regimes. The report recognizes that small biomass plants, (<50 MWe) tend to use locally sourced biomass fuel delivered by road. The Arup study estimated that the UK could host 50-60 dedicated biomass plants distributed around the country. In addition, large plants, up to 350 MWe, could be located near ports specifically to access a wide range of imported fuels. The study indicates that *"up to 1.8 GWe of high capacity factor, low planning risk* of conversion capacity could be feasible (ARUP, 2011).

Limited co-firing can be achieved in most UK coal plant with little modification, by pulverizing the coal and biomass simultaneously in the existing coal mills, a technique usually termed 'co-milling'. It is now considered that co-firing at rates of 20-50% (currently to benefit from ROC support co-firing must represents at least 15%), biomass throughput (or more) is possible, though there are still important technical challenges. Many generators have concluded that large volumes of biomass can be successfully sourced, transported and burnt in conventional power stations, replacing coal, which represents a significant shift from early years. Consequently, current co-firing/conversion programs are focusing on setting up supply chains capable of sourcing and transporting biomass in larger volumes(DECC, 2011).

The Market Electricity Reform (MER) is an important institutional step whose aim is to address the electricity market stakeholders concerns e.g. to safeguard demand and ensure the best value for investments throughout the whole power chain; and create a flexible and competitive electricity market, enhance the market capacity to finance large investment in low carbon electricity (see DECC (2011b) for further details. A smooth change is planned from the RO which will allow new generators to

[4]This section was extracted from the UK country report 2010 of IEA Bioenergy Task 40, written by Frank Rossillo Calle and Sofia Galligani, available at www.bioenergytrade.org

have a choice between the two schemes until 2017; and following closure of the RO to new entrants, technology payments made under the RO will be grandfathered" (DECC, 2011a & 2011b).

The FiT, introduced in April 2010, is another option to attract new investment into biomass-based electricity generation and to reduce CO_2 (DECC, 2011c). The incentive consists of payments for every kWh of electricity generated, depending of the size, technology type and date of installation. Small electricity generators also receive a payment for the surplus electricity sold to the grid, "paid over and above the generation tariff, either at a guaranteed flat rate of 3p/kWh or at the open market value. Tariffs are exempted from income tax but subjected to Corporation Tax" (Carbon Trust, 2011b). As such, profitability is guaranteed for the generator, reducing investment risk in renewable technologies.

In 2010 heat from RE accounted for 1% of UK's heat demand; the target for 2020 is 12% (Carbon Trust, 2011). The most important scheme to promote heat from RE is the RHI, introduced in March 2011. The aim is to achieve 57TWh of heat and save 44 million tonnes of carbon by 2020 (DECC, 2011a).This is the first such scheme to foster the provision of renewable heat, providing long-term financial support for up to 20 years (Buckinghamshire County, 2011).

The RHI will be implemented in two phases, phase 1 deals with non-domestic users and commenced in July 2011. Phase 2 will address the domestic residential sector, starting October 2012. It is predicted that Phase 1 will result in around 13,000 renewable heat installations in industry and a further 110,000 in commercial and public sectors (Hawkinks Wright, 2011).

To achieve the expected capacity by 2020, will require an annual growth rate of 9% in the next decade. DECC anticipates that demand will be mostly from the conversion of coal plants, dedicated biomass generation, biomass waste combustion, and anaerobic digestion. Landfill and sewage gas are not expected to increase as it is already largely exploited. Biomass electricity prices are expected to remain stable according to the DECC scenario, ranging from £70 to £173/MWh in 2020, compared to £75-£194/MW in 2010. These ranges are large due to the different technologies considered. Prices are more stable for mature technologies with no major improvements expected e.g. combustion technologies; there is, however, potential for improvement in several other processes such as anaerobic digestion, gasification and pyrolysis(DECC, 2011a).

However, the deployment of new capacity is not assured as there are many challenges ahead, i.e. minimizing the investment risk, de-risking the supply of sustainable feedstock, planning issues, and the regulatory framework. To overcome such challenges some priority actions are being proposed by the government, including Electricity Market Reform to increase projects revenue, expand supply chains for waste wood and solid recovered fuel, better information on available waste, or incentives to feedstocks (DECC, 2011a).

According to the DECC predictions, non-domestic biomass for heat could contribute up to 50 TWh of renewable energy by 2020, mainly from biomass boilers and biogas injection to the gas grid. Other sources identify a market potential ranging from 27 to 55 TWh of non-domestic biomass for heat by the same year. Imported biomass heat prices ranged between £22 to £156/MWh in 2010 and are expected to remain more or less unchanged in real terms, between £22 to£159 per MWh in 2020. Capital and installation costs are projected to fall slightly due to the learning effects, whilst operating prices are projected to raise with increasing feedstock prices (DECC, 2011a).

2.15.2 Production capacity and feedstock

Updated data on the current capacity and actual production of the pellet industry in UK are scarce; in 2009 a report of the Pellets@las project indicated an estimated production capacity of 218,000 tons and reported also a number of new additional plants that had started operations in 2009, whose estimated production capacity is shown in table 2.20. However, for 2008 the estimated actual production was only 125,000 tons.

Company	Capacity (tons/y)
Forest Bio Products (Perth)	40-70,000
Clifford Jones (Rutin, Wales)	30,000
Briquette and Pellet Company (Lowestoft)	6,000
Puffin Pellets (Boyndie, Scotland)	25,000 tons
Balcas (Invergordon)	100,000 tons

Table 2.20 – New pellet plants established in 2009

Most plants are located in close proximity of timber supplying areas and existing sawmills, with the largest existing and potential capacity in Scotland. Feedstock used are sawdust, clean waste wood (diverted from landfill), energy crops (such as willow grown on short rotation coppice) and forest thinning. According to a report of the UK Forestry Commission, in 2010 a total of 197,000 tons of wood pellets and briquettes were produced, compared to 118,000 tons in 2009.

2.15.3 Consumption

In the absence of official statistics, it is possible to extrapolate the consumption of wood pellets for 2010 by adding net imports (imports minus exports) to the estimated production level of 2010. Pellet imports for 2010 were estimated at 550,000 tons in 2010 by the UK Forestry Commission (UF FC, 2011), while exports were in the range of 65,000 tons. On this basis, we can conservatively estimate an overall consumption of about 683,000 tons for 2010. This represents a significant increase compared to the estimation of only 125,000 tons of the Pellets@las project for 2008. This increase is strongly driven by the growing demand of industrial wood pellets for co-firing at power plants, which are stimulating imports. Since it is not easy to trace such flows as this is regarded as confidential information by power utilities and independent importers, it is possible that the actual consumption level might be even higher. As a matter of fact, according to Drax Environmental Performance Review, Drax alone consumed over 1 million tons of wood pellets in 2009.

2.15.4 Trade and logistic aspects

This difficulty in finding coherent data from different sources on wood pellet imports to UK also appears when looking at Eurostat statistics. Indeed, for 2010 Eurostat shows a much higher import volume than reported by the UK Forestry Commission e.g. 884,000 tons, of which 510,000 tons came from outside the EU e.g. Canada, U.S., Russia and South Africa, while the remaining 374,000 tons were imported from EU member states, mainly Portugal, Germany and Estonia.

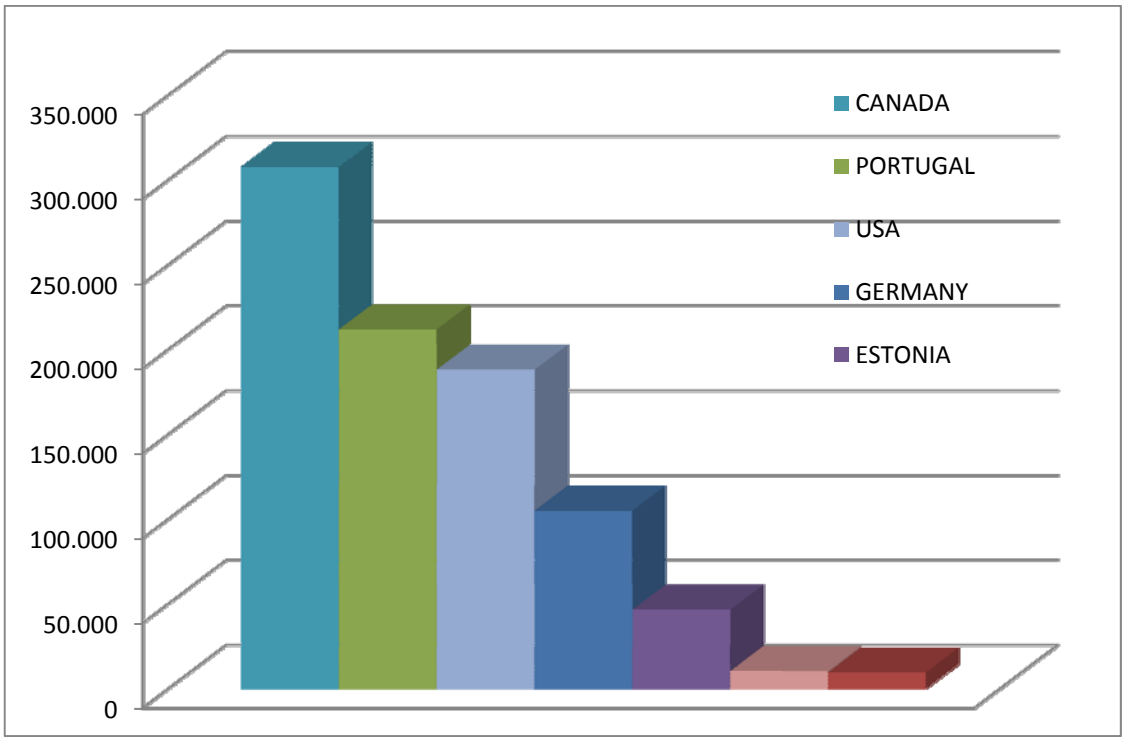


Figure 2.55:*Pellets imported to the United Kingdom in 2010 (tons).**Source**: Eurostat.*

On the other hand, exports from UK in 2010 were much lower than imports, around 65.000 tons, mainly exported to Denmark, Sweden and Ireland

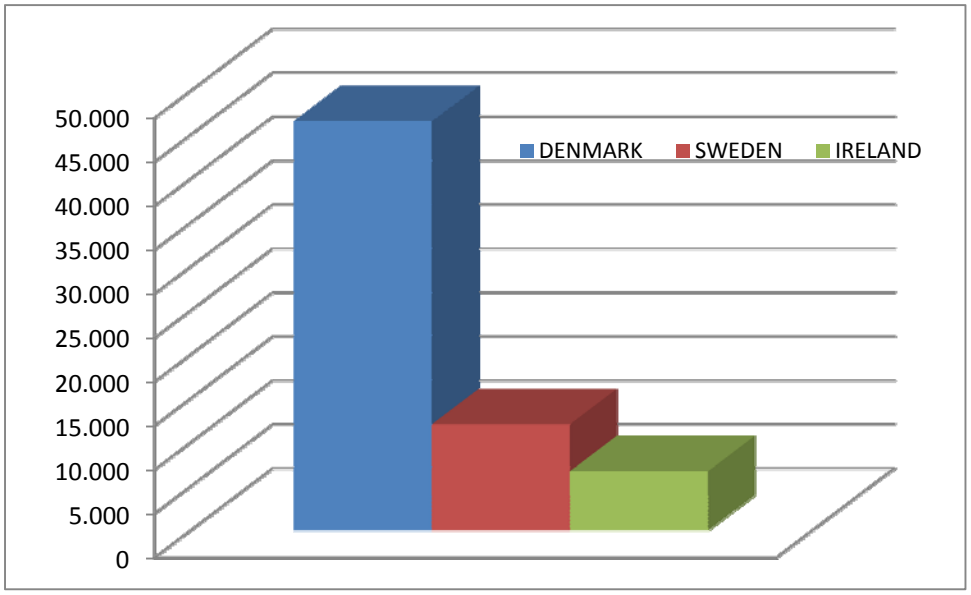


Figure 2.56:*Pellets exported by the United Kingdom in 2010.**Source**: ETA – Florence.*

2.16 Hungary

2.16.1 Regulatory framework production and capacity

The pellet industry in Hungary has experienced a significant increase since 2007.In 2008, 7 pellet plants were active totaling just 5,000 tons of production. In 2008 the Hungarian Pellet Association (Mapellet) was founded and today it represents the majority of pellet producers, boilers and fireplaces producers and distributors, altogether 38 members. A subsidy system funded through the Environment and Energy Operational Program provides investment subsidies up to 50-70% for the establishment of new pellet plants.

In 2010 10 pellet producers were listed as shown in table 2.21 below, 2 of them producing agropellets

Name	place	fuel type	capacity (t/hour)	production in 2008 (t)	estimated production in 2010 (t)
T&T Technik Kft	Szentes	agropellet	1,5	1900	3600
Németh-Fa Kft	Lenti	wood pellet	1,0	800	1000
Pannon Pellet Kft	Belezna	wood pellet	1,8	test	11000
Pellet Produkt Kft	Petőháza	wood pellet	2,0	test	6000
Raklap és Tüzép Kft	Lajosmizse	wood pellet	16,0	test	80000
Albapellet Kft	Agárd - Pálmajor	agropellet	1,0	test	4200
Gold Pellet Kft	Zsira	wood pellet	2,0	n.a.	6000
Fantázia Agrofa	Cegléd	wood pellet	6,0	n.a.	30000
Wood Pellet Kft	Cegléd	wood pellet	4,0	0	20000
Skála Energy Ker. Kft.	Técsö. Ukrajna	wood pellet	5,0		
			40,3	**2700**	**161800**

Tab. 2.21 – Pellet plants and production capacity in Hungary in 2010 – Source: 4biomass.eu

The production capacity in 2010 was estimated at 160,000 tons, while actual production in 2009 was 68,000 tons and 134,000 tons in 2010 (estimated).The growth of pellet production in Hungary has increased sensibly in recent years, in 2008, there were 7 plants for pellet production. Production itself reached 5,000 tons per year, which is also the total production capacity of the country (Pellets@las).

Based on a public report of the HPA in 2009, after plant tests, the aggregated capacity of Hungarian pellet production will be almost 20 times bigger than it was in 2008. Three major investments took place in recent years, which made the plants reach a capacity of 6,000 tons in Petıháza, 11,000 tons in Belezna and 80,000 tons in Lajosmizse.

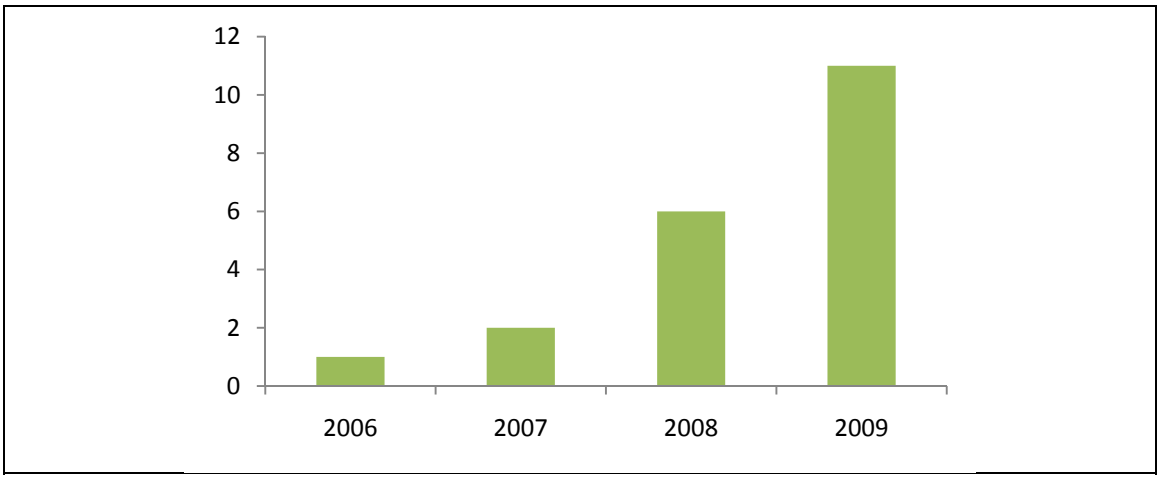


Figure 2.57: Number of pellet plants in Hungary.Source: Magyar Pellets Egyesulet.

It was estimated that in 2010 the pellets production capacity could amount to 160,000 tons (Magyar Pellets Egyesulet "A pelletgyártás helyzete és fejlődési irányai").

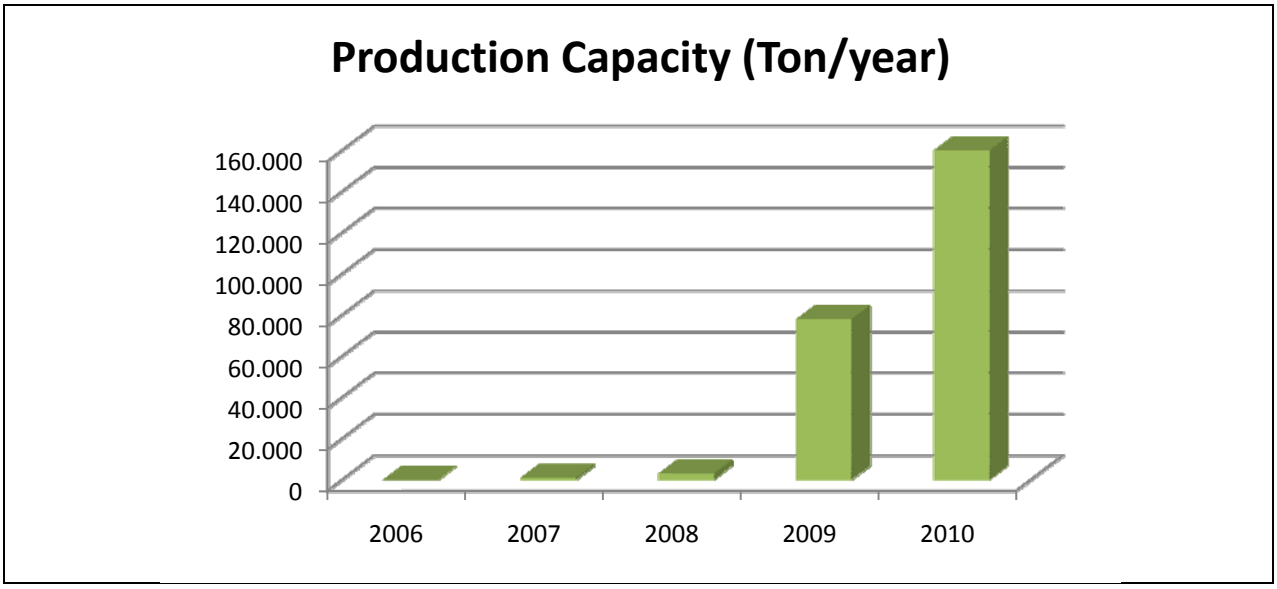


Figure 2.58: *The evolution of pellet production capacity in Bulgaria.**Source:** Magyar Pellets Egyesulet.*

However, according to The Bioenergy International, at December 2009 the pellet production capacity was 125,000 tons/year and in January 2011 it decreased to 90,000 tons/year.

2.16.2 Consumption

Domestic consumption of wood pellets is very small, in 2008, the level of consumption was 1,000 tons per year. 80% of wood pellets are exported to Poland and Italy, while agripellet is almost exclusively used for domestic consumption in biomass boilers.

The majority of pellets is sold in small bags (15 kg to 50 kg), followed by big-bags (500 kg to 1500 kg) and bulk pellets.

Consumption can be best approximated by sales figures from boiler and stove manufacturers and traders. But it is not possible at the moment to say even with that estimation whether we are close to real numbers. Most of Hungarian consumers have small or medium-size capacity, thus there is no survey or questionnaire that can be distributed among all of them. Even with hard work based on approaching consumers and receiving their feedbacks, Kazai concluded that only a really small portion of the total Hungarian production is consumed by domestic users. The overall number of questioned consumers were only enough to get a picture of the purchase habit, satisfaction rate about the technique and other sociological themes.

Based on interviews the sales increased to around 500 pellet stoves and over 2,000 boilers in 2008. However, we should consider that these interviews do not represent the whole market so that underestimations are possible. We should also add that Hungarian investments on the field of boiler manufacturing are not focused only on equipments fed with wood pellets, but also on those which can use mixed pellets, wood chips and other biomass energy sources (Pellets@las).

2.16.3 Trade and logistic aspects

In 2008, the level of export was 4,000 tons per year (Pellets@las).

It is estimated that 75% of the production of pellets in 2009 was exported. Only 25% of the production is used to supply domestic needs.

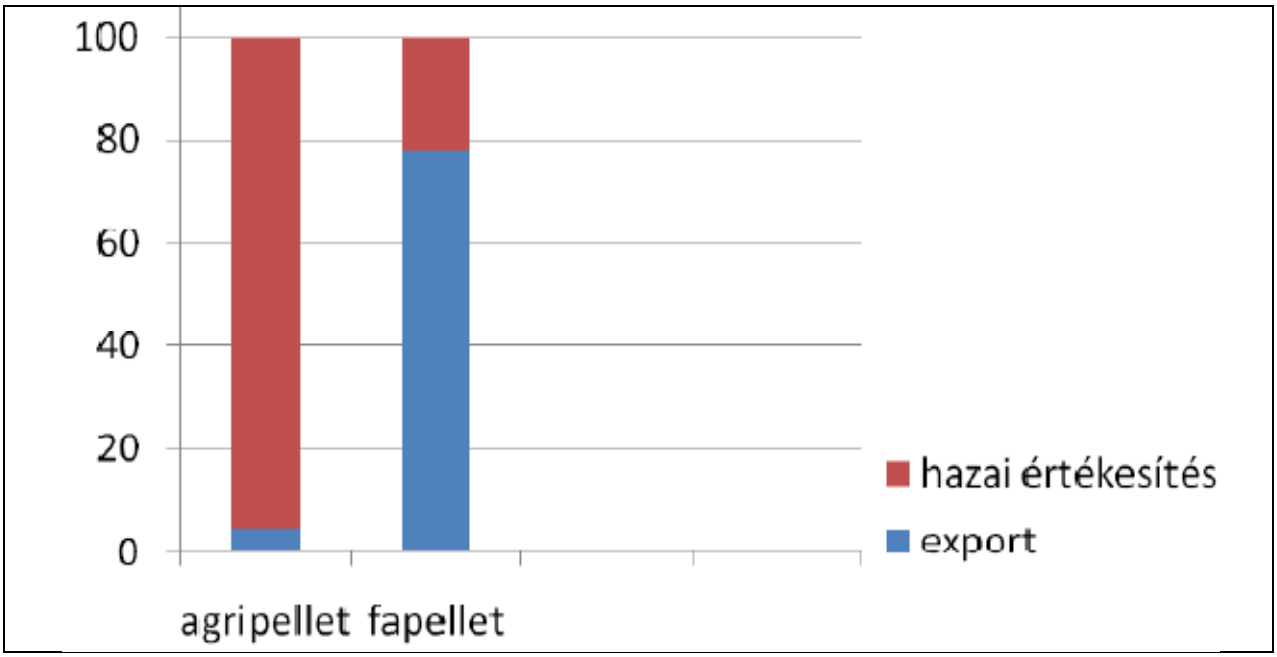


Figure 2.59: *Pellet and agripellet export, in % national production.**Source:** Magyar Pellets Egyesulet.*

As mentioned earlier, most of the production capacity is set up close to the available raw materials, which means generally the western part of the country. These market actors based their activity of producing and trading wood pellets on the possibility to export their product. The producers in the South-eastern part of Hungary based their production on agricultural main products or by-products. Most of the producers from this region are working seasonally, as a result of the raw material occurrence, just to serve the local needs in the area without trading larger amounts.

The majority of pellets is sold in small bags (15 kg to 50 kg), followed by big-bags (500 kg to 1500 kg) and pellets sold loose.

2.17 Ukraine

2.17.1 Regulatory framework market drivers and barriers

According to IEA Statistics, total energy production in Ukraine in 2008 constituted 3.4 EJ (total primary energy supply was 5.7 EJ) [1]. Electricity and heat energy production equaled 0.69 EJ and 0.53 EJ correspondingly [2].

Presently, natural gas makes the major contribution to Ukraine's total primary energy consumption (37%) followed by coal (26%), nuclear energy (17%) and oil products (17.5%). The share of renewables in the total energy consumption is 2.5%, including large hydro 2% and biomass (mainly firewood and peat) 0.5%. [3]

The most promising and easily accessible forms of biomass are wood wastes, cereals straw and, sunflowers husk. Potential renewable energy sources are presented in table 2.22.

Renewable energy source	Technically achievablepotential (annual)	
	Million tons of oil equivalent	EJ
Wind energy	21.0	0.88
Solar power	6.0	0.25
Heat pump	18	0.75
Geothermal energy	12.0	0.50
Bioenergy	20	0.84
***Wood biomass**	2.1	0.09

Table 2.22 *Potential of renewable energy in Ukraine*

Source*: Liven O. (2011) [4]* Bashtovoi A. (2010) [5]

In May, 2009The Ukrainian Parliamentpassed a lawproviding a ten-year profittax exemptionfor enterprises dealing withproduction and saleof biofuels, including wood pellets. In particular, the producers of biofuels as well as producers of heat, combined heat, and power from biofuels have been free of the relevant profit tax since the beginning of 2010 for a 10-year period [3]. The second law is the Law of Ukraine "On Amendments to the Law of Ukraine "On Energy Industry" With Regard to Encouraging Use of Alternative Energy Sources". The law determined the green tariff for power produced from renewable energy sources. The minimum green tariff for electricity generated from biomass is 12.39 € cents/kWh, which is over two times higher than the regular retail tariff for the consumers of electricity. Comparison with other European green tariff shows that the value of Ukrainian green tariffs for biomass plants is quite high [3]. This new laws offer the opportunities for renewable energy development at Ukraine.

Drivers

1) Production costsare significantly lower than in the EU (around 40-50 euro/tone)
2) Big potential for domestic consumption development
3) Government support ("green tariff" introduction, tax law)
4) Some regions have a biomass (wood) potential
5) Huge potential for agro-pellet production

Barriers

- Lack of raw materials at a good price (in some regions)

- Outdated / low quality equipment
- Low production capacities of the producers
- Part of Ukrainian pellets is below the EN-plus and EN-B standard
- Some logistics problems (reasonable price vehicles are not always available)
- High cost of the heating equipment operating on pellets/briquettes. [6]

2.17.2 Production capacity and feedstock

The first specified pellet plant in Ukraine started to operate approximately in 2005. The number of pellet and briquette plants is growing rapidly. In 2009 in Ukraine there were more than 150 companies for the production of briquettes with different productivity, as well as about 50 plants for the production of pellets. However, in 2009 due to resource problems, as well as unfavorable external conditions, a substantial part of them idle or working irregular with low load. Some companies ceased their operations or are going to do it in case of continued unfavorable market situation. According to the research, in 2010 there were about 71 producers of briquettes, as well as 71 plants for the production of pellets in Ukraine. [7]

The share of wood pellets constitutes only 30-35% of total production; the rest is occupied by pellets from sunflower husk and other agriculture residues [8]. The most important wood pellet producers in Ukraine in 2009 are presented in the table below.

Name	Exports to	Pellet production, tons**
Karpat Pellets, Ltd (Zakarpats'ky region)	Slovakia	300
***Forest Ukraine, Ltd (Kyiv region)**	Germany, Lithuania	1,200
***Energo Trade Ukraine Ltd (Kyiv region)**	Italy	2,600
Barlinek Invest, Ltd (Vinnytsia region)	Poland	27,500
Ecobioprom Ltd (Chernigiv region)	Denmark, Germany	4,400

Table 2.23 Main wood pellet producers in 2009

**cancelled production in 2010, but remain as traders*

*** data rounded by author*

Source:Scientific Engineering Centre "Biomass", 2010. [7]

In total, during the current and next year, Ukraine plans to build more than 10 pellet plants. In general, Ukrainian pellet production is agri-pellet oriented. [12][8] The development of the pellet production in Ukraine is presented at Figure 2.60.

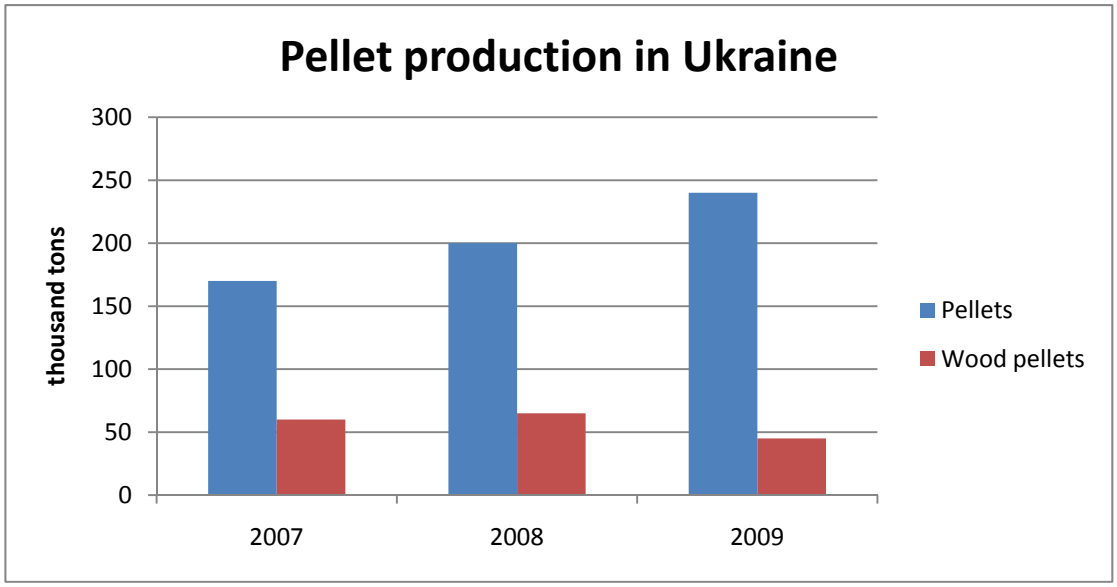


Figure 2.60 *Pellet (total) and wood pellet production in Ukraine.*

Source*: created by author; based on data from Zheliezna T, p.7(2010) [6];* Scientific Engineering Centre "Biomass"(2010)[7]

In 2009 wood pellet production was 44,000 tons and total pellet production was more than 235,000 tones [7]. In 2010 production growth has been continued. According to Fuel Alternative total production (agri-pellets, wood pellets and briquettes) in 2010 was 640,000 tones. Wood pellet export in 2010 consist 87,000 tones [9]. Considering the fact, that Ukraine exports around 90% of their pellets, it is possible to assume that wood pellet production in 2010 was approximately 95,000 tones.

Around 15.6 % of Ukrainian territory is covered by forests. Forest covered area amounts to 9.4 million hectares. Polesye and Carpathians are the main forest areas in Ukraine.

Annual harvesting of merchantable wood comprises about 15 million m^3 [10].

The potential resource of wood biomass for energy in Ukraine amounts to 7.0-7.5 million m^3 annually. It includes saw-mill by-products (2.8-3.0 million m^3 per year), logging residues (branches, crowns remains etc. (1.7-2.0 million m^3 per year), firewood (1.5-2.0 million m^3 per year) and about 1.0 million m^3 per year of technical timber (pulpwood, small logs) which is currently exported. [11]

In general, utilization of forest growth in Ukraine is substantially lower than in other European countries. The utilization rate of annual forest net growth in Ukraine is about 40-50%. The annual theoretical and technical production potentials for forest biomass consists 312 PJ and 90 PJ accordingly.[10]

Experts have different opinions about solid biofuel potential in Ukraine. The production potential of wood pellets in Ukraine varies according to source from one to two million tons per year [12, 13]. Ukraine has vast area of underutilized agricultural land. There are different views on straw potential estimation in Ukraine. According to the one methodology Ukraine had about 9.2 million tones of straw available for alternative use in 2009.

Ukraine has vast area of underutilized agricultural land. There are different views on straw potential estimation in Ukraine. According to the one methodology Ukraine had about 9.2 million tones of straw available for alternative use in 2009[14]. According to Fuel Alternative every year in Ukraine forming

more than 20 million tons straw resource; half of it is burned at the fields. Consequently, each year from 10 million tons of straw it's possible to produce around 8 million tons of biofuel. [15]

According to other source potential of agro-pellets is evaluated to be 12 millions tones per year. [13]. Most probably, that calculation was based on energy equivalents methodology, as according to that methodology the available amount of straw in Ukraine is 13.6 million tons (in 2009). [14]

2.17.3 Consumption

Domestic consumption is around 15% for agro-pellets and around 10% (9% in 2009 and 12% in 2010) for wood pellets [9]. The main wood pellet consumers are small factories (transforming their timber waste into energy), wood processing companies, food processing plants, agro-product processing companies and private buildings [8].

Over 20 straw fired boilers, mostly below 1 MW, are in operation in rural areas. About 500 modern wood fired boilers, mostly below 2 MW, are already installed, and over 1,000 old boilers, which were converted from coal and oil to biomass, operate on enterprises of forest and wood processing industry. Typical wood pellet and wood briquettes price in Ukraine is 70 € and 61 € per ton accordingly. [3]

Regardless on low domestic demand, the rapid development of alternative energy in the EU has created the preconditions for development of Ukrainian pellet market.

2.17.4 Trade and logistic aspects

Ukrainian pellet market is export oriented. More than 80% of Ukrainian pellets are exported to Northern and Eastern Europe. The major importer of Ukrainian wood and agro-pellets is Poland. The wood pellets export in 2010 is present in figure 2.61.

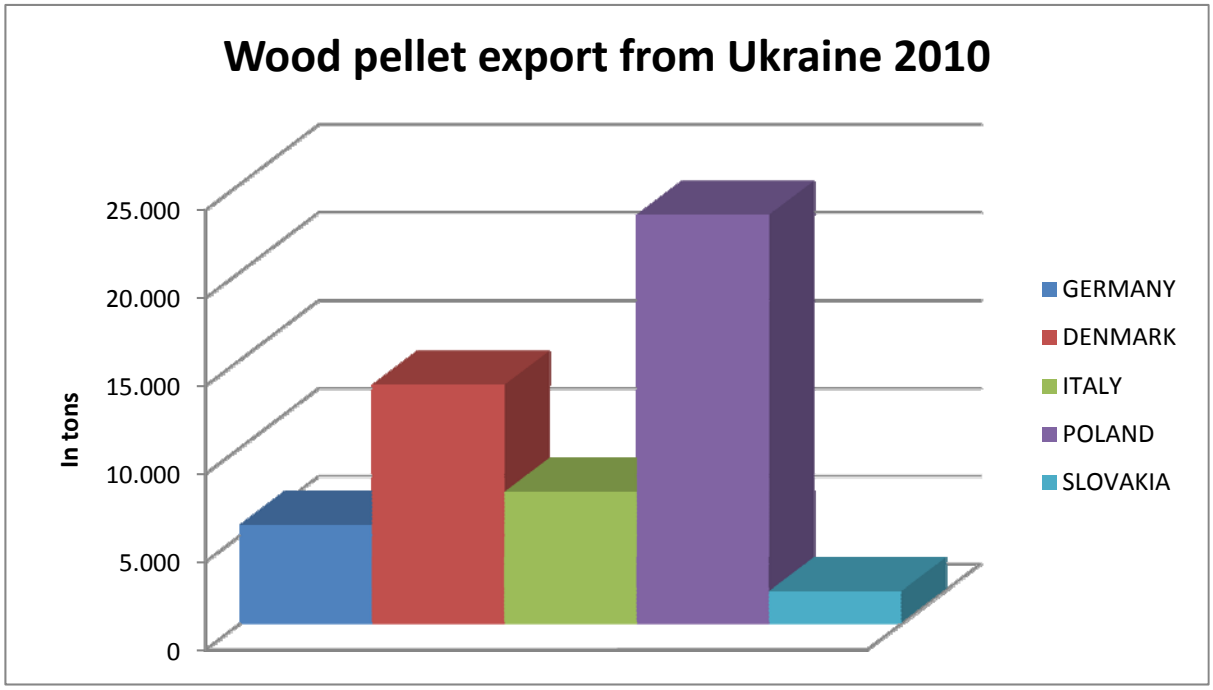


Figure 2.61 Volumes of Ukrainian wood pellet export in 2010

Source: *Eurostat, 2011 [16]*

According to Fuel Alternative data solid biofuel export from Ukraine in 2010 increased remarkably comparing to 2009. Wood pellets export increased 134.6 % to 87,100 tones; wood briquettes export increased 76.2% to 48,000 tones.

There are several sea ports in Ukraine, but transport net logistic is not updated, that complicate theregionaltransportation. [17]

Ukrainian pellets are exported overseas though Baltic ports (Klaipeda and Liepaya (Lithiania), Vetspils (Latvia), Paldiski (Estonia), Sillamae (Estonia), and Tallinn (Estonia). Probably, some pellets go via Black Sea ports, but this is not a systematic path. Pellets are also transported to Europe by trucks and via railway. [18]

According to many experts opinion, most of the pellets will be exported during the next years-.However, in Ukraine, the number ofboilers, working onbiomass, includingwood pellet is increasing, but it is still relatively small.

2.17.5 Pellets quality and standard

There is no Ukrainian standard for pellet production. Considering the fact that more almost

90 % of pellets are exported to EU-countries, it's logical to assume that Ukrainian producers are using EU pellet standards.

2.17.6 Price trends

Straw pellet prices in Ukraine currently vary between € 60-125 /t, wood pellet prices range from € 80 to 160 € per ton. [14] According to other source in 2009 wood pellet price ranges from € 70- 100 € per ton (FCA condition). [6] The average price of pellets, sold to Poland (FCA) in 2009 was about € 86 per ton. The second volume of export of Ukrainian pellets was in Germany last year, by the average price € 116.6 per ton. [7]

2.18 Baltic States: Estonia, Latvia, Lithuania

2.18.1 Regulatory framework market drivers and barriers

The Baltic States, Estonia, Latvia and Lithuania are significant and interesting wood pellet producers. Rich forest area, cheap labor, low energy cost and low taxes in Baltic States are quite good conditions for wood pellet production. [1]

National energy production and consumption in the Baltic States depends on country-specific energy production means, established supply routes and infrastructure, and on specific economic and political considerations. In the primary energy supply, each of the Baltic States has a specific feature that distinguishes it from the other two and makes it unique. [2]

The Estonian electricity production is based on a small number of large fossil-fuel power plants. Oil shale share in Estonian power production consist 88%. Furthermore, natural gas, oil shale gas, shale oil, diesel oil, wood and peat are used as fuels; also, small hydropower plants and a growing number of wind turbines are in operation.

The Latvian electricity system is based on hydropower and co-generation of fossil fuels (mainly natural gas and coal to some extent). [3] In total, 59% of the electricity produced in Latvia comes from hydro power. [4]

Up until recently the Lithuanian electricity system is dominated by nuclear power production. Nuclear power share in electricity generation in 2009 was 71%. However, in the end of 2009, main source of Lithuanian's electricity in the Ignalina Nuclear Power Plant was closed and Lithuania has been facing difficult choices about where to find new sources of electricity. [2] Table 2.24 presents energy production in Baltic countries.

Country	TPES (2008) EJ*	**Proportion of total final energy consumption of energy from renewable sources **(%)**	**National overall targets in 2020 (%)****
Estonia	0.22	19.1	25
Latvia	0.18	29.9%	40
Lithuania	0.38	15.2*	23

Table2.24 Energy production in Baltic States 2008

**Include hydro, biomass, waste, geothermal, solar, wind and tide energy*
Source:* *IEA Stat [5], ** Onder T., Hemingway J.[6]*

Dominant sources of renewable energy in Estonia are solid biomass, biofules and small-scale hydro power; which cover around half of the country's renewable energy sources. Since 2003, installed wind power has increased and reached one third of country's RES. [7]. Until 2007 the share of renewable energy remained around 1%, then in 2008 it was 2.1% and in 2009 consist 6.1 %. [8]

The proportion of electricity generated by renewable energy sources in Latvia is among the highest in EU. Large-scale hydro-energy is the dominant renewable energy source accounting for 94% of all renewable production. Small-scale hydro- and onshore wind power recorded production growth in recent years. [7]

The biggest potential is properly within biomass, this is already another important energy resource in Latvia, and the share of biomass in the energy production is expected to rise in the future. [8].

Hydro power is the dominating source of renewable electricity generation in Lithuania. In 2009 70% of green energy was generated by hydropower plants while wind farms have made 20% and bio fuel 10% [4]. According to Lithuanian National Energy Strategy the main emphasis of the renewable energy development will be on biomass. Lithuania plans to increase biomass-based electricity production from 100 GWh/yr in 2009 to 1,200 GWh/yr in 2020.

Renewable Energy is promoted and supported by governments in Baltic States, which are committed to renewable energy targets of the European Union. Besides National targets for RES share, in all this countries feed-in-tariff for renewable energy production is in power. Table 2.25presents feed-in-tariffsin Baltic States.

Country	Technology	Support level (feed-in tariff)	Start year	Duration [years that an investor is entitled to support	Comments
Estonia	CHP	54 €/MWh	2010	12 years	from the beginning of
Lithuania	Solid/gasification	8.6 [€cents/ kWh]	2009	11 years	
Latvia	Power plants with electric capacity ≤4 MW	C= ((Tg*k)/9,2))*4,5	2007	10 years	For the first 10 years from the beginning of PP operation
		C= ((Tg*k)/9,2))*3,4	2007	10 years	After first 10 years

Table 2.25 Feed-in-tariff in Latvia, Estonia and Lithuania for electricity production from biomass

C = price of electricity without VAT

Tg = natural gas tariff approved by the Regulatory Authority (without VAT)

k = factor used for price differentiation depending on the installed capacity of the power plant (varies in the range from 1,240 to 0,965)

Source:*European Renewable Energy Council (EREC) [9]*

The bioenergy market in Baltic States is rather unique. Estonia and especially Latvia have high share of renewables in their energy mix and also Lithuania uses a larger RES share than the European Union average. Estonia and Latvia have strong pellet markets (Estonia has the biggest volume of produced pellets per capita in the world) but like in Lithuania the production of pellets are mainly focused on exports. [1]

Main drivers for pellet production and trade in Baltic States:

- Relatively low costs of production (raw material salaries and energy);
- Raw material – there is a wood resource available and cheap labor and energy costs can make the price competitive [1]
- Big ports for pellet transport in Sillamae (Estonia), Klaipeda (Lithiania), Liepaya, Vetspils (Latvia), and Paldiski (Estonia).

Main barriers:

- Lack of domestic equipment producers/consultants/experts;
- Lack of easy and good quality supply chain for any target group.[1]
- Lack of big domestic consumers

2.18.2 Production capacity and feedstock

Pellet production in the Baltic States started at the beginning of the 21st century. It was based on to foreign investments and increasing demand in the Baltic Sea Region (Sweden, Denmark etc.) boosted the investments. The original know-how is also based on Scandinavian experience.

From the beginning the pellets from Baltic States had a good position in the Nordic market, due to lower production costs (mainly lower energy prices and salaries). The further development was related to the growth of the overall wood industry and increasing fossil fuel prices.[1]

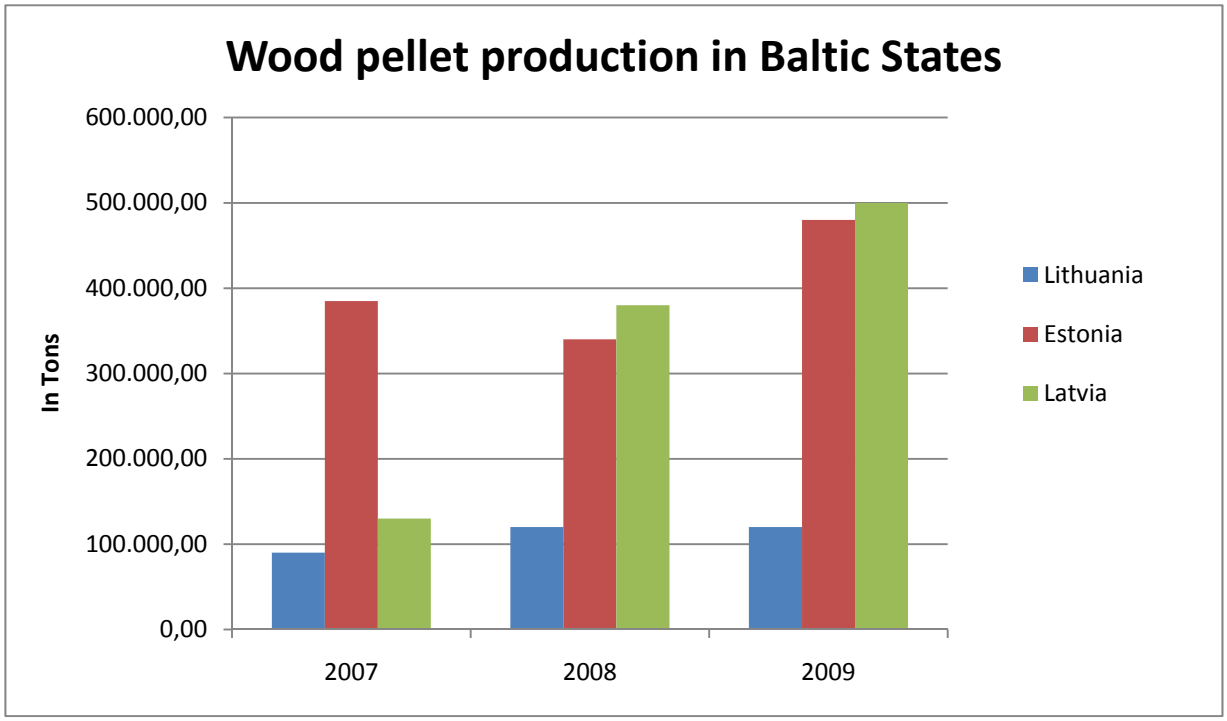


Figure. 2.62 *Pellet production in Baltic States (data is approximate from different sources)*

Source: *Pellet Atlas project [10]; Sikkema R, Y 2011 [11]*

The share of Estonia in the production of renewable energy in agriculture and in forestry is small, compared with EU-25. In 2009, the production of wood pellets was 45% bigger than in 2008. A range of bio-energy and CHP projects were initiated in 2009, where several plants have been built and more are in the under construction. [4]

Latvia is one of the largest producers of pellets in Europe. There are around 20 pellet plants with total capacity of 750 thousand tons / year. Moreover the ports of this country are the major trans-shipment points for Russian and CIS countries pellets to Europe. Most of Latvian pellet mills are located near Riga. Previously, the largest pellet company in Latvia was the Baltic Bioenergy Group, which is completely closed. Today the major players of pellet market in the country are Graanul Invest and Latgran. AS

Graanul Invest announce about new 180,000 tones/year pellet mill construction in Incukalns (Latvia). The plant will also have a CHP unit mainly using forest residues as a fuel. Operation is planned to start in July 2011 and to reach full capacity by the mid of 2012. This plant will be seventh for AS Graanul Invest and will increase their production capacity to 640 000 tones of pellets annually.[12] Also, Latgran (another big pellet producer) will open a 140 tonnes/year plant at southeast of Latvia in the near future.

In Lithuania, production of wood briquettes was started in 1994 and wood pellets in 1999. The bioenergy market in Lithuania is very different to those in Latvia and Estonia. The main difference is that bioenergy products are less traded internationally [1].Lithuaniaplans tosignificantlyincrease pellets productionin thenext10years. By 2020 biomass is targeted to cover up to 70% of heat energy and 6% of electricity. In 2008, production capacity of briquettes was equal approximately to 60 thousand tons and pellets 120 thousand tons per year. About 70% of wood briquettes and almost all pellets are exported abroad. [14] List of major Baltic pellet producers is present in following three tables.

ESTONIA 2008/2009

Name	Location	Installed capacity	Actual production
Hansa Graanul	Patkula	110 000	CLOSED
AS Flex Heat	Rakvere	105 000	91 000
Graanul Invest/Delcotec	Paide	40 000	N/A
Vapo Oy	Tootsi Turvas Pärnu	15 000	CLOSED
Graanul Invest	Paide	105 000	N/A
Graanul Invest AS Pellets	Rakvere	10 000	N/A
Graanul Invest	Patküla	100 000	N/A
Total installed capacity		485 000	

Table 2.27Pellet producers in Estonia 2008/2009

***Source**: Bioenergy International Magazine № 35 [15]*

LATVIA 2008/2009

Name	Location	Installed capacity	Actual production
Lantmännen Agroenergi	Talsi	90 000	47 000
BBG, Zemgales Granulas	Lecava	25 000	CLOSED
Latgranula/Incukalna	Riga	24 000	N/A
CED	Katrinkains, Cesu	12 000	N/A
TallOil Sia Marama	Liepaja	48 000	CLOSED
BBG Gaujas Granulas	Riga	84 000	CLOSED
BBG Videzemes	Cesvaine	12 000	CLOSED
Kurzemes Granulas	Ventspils	42 000	N/A
Graanul Invest	Launkalne	120 000	60 000
Latgran	Jaunjelgava	75 600	N/A
Latgran	Jekabpils	110 000	N/A
Nordic Bioenergy	Riga	15 000	CLOSED
Remars Granula	Riga	60 000	CLOSED
Katlakalna	Latvia	24 000	N/A

Dekmeri	Baldone	12 000	N/A
Ekosource	Aluksne	12 000	N/A
Frix,	Valmiera	24 000	N/A
Kokagentura	Lecava	30 000	N/A
Nelss,	Aizkraukle	84 000	N/A
Priedaines	Varaklani	12 000	N/A
SBE	Talsi	72 000	N/A
Total installed capacity		980 000	

Table 2.28 Pellet producers in Latvia

***Source**: Bioenergy International Magazine № 35 [15]*

LITHUANIA 2008/2009

Name	Location	Installed capacity	Actual production
GaireLita	Radviliskis	18 000	12 000
Graanul Invest	Alytus	70 000	N/A
Granulita	Baisogala	25 000	25 000
Biofuelz	Prienai	14 000	10 000
Utenos Gelzbetonis	Utena	4 200	CLOSED
Biodela	Vilnius	18 000	12 000
Total installed capacity		150 000	

Table 2.29 Pellet producers in Lithuania

***Source**: Bioenergy International Magazine № 35 [15]*

About 52% (2,217,000 ha) of the Estonian, 53.8% (3,354,000 ha) of the Latvian and 34.5% (2,160,000 ha) of the Lithuanian territories are covered by forests. Wood industry is one of the largest industries in Estonia. Over 1,000 enterprises engage in wood processing and manufacture of wood products.[16] Estonia has ample forest resources, the amount of wood waste generated annually is still only 4-5 million cubic meters. [18] Total primary energy content of biomass in Estonia, which could be used for energy production, exceeds 20 TWh annually.

The annual volume of tree felling in Lithuania is around 6 million cubic meters. The consumption of wood fuel and wood waste fuel is around 3.7 million cubic meters. Wood accounts for 6 percent of the total energy produced in Lithuania. [19] It is estimated that 1.5 million tones of biomass could be extracted from forest resources. The largest potential for forest fuel resources is located in the southeastern portion of the country.[20] The techno-economical *potential*for bioenergy use in *Latvia* is estimated to be 214 PJ per year and production of refined biomass fuels is 6.5 PJ annually.[21]

2.18.3 Consumption

There is relatively low domestic pellet consumption in Estonia, Latvia and Lithuania. There is no large-scale consumers, because of that domestic market are not well-developed. Unfortunately, there is lack of comprehensive data about pellet consumption in Lithuania. According to Pellet Atlas project data in 2008 Lithuanian wood pellet consumption was 20,000 tons/year. It's around 15% of total Lithuanian production.

Wood pellet consumption in Estonia is low. According to Statistics Estonia in 2009 year 95% of the produced pellets were exported from Estonia to EU. We have every reason to believe that domestic consumption was around 20,000 tons in 2009.

In Latvia in 2008 consumption was almost 80,000. According to Latvia Statistics in 2009 wood pellet consumption is decreased on 23% compare to 2008. [23] Consequently, wood pellet consumption in 2009 was approximately 60,000 tons annually.

2.18.4 Trade and logistic aspects

Today pellet market in Baltic States is still strongly export oriented. Major export directions of Baltic pellets are Scandinavian countries, Germany and UK. At the following figures is present pellet export from Baltic countries in 2010.

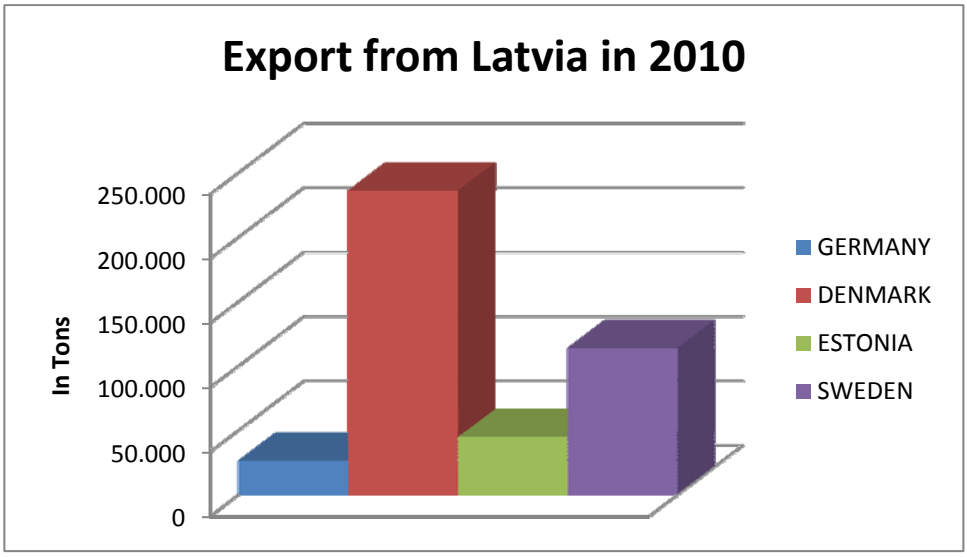


Figure2.63Wood pellet export from Latvia in 2010

Source: *Eurostat, 2011[24]*

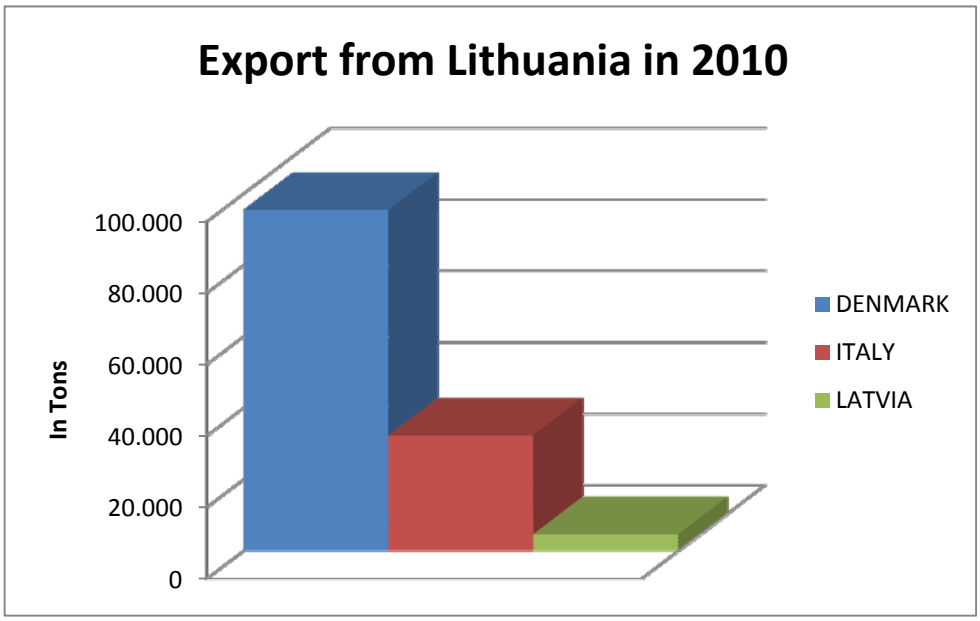


Fig 2.64 Wood pellet export from Lithuania in 2010

Source: *Eurostat, 2011[24]*

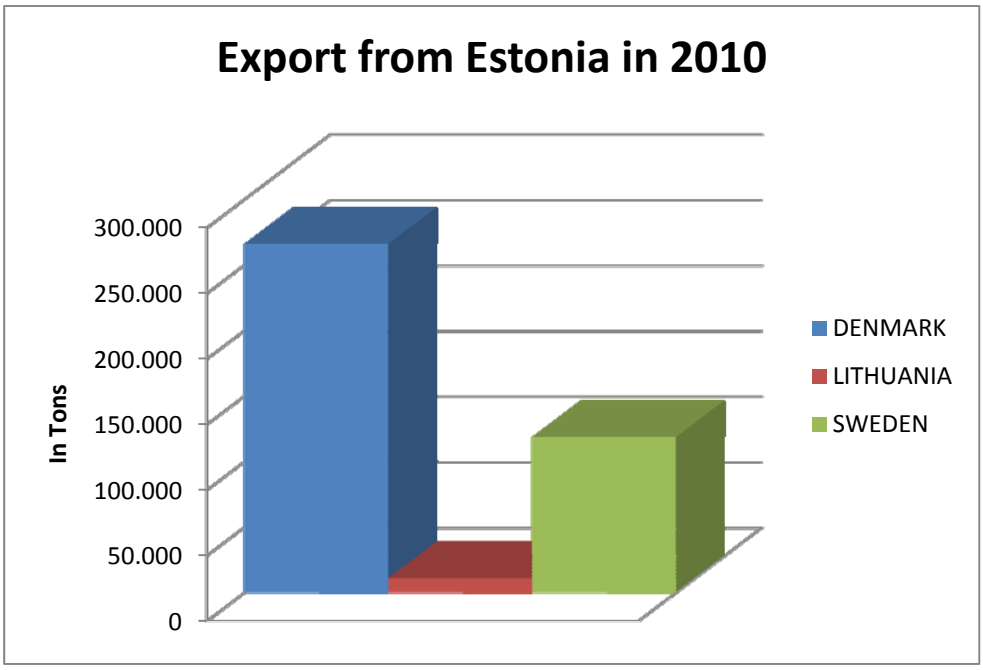


Figure2.65Wood pellet export from Estonia in 2010

Source: *Eurostat, 2011 [24]*

Wood pellets import from other countries to Baltic States is negligibly small comparing to Baltic's export to EU. Essentially, it's possible to mention only import from Belarus to Lithuania according to Eurostat in 2010 it was around 24,000 tones.

The major export flows from Eastern Europe originate from Russia and the Baltic States. Majority pellet exports to Europe take place through St. Petersburg harbor in North-west Russia and via Riga harbor in Latvia. Average export prices in Riga have gone up on an annual basis to about 119 € per ton by the end of 2009, the average shipping costs from Riga to Denmark, as estimated by involved pellet actors, were about20 € per tone.[11]

According to regional peculiarities the main transport mode is mixed but international ship transport over the Baltic Sea strongly dominates. Local transport is done by trucks and railway. These logistics of pellet products cause a significant output of non-renewable CO2. As it also requires extra energy for long-distance logistics the already relatively low energy payback ratio for the pellets from Estonia, Latvia and Lithuania is further reduced. [1]

2.18.5 Pellets quality and standard

There is no special wood pellet standard in Baltic States. Considering the fact that, major part of Baltic pellet is exporting to Denmark and Germany therefore it is possible to assume that Baltic's producers using those countries pellets standards. From January 2010 ENplus (for private pellets) and EN-B (for industrial pellets) were introduced, consequently Baltic producers start manufacture pellet products in accordance with this new pan-European standard.

2.18.6 Price trends

Wood pellet prices in Baltic States are differ among them. The price monitoring is presentedis Figure 2.66.

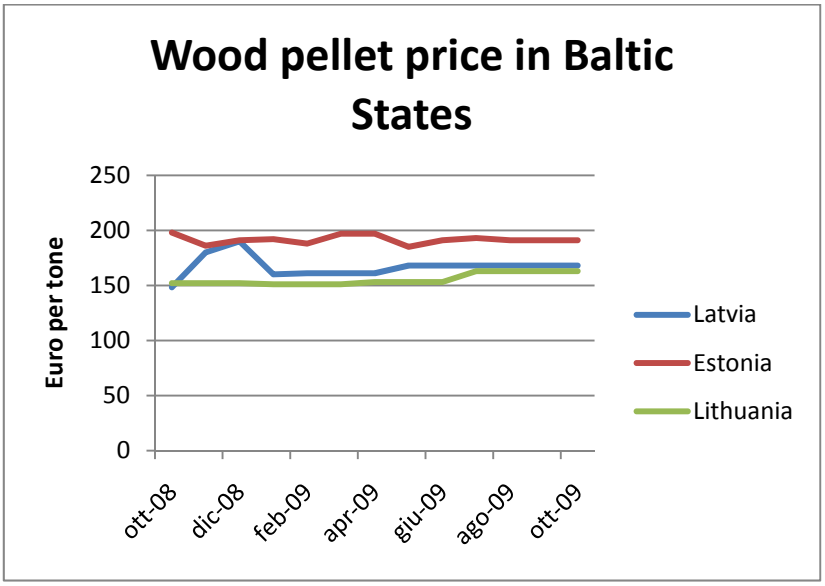


Figure. 2.66 Wood pellet price in Baltic States

Source: *created by author; based of Pellet Atlas project data [10]*

2.19 Czech Republic

2.19.1 Regulatory framework market drivers and barriers

The production of wood pellets and briquettes in Czech Republic started in the nineties, the expansion of the sector is driven mainly by exports to neighboring countries.

The current regulatory framework supports the general development of renewable energy and especially electricity (Act No 180/2005). Other support measures target cogeneration, energy efficiency measures and a tax relief (Act. No. 586/1992 Sb) on incomes generated by plants using RES.

A State Environmental Fund provides subsidies for energy efficiency and heating in the residential and public.

2.19.2 Production capacity and feedstock

According to the research done by the Czech Ministry of Industry and Trade, there were nearly 60 manufactures of briquettes and pellets in the Czech Republic in 2004. Altogether, they produced about 125,000 tons of briquettes and over 12,000 tons of pellets. The large majority of these products was exported, especially to Austria and Germany.

In 2008, 12 companies were producing pellets as their primary activity. The 2008 production capacity was about 78,000 tons per year, but the production was only 27,000 tons and 24,000 tons were exported.

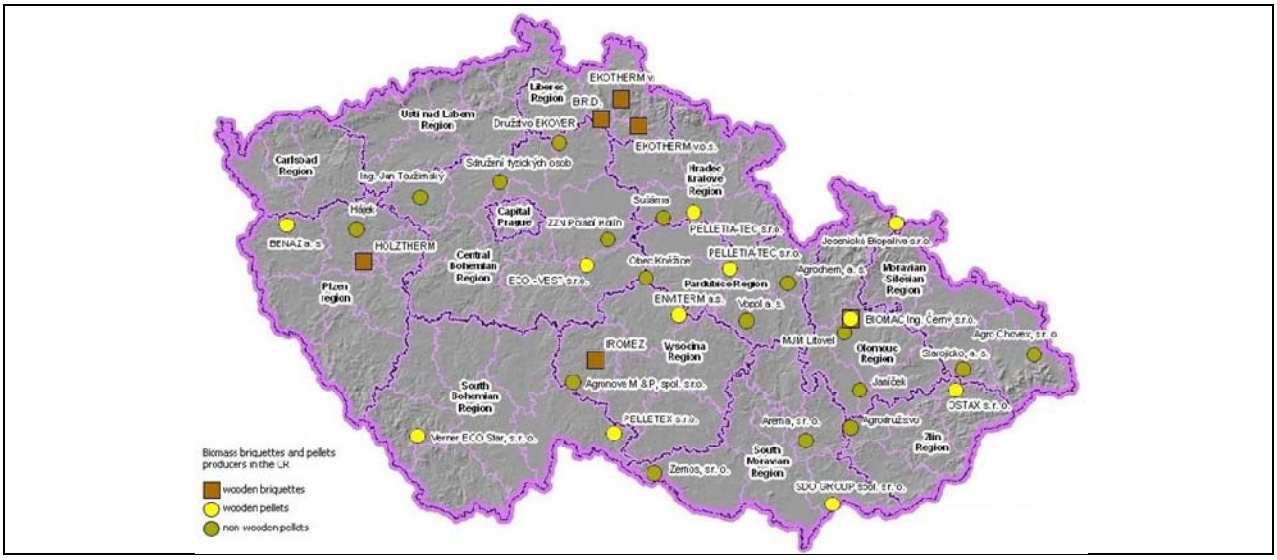


Figure 2.67: Location of major producers of briquettes and pellets in the Czech Republic in 2008.

Source: *ACCESS D13- Maps and databases on the biomass potential.*

According to the Bioenergy International, the pellet production capacity in 2009 amounted to 171,000 tons but the production was of 40,000 tons. In January 2011 it reached 194,000 tons.Most of the pellets is produced from spruce or pine sawdust.

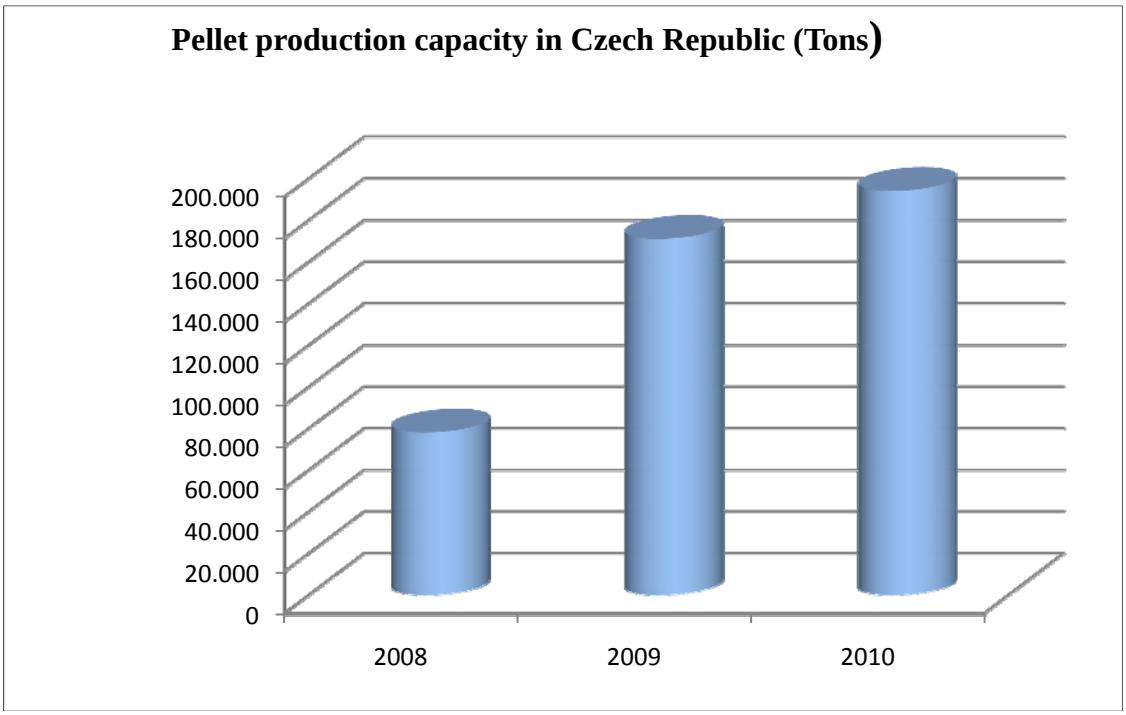


Figure 2.68: The evolution of Pellet production capacity in Czech Republic.

***Source**: ETA – Florence.*

2.19.3 Consumption

Use of biomass for energy showed an unprecedented growth in recent years in theCzech Republic both on a small-scale level (individually by households) and also inlarger installations (heat and/or power plants in industry and district heating systems).

In 2008, only 45,000 tons of briquettes and 3,000 tons of pellets were used within theCzech market, with about 40,000 tons of briquettes and most of the produced pelletsconsumed by households for individual heating.

2.19.4 Trade and logistic aspects

According to Eurostat in 2010Czech Republic exported 96,000 tons, mainly to Austria, Italy and Germany; imports were limited to 14,000 tons from Austria, Ukraine and Germany.

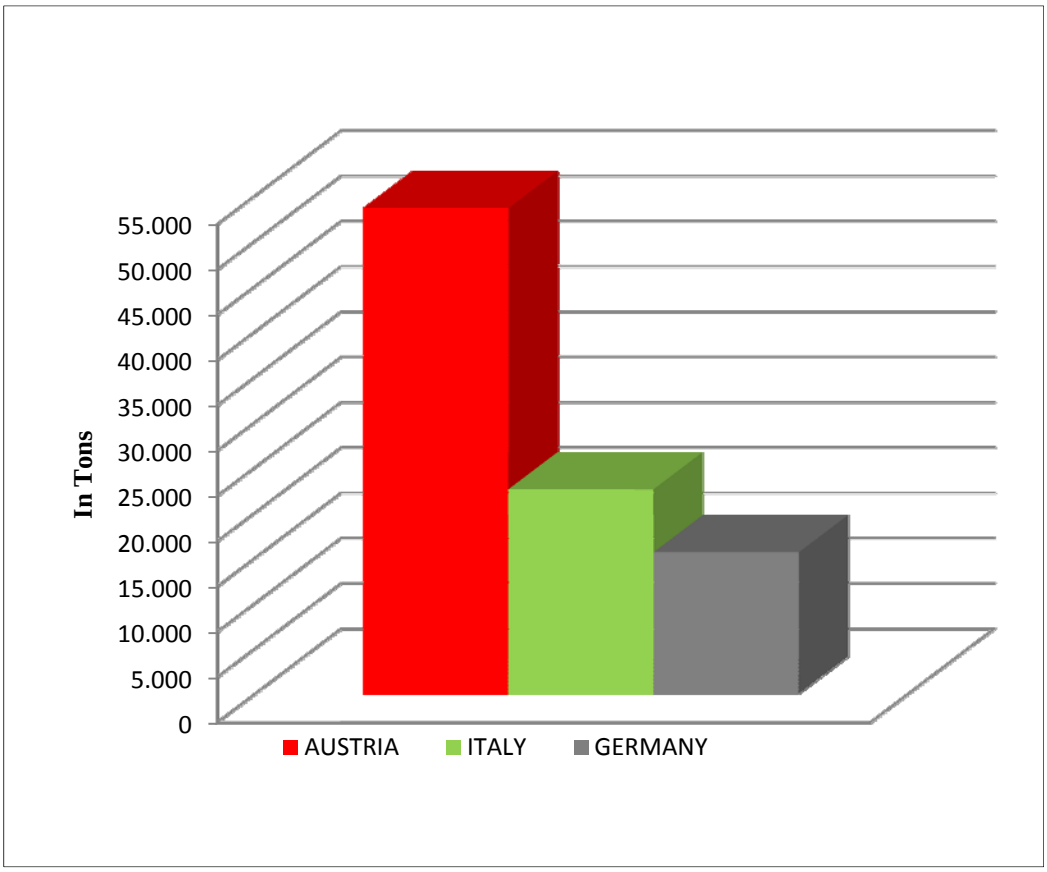


Figure 2.69: Pellet exports from Czech Republic in 2010 Source Eurostat.

2.19.5 Pellets quality and standard

The quality of pellets produced in the Czech Republic is very high, some manufacturers possess the quality certificates Önorm M 7135 or DINplus. Most manufacturers possess test certificates issued by an independent Institution for Fuels Research and Utilization.

3 The Wood Pellet Industry and Market in North America

Douglas Bradley, Richard Hess, Jacob Jacobson, Leslie P. Ovard

3.1 Canada

3.1.1 Raw Material

In 2004, Canadian sawmills produced 83.5 million m^3 of lumber, shown in Table 3.1, yielding 21.2 million ODt of mill residues (sawdust, bark etc). Most mill residues were utilized, but there was still a surplus of 2.7 million ODt. The financial crisis in the United States (US), which was followed by a worldwide recession, changed the situation entirely. Millions of unsold US homes drastically reduced home building and subsequently the demand for Canadian lumber. Production fell to 45.1 million m^3 in 2009, wiping out mill residue surpluses. By December of 2009, sawmill production began to increase, and while projected output in 2010 was only 65% of the peak in 2004, it was still 20% higher than 2009. Mill residue production in 2010 was estimated at 13.7 million ODt, though all of this is utilized. With coming sawmill production increases, it is projected that 5.5 million ODt of new mill residue will come on the market annually by 2012, shown in Table 3.1.

	Lumber Production m^3 X 1000			Production BDt X 1000	Available 2012 BDt X 1000				
	2004	2010 LE	%	Mill residues	Hog piles	Roadside	Urban	Total	Mill residues
BC	39,206	27,455	70	6,979		9,946	1,303	11,249	2,792
Alberta	8,054	7,638	95	1,942		2,544	1,017	3,561	777
Sask	1,182	121	10	31	290	424	251	965	12
Manitoba	637	121	19	31		131	305	436	12
Ontario	8,727	3,578	41	909	1,160	2,431	3,900	7,491	364
Quebec	19,884	11,778	59	2,994	525	5,213	2,490	8,228	1,198
New Bruns	4,040	2,377	59	604	26	610	146	782	242
NS/Nfld/PEI	1,784	893	50	227	37	658	338	1,033	91
Canada	83,514	53,961	65	13,717	2,038	21,957	9,750	33,745	5,487

Table 3.1 Lumber Production and Biomass Availability

In BC, Alberta, and Manitoba, sawmills have been required to incinerate mill residue, primarily bark, that was not used internally or sold. In Saskatchewan and Eastern provinces, incineration has not been allowed, so mills have piled excess residue at the mill site in giant hog piles. In a few cases, the bark is too wet to be economically usable or it is contaminated with rocks or soil, but many of these piles are

excellent sources of biomass for energy. In 2010, it was estimated that there are over 60 piles of bark, totaling over 20 million ODt, that are uncommitted for other uses, have very little contamination, and are dry enough to be used for bioenergy feedstocks If mined over 10 years, these resources were projected to yield 2 million ODt p.a. Since the 2010 estimate, new analyses have shown that the amount of usable bark was underestimated by 2 million ODt.

As mill residue surpluses have declined in recent years, companies and provincial governments have began to look seriously at harvest residues as a fuel source. Since full tree harvesting dominates in Canada, much of the harvest residues are already at roadside. A Biomass Inventory and Assessment Tool (BIMAT) was developed to identify and characterize biomass sources potentially available for bioenergy. The model reflects harvest operations by province; e.g., Ontario uses full tree harvesting and 90% of harvest residue is left at roadside, while Quebec uses cut-to-length harvesting in 40% of its operations and leaves only 60% of residues at roadside. BIMAT estimates harvest residue volumes at roadside based on the maximum sustainable harvest level in each province to be 31.1 million BDt p.a., including tops and branches from harvesting and thinning operations, and bark and log exterior residue from full tree chipping. With annual harvest below the allowable annual cut for several years, and with poor US market factors, a better estimate for available harvest residue in 2010 might be 22 million ODt. BIMAT also estimates 9.75 million ODt of urban wood available annually, including discarded wood products, trees, branches and stumps from park maintenance, pallets and crates etc[5]. The total woody biomass available is 33.7 million ODt, shown in Table 3.1. When the US housing market recovers in 2–3 years, we project an additional 5.5 million ODt in mill residues and 12 million ODt in harvest residues available.

Purpose-grown sources of woody biomass, primarily willow and hybrid poplar, are being explored near biomass users. Approximately 2500 hectares are being established annually with scale-ups planned in Ontario and the Prairies. Land suitability potential in Canada for these applications is 8–16 million hectares, primarily in the Prairies, Ontario, and Quebec. Establishment costs are 50–70% of the total delivery costs.

Managed juvenile hardwood stands are also projected to yield 30–60 ODTs of biomass using progressive chipping, baling, or bundling harvest systems in short-rotation operations. There are 100,000–110,000 hectares harvested annually in the boreal forests that could consider this option. Trials are being conducted by forest companies and bioenergy research agencies to determine the cost of supply chains. The Prairies, northern BC, Ontario, and Quebec have significant opportunities for this source of woody biomass.

Farmland occupies 67.5 million hectares in Canada, or 6.7% of the total land base. Crops are grown on 54% of farmland. Agricultural biomass available for energy may be 17.3 M Odt p.a., or 309 TJ. A June 2007 estimate suggests that 2 million tonnes p.a. of agricultural residues would be available based on 10-year average yields and collecting residue once in every 4 years[6].

3.1.2 Production and Capacity

The manufacture and export of wood pellets in Canada has grown exponentially in the past several years, primarily on the west coast. As shown in Table 3.2, capacity grew from 500,000 tonnes in 2002 to 3.2 MT in 2011, but Canadian pellet production declined in 2008 largely due to a shortage of mill residues as a result of sawmill closures brought on by a severe downturn in the US housing market and subsequent decline in lumber demand. For many pellet manufacturers, a major fibre source is now harvest debris and non-commercial roundwood (in some cases 70% of feedstock) supplemented by mill residues. Supply chains to draw from this source have not been fully developed. Raw material costs

[5]Canada Report on Bioenergy 2010, D Bradley, Climate Change Solutions

[6] Mark Stumborg, presentation CanBio Bioenergy Conference Ottawa, June 2007

have increased 3–4 fold, requiring export contracts to increase 30–40% in price in order to sustain financial viability for pellet mills. Ontario, Quebec, and BC are all working with mechanisms to ensure sufficient fibre for pulp mills, sawmills, pellet plants and other uses. Pellet production is was 1.4 million tonnes in 2009 compared to capacity of 2.1 million tonnes. Pellet production can reach 20 million tonnes sustainably[7].

	2002	2003	2004	2005	2006	2007	2008	2009	2010*	2011*
Capacity	500	540	730	950	1.300	1.600	2.085	2.083	2.527	3.262
Production	499	533	727	936	1.135	1.485	1.335	1.400	1.750	2.087
*estimated										

Table 3.2 Canadian Pellet Manufacturing- 000 tonnes p.a.

There are 39 pellet plants operating with total capacity of 3.2 million tonnes, as shown in Table 3.3. Eleven plants with more than half of Canada's capacity are in BC, on the west coast. BC also boasts the three largest pellet plants in Canada: Pinnacle-Meadowbank 200,000 tonnes; Pinnacle-Williams Lake 150,000 tonnes; and Pinnacle/Canfor-Houston 150,000 tonnes. Pinnacle Pellet is the dominant producer, operating four plants in BC and one in partnership with CanFor and the Moricetown First Nations in the 150,000-tonne plant in Houston.

[7] John Swaan

	Plant Name:	Location:	Capacity tons/y
1	Woodville Pellet Corp-10f2 Highland Plant	Merritt, BC	120.000
2	Gold Standard Pellet Fuel (SBC Firemaster)	Surrey, BC	45.000
3	Okanagan Pellet Company	West Kelowna, BC	50.000
4	Pacific BioEnergy Corp. *Conf*	Prince George, BC	350.000
5	Premium Pellet Ltd.	Vanderhoof, BC	140.000
6	Princeton Co-Generation	Princeton, BC	90.000
7	Tahtsa Pellets Ltd.- Pacific Flame	Burns Lake, BC	80.000
8	Vanderhoof Speciality Wood Products	Vanderhoof, BC	30.000
9	Pinnacle Pellet- H	Houston, BC	240.240
10	Pinnacle Pellet- W.L.	Williams Lake, BC	200.200
11	Pinnacle Pellet- MB	Strathnaver, BC	220.000
12	Pinnacle Pellet- B.L.	Burns Lake, BC	320.320
13	Pinnacle Pellet- A	Armstrong, BC	61.880
14	Pinnacle Pellet- Q	Quesnel, BC	100.000
15	Vanderwell Contractors	SlaveLake, AB	60.000
16	La Crete Sawmills	La Crete, AB	50.000
17	Foothills Forest Products	Grande Catche, AB	25.000
18	Industries LacWood	Hearst, ON	7.000
19	Gildale Farms	St.Marys, ON	4.000
20	Energex Pellet Fuel	Lac-Megantic, QC	120.000
21	Lauzon Recycled Wood Energy	St. Paulin, QC	30.000
22	Lauzon Recycled Wood Energy	Papineauville,QC	60.000
23	Granulco	Sacre-Coeur, QC	20.000
24	Granules de la Mauricie	Shawinigan-Sud,	22.000
25	Granules LG	St.Felicien, QC	120.000
26	Trebio Inc.	Portage-du-Fort,	130.000
27	Granule Boreal	Amos, QC	50.000
28	Marwood	Tracyville, NB	12.000
29	Nashwaak Valley Wood Energy	South Portage, NB	17.500
30	Crabbe Lumber	Bristol	40.000
31	TP Downey	Hillsborough,NB	40.000
32	Groupe Savoie	St-Quentin, NB	55.000
33	Shaw Resources (1of2)	Belledune, NB	75.000
34	Shaw Resources (2of2)	Shubenacadie, NS	90.000
35	Enligna	Musquodoboit	100.000
36	Finewood Flooring	Baddeck, NS	10.000
37	Cottles Island Lumber Company	Summerford, NL	12.000
38	Exploits Pelletizing	Bishops Falls, NL	15.000
39	Holson Forest Products	Roddickton, NL	50.000
	Survey Operating Total:		**3.262.140**

Table 3.3- Pellet Plants in Canada- (2011)

Alberta now has four sawmills with combined capacity of 149,000 tonnes. Ontario is far from ocean ports and has only one small plant operating. Quebec has capacity of 290,000 tonnes over five plants, all capable of exporting by way of the St Lawrence River. The Atlantic Provinces have been particularly hard hit by sawmill and pulp mill closures in recent years, and governments are anxious to utilize the forest resource to create jobs in struggling communities. Three new pellet plants have been built in the last year: Groupe Savoie-St. Quentin New Brunswick, 55,000 tonnes; Holson Newfoundland, 50,000 tonnes; and Cottles- Newfoundland, 12,000 tonnes. Overall, there are now 12 pellet plants in the Atlantic Provinces.

3.1.3 Consumption and Exports

Canada has rich oil and natural gas resources and over decades has developed a wide infrastructure for distribution. Most of Canada's population is on a natural gas distribution system, the exceptions being remote northern communities and parts of Quebec and the Atlantic provinces, which are still on oil. The domestic market for pellets is very small, estimated at 100,000 tonnes annually. Approximately 1.3 million tonnes are exported annually, mostly from BC. Much of BC pellet production is in the interior 400–600 km from ocean ports. Pellets are shipped by rail either to the northern port of Prince Rupert, or south to Vancouver. While these ports have been enhanced over time, there are still inefficiencies that can be removed with investment. On the east coast, Enligna has exported from the port of Halifax for some time. With new pellet production in New Brunswick, the port of Belldune is increasingly being used for exports.

Canada is aware of the Swedish model whereby large capacity was built initially to supply large power plants, and with assured pellet supply, a domestic heat market was subsequently built over time. Canada anticipates utilizing its forest resources to build capacity for exports, but over time anticipates an increasing amount will be used domestically. A larger domestic market has taken on increasing importance in the last year because of the unforeseen fall in the value of the Euro relative to the Canadian dollar. Pellet manufacturers are paid a € price, and so revenues received for pellets often result in squeezed profits, especially for smaller plants. It is estimated that production was only 1.4 million tonnes, compared with capacity of 2.1 million tonnes in 2009, due to plant closures and production slowdowns. As such, the Canadian Bioenergy Association in 2011 began a new Go Pellets initiative to promote development of a domestic pellet market. Go Pellets will roll out regionally, beginning in the Atlantic provinces, BC, and the North West Territories, and later into Quebec and Ontario. Because of the lack of pellet infrastructure and lack of knowledge of pellet utilization by consumers, it is projected that the domestic market will grow slowly.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Domestic	99	88	87	88	135	250	230	100	350
US	230	210	265	265	400	495	335		400
Offshore	170	235	375	583	600	740	770	1.400	1.250
Total	499	533	727	936	1.135	1.485	1.335	1.500	2.000

Table 3.4.Canadian wood pellet markets by destination (tons × 1000)

3.1.4 Proposed Pellet Plants

Ontario Power Generation (OPG), Ontario's largest power producer, is legally obligated to eliminate power production from coal by December 31, 2014. Its plan is to convert several generating units to biomass and natural gas, beginning with one unit at the Atikokan generating station, one unit at the Thunder Bay generating station, and then two units at Nanticoke on Lake Erie. Pellet testing has

beengoing on at Atikokan for a couple of years. An explosion that occurred there in December 2009 because of unfamiliarity with pellets has led to a slowing down of the biomass conversion strategy, and even influenced a revised plan to convert some units to natural gas to replace coal.

Atikokan will need 90,000 tonnes pellets annually, projected for 2012. If all four OPG generating units are converted to biomass, the demand for pellets will be 2–3 million tonnes by 2014. To ensure this supply, OPG requested proposals for pellet supply including price intentions. As a result, there are approximately 18 proposals to build pellet plants in Ontario. Of course not all will be built. Most of the wood resource in Ontario is owned by the Province, and while many of the proposals include a significant amount of private wood and wood rights from existing Sustainable Forest Licenses, many are dependent on receiving new wood supply agreements from the Province. Ontario is scheduled to begin allocating wood to bioenergy projects in early 2011, for pellet manufacturing, and also for bio-heat, bio-power, and bio-refinery projects. All of these proposed pellets plants hope to supply OPG, but most will be interested in the viability of the export market. While many of the plants will be in the far north of the province, the Great Lakes Seaway system is a low-cost transport option that has been used by the pulp and paper industry for decades that will enable low-cost transport to the ocean ports of Montreal and Quebec City. The port depth standard for the Great Lakes Seaway system is 24 ft (8 metres), sufficient for small ocean-going vessels.

There are several pellet plants at various stages of construction. Holson Forest Products began trials in November 2010, and is considered a “producer” in Table 3.3. Atikokan Renewable Fuels has almost completed construction on a 127,000-tonne pellet plant in Ontario and anticipates start-up in the second quarter 2011. On January 12, 2011, Canadian Bio Pellet broke ground on a proposed 450,000-tonne plant at Ingleside Ontario, but it is believed this project is still looking to complete financing. Ecoflamme has wood supply in place and has completed a plan for a 35,000-tonne plant in Western Quebec, but it is still looking to complete financing and also improvement in the export market price. Industries Lacwood in Hearst has completed a 7,000-tonne plant. In addition to these plants, there are at least 17 known projects with capacity of over 1 million tonnes in the planning stages, shown in Table 3.4. Not all of these will be built, and many await a stronger Euro price for export markets.

	Name	City	Province	Capacity	Status
1	**General Biofuels Canada**	Terrace	BC	500,000	2011
3	**Pacific Bioenergy**	Kitwanga	BC		
4	**Pelltiq't Energy**	Kamloops	BC	175,000	2010
5	**Shulus Power**	Merritt	BC		
6	**Tahtsa Lumber**	Burns Lake	BC		
7	**Dansons & Sundance Forest**	Edson	AB	30,000	2010
8	**Winnipeg Forest Prod**	Winnipeg	Man	10,000	
9	**Canadian Biofuel**	Tillsonburg	ON	27,000	
10	**Fibre Brain**	Sault Ste Marie	ON	32,000	
11	**Kenora Forest Prod**	Kenora	ON		

12	**Nipissing First Nation**	Nipissing	ON	24,000	
13	**White River Forest Prod**	White River	ON	100,000	
15	**Woodville Pellet**	Kawartha Lakes	ON	75,000	
16	**Granulco**	Sacre-Coeur	QC		
17	**York Energy**	Nackawic	NB		

Table 3.5 Proposed Plants (Canadian Biomas)

Plant Name	Location	Capacity (tons/y)
Lhtako Energy Corp.	Quesnel, BC	
Whitesand First Nations	Armstrong, ON	60.000
Atikokan Renewable Fuels	Atikokan, ON	140.000
Direct Pellet Industries Inc.	Haliburton, ON	16.000
Pellagri Energy	Hartsville, H.R., PEI	n.a.
Woodville Pellet Corp. (2of2)	Kirkfield, ON	n.a.
Granules LG International Inc.	Mashteuiatsh, QC	80.000
Survey Total of Under Construction		296.000

Table. 3.6 – Canadian Pellet Plants Under Construction

3.1.5 Prices

Pellet export contracts are in Euros. Due to the collapse of the Euro in 2010 due to financial difficulties in several EU countries, mill nets at Canadian pellet plants have declined from $154/t to $125/t, as shown in Figure 3.1.

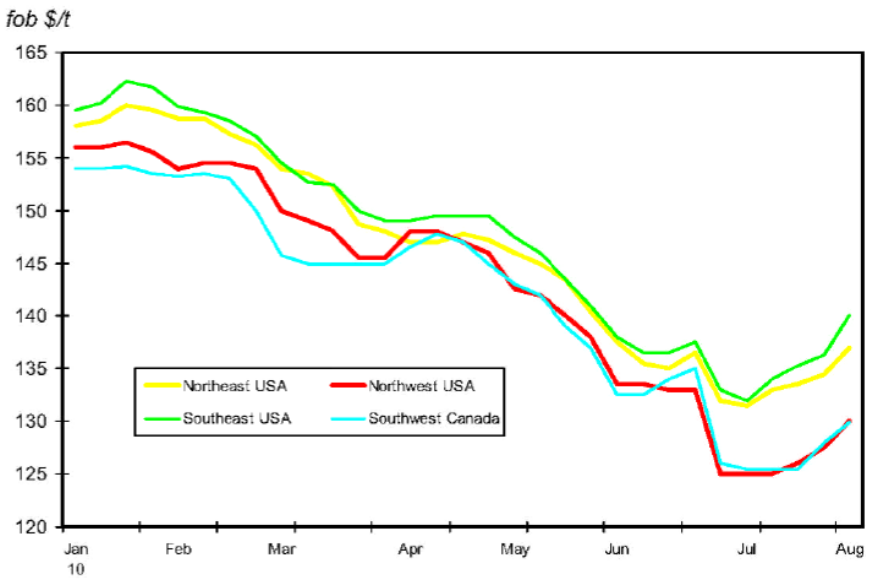


Figure 3.1 – "North America Export prices". Pellet Prices $Canadian

3.1.6 Market Drivers

The chief market driver is the search for new economic livelihood in communities following the winding down of the Canadian pulp industry due to globalization of pulp supply from low-cost regions, combined with the recent collapse of the sawmill industry. These industries formed the backbone of the economy for many small communities across the country, and while some of the sawmill production will return, in many cases pulp mills and smaller inefficient sawmills have shut forever. These communities are searching for new sources of socioeconomic growth, many expecting to utilize newly freed-up wood supply.

In BC, the mountain pine beetle infestation has killed a major proportion of Jack Pine trees in the interior. The BC government has been promoting utilization of this wood for traditional lumber and pulp products, and also for bioenergy and bioproducts.

In the US, the Biomass Crop Assistance Program (BCAP) reduced the cost of fibre to US pellet plants giving them a $50/tonne feedstock advantage over Canadian suppliers. As a result, the market for Canadian pellets in the US North East dried up; however, the BCAP benefit ended in April 2010 and US markets are opening up again. While the US market was essentially closed and the EU market became unattractive due to low prices, pellet manufacturers began to enter the Asian market, which now appears to be a promising option.

The short-term loss of two major export markets caused Canadian suppliers to seriously address the opportunity to grow the domestic market for pellets. The Canadian Bioenergy Association is now preparing a strategy to implement Go Pellets, a program to promote domestic use of pellets. It is still expected that most pellets will be exported.

Canada expects to begin construction on a 30,000-tonne demonstration plant that will produce pellets 15–20% more dense by volume than traditional pellets, reducing the cost of ocean transportation. The pellet would also water proof, thus making storage and transportation easier.

3.1.7 Future export scenario

Future export potentials are largely conjectural. As the pulp industry and sawmill industry wind down, demands for newly freed-up wood will be widespread for district heating, CHP, pellets, other transportable products, such as pyrolysis oil, torrefied wood, and bio-chemicals from biorefineries. Pellet capacity is 2.1 million tonnes, but with planned expansions, proposed new plants, and future unannounced plants, capacity could reach 5.8 million tonnes by 2020. Domestic demand today is only 100,000, but in the long term it could reach 2.3 million tonnes by 2020, leaving export potential at 3.5 million tonnes, almost triple today's exports.

	2011	2020
Capacity	3,262,000	5,775,000
Domestic Demand	100,000	2,300,000
Exports	1,972,000	3,475,000

Table 3.7 Supply Demand 2020

3.2 United States

3.2.1 Policy and regulatory context

Energy consumption in the United States is projected to require an increasing portion of its renewable energy sources including biofuels, among which are wood, and agricultural biomass [1] (**Figure** 3.2). Goals set by federal agencies will drive an increasing demand for biomass.

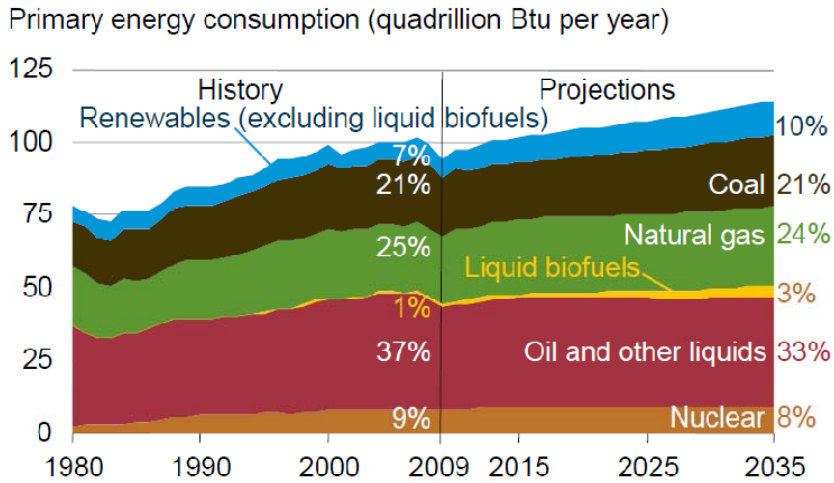


Figure 3.2: Primary Energy Consumption by Fuel (Source: [1])

The EIA projections estimate that renewable energy produced by 2035 will be ~10% of all U.S. energy consumption. Further analysis of the biofuels consumption in the US shows that of the renewable energy sources excluding biofuels, nearly 30% are wood or biomass waste. This equates to ~2% of the total energy consumption in the US coming from biomass in 2009, and the projections for 2035 show a strong increase in this amount. As of 2009, biomass energy production equates to ~2–2.5 quadrillion Btu.

The EIA projections also show coal as providing 21% of energy consumed. If biomass is blended at 20% to co-fire coal plants, this will result in an additional 4 quadrillion Btu of biomass consumption [1].

The EISA goals aim to produce 16 billion gal/year of cellulosic biofuels [2], and the US military has set goals for biofuels production. The Air Force has proposed to replace 50% of its domestic fuel requirements with alternative fuels from renewable sources by 2016. The Navy has likewise set a goal to provide 50% of its energy requirements from alternative sources [3].

The Department of Energy (DOE) has set similarly ambitious goals [4]. The DOE goal is to replace 30% of 2004 gasoline use with biofuels. This equates to ~60 billion gal/year, of which, 45 billion gal/year would be produced from lignocellulosic resources. This would require 530 million dry tons of herbaceous and woody lignocellulosic biomass per year.A study conducted by the DOE [5] estimates the total available biomass in the US, including crop residue, purpose-grown energy crops, and forest resources at over one billion dry tons annual production capacity. A similar study by the National Academy of Sciences estimates a total of 416 million tons [6]. If a conservative estimate of possible biomass sources were taken to be ~700 million dry tons, this would result in a potential energy production of 12.75 quadrillion Btu.

In order to meet the increasing demand on biomass for energy use, biomass must be economically transportable, uniform in its handling properties, and meet conversion specifications. The Feedstock Logistics Interagency Working Group of the Biomass Research and Development Board recommended

in their 2011 report [7], among other things, that supply systems are required to increase feedstock bulk density to make biomass for energy production economically viable. If biomass is to be transported more than 200 miles from the point of collection, it will only be economically viable if the bulk density of the biomass is sufficiently high. Pelleting biomass is a primary technology currently in use for increasing biomass bulk density, and enables economic long distance transportation of biomass for energy production. Pelleting also provides a means of ensuring uniformity in biomass properties delivered to the end user. It allows a variety of feedstock materials, in a variety of raw forms, to be made uniform and standardized, resulting in the necessary commodity product characteristics that will enable national and international markets for biomass utilization.This report considers the consumption and export of pellets in the US, raw material availability in the US, the current pellet production and capacity, including proposed pellet plants. It also considers end use of pellets produced in the US, energy prices and economic drivers for use of biomass pellets, and some future projections for the US pellet industry.

3.2.2 Raw Material

There are many underutilized sources of biomass in the US that could be collected, pelleted, and used for energy production. The predominant source currently used for pellets in the US is sawmill residue, followed by chips and roundwood, depending on the capacity of different plants. Primary mill residue in the nation yielded 77 million dry tonnes/year (85 million tons/year). Of that total, 1.61 million tonnes (1.77 million tons) went unused (Table 3.8) and were burned as waste or disposed of in landfills [8].An analysis of available crop residue in the US, excluding residue necessary for soil health, grazing, and other uses, and based on total grain production, shows over 157 million tonnes of residue that could be collected [8].

State	Total	Unused	State	Total	Unused
Alabama	5,857	10	**Montana**	1,937	41
Alaska	231	131	**Nebraska**	57	9
Arizona	109	0.2	**Nevada**	0	0
Arkansas	3,623	2	**New Hampshire**	925	19
California	4,772	8	**New Jersey**	17	0.2
Colorado	181	87	**New Mexico**	165	4
Connecticut	75	0	**New York**	1,063	24
Delaware	14	0.05	**North Carolina**	3,900	14
District of Columbia	0	0	**North Dakota**	0	0.2
Florida	1,901	4	**Ohio**	786	18
Georgia	7,231	66	**Oklahoma**	633	0
Hawaii	0	0	**Oregon**	6,454	9
Idaho	4,400	69	**Pennsylvania**	1,358	144
Illinois	233	14	**Rhode Island**	21	0
Indiana	574	26	**South Carolina**	2,468	9
Iowa	130	2	**South Dakota**	142	5
Kansas	29	5	Tennessee	1,557	153
Kentucky	1,433	77	Texas	2,085	8
Louisiana	3,577	14	Utah	102	20
Maine	421	35	Vermont	103	0
Maryland	138	0.2	Virginia	2,147	66
Massachusetts	113	0	Washington	5,597	6
Michigan	1,314	41	West Virginia	807	114
Minnesota	985	65	Wisconsin	1,621	30
Mississippi	4,548	79	Wyoming	255	47
Missouri	1,036	130	**US Total**	**77,125**	**1,606**

Table 3.8: Estimated Primary Mill Residues by State (Thousand Dry Tonnes) (Source: [8])

Further analysis of available production potential in the US estimates the total potential biomass production is just over 1.3 billion dry tons [5]. In a similar study, the National Academy of Sciences estimated that the total current production capacity is 414 million tons annually, with a projected increase to 548 million tons/year by 2020. This study included agricultural residue, dedicated fuel crops, woody residue, animal manure, and municipal solid waste [6].

In a biomass resource assessment update recently released by the Department of Energy [5], baseline yield assumptions identified over 134 million tons/year at <$40 per dry ton and over 252 million tons/year at <%60 per dry ton in 2012. These estimates increase in 2030 to 238 million tons/year at <$40 per dry ton and 760 million tons/year at <$60 per dry ton (Table 3.9).

	<$40 per dry ton				<$50 per dry ton				<$60 per dry ton			
Feedstock	2012	2017	2022	2030	2012	2017	2022	2030	2012	2017	2022	2030
	Million dry tons											
Forest resources												
Primary forest residues – all land	48	49	44	50	51	51	52	52	57	58	58	59
Primary forest residues without federal land	44	44	45	45	46	46	47	47	50	51	51	52
Forest processing residues and wastes	31	32	32	34	40	41	42	43	40	41	42	44
Total forest & wood wastes resources	**79**	**81**	**82**	**83**	**91**	**92**	**93**	**95**	**97**	**98**	**100**	**102**
Total without federal land	74	76	77	79	85	87	88	90	90	92	93	95
Agricultural resources												
Crop residues (major crops)	27	41	52	80	94	117	136	164	111	135	154	180
Agriculture processing residues and wastes	31	36	40	46	50	56	65	82	51	58	67	84
Total agricultural residues & wastes	**59**	**77**	**92**	**126**	**143**	**174**	**201**	**245**	**162**	**192**	**221**	**265**
Energy crops[1]												
Perennial grasses	-	3.0	12	30	-	41	77	129	-	90	188	252
Woody crops	-	0.0	0.0	0.1	-	0.9	40	67	-	5.9	84	126
Annual energy crops	-	0.7	1.8	4.2	-	3.8	7.3	14	-	5.0	10	19
Total energy crops	**-**	**3.7**	**14**	**34**	**-**	**46**	**124**	**210**	**-**	**101**	**282**	**400**
Total with all land	**138**	**161**	**187**	**243**	**234**	**311**	**418**	**551**	**258**	**392**	**602**	**767**
Total without federal land	134	157	182	238	229	306	413	545	252	385	595	760

Note: *The total forest supply is 239 to 251 million dry tons at the highest price to roadside.*

Table 3.9: Table showing the projected amount of the different types of biomass that would be available through 2030 [5].

The study identified the contributions from forest residues/waste, agricultural residues/waste, and energy crops. The contribution mix changes dramatically from 2012 to 2030, where no energy crops are available until at least 2017, but by 2030, over half the supply will come from energy crops (Figure 3.3) [5].

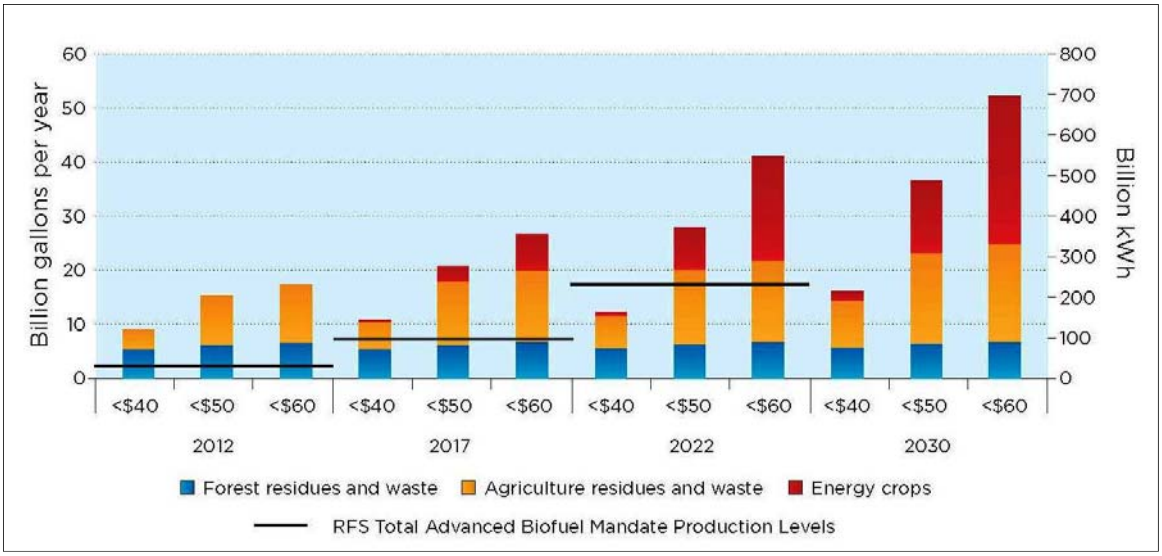


Figure 3.3: Projected amount of biomass that would be available at different payment levels [5].

3.2.3 Production and Capacity

Most plants in the US in 2009 were small, relying on sawmill residue outputs for fiber and thus were typically limited to 100,000 tonnes or less per year [9].

Estimated Capacity by Year	2003	2004	2005	2006	2007	2008	2009	2010
US Northeast	140	143	180	253	416	589	1056	1221
US West	281	308	354	458	473	589	711	883
US North	122	122	158	344	502	964	1855	2165
US South	12	25	59	183	357	424	702	
Total	555	598	751	1238	1748	2566	4324	5940
	Capacity (*10^3 tonnes)							

Table 3.10: US Estimated Wood Pellet Production Capacity by Sector (Source: [9])

The reliance on sawmill residues led to imbalances between supply and demand for biomass as the sawmilling sector retrenched in the 2008–2009 recession. This led pellet mills to turn to roundwood or other non-sawmill sources of biomass. In 2008, wood pellet production in the United States massed 1.8 million tonnes, just 66% of capacity as a result of limited mill residue availability that constrained plant activity output [9]. There are nearly 100 pellet plants currently in the US which are listed in Table 3.11.

	Plant Name:	Location:	Capacity (tonnes)
	Northern U.S.		
1	Pike Pellets	Griggsville,IL	-
2	Koetter and Smith	Borden , IN	1,000
3	Fiber By-Prod	White Pigeon, MI	41,000
4	Kirtland Products	Boyne City, MI	14,000
5	Maeder Brothers	Weidman, MI	23,000
6	Mich Wood Pellet	Grayling, MI	45,000
7	Mich Wood Pellet Fuel	Holland, MI	45,000
8	Renewafuels	Marquette, MI	136,000
9	Vulcan Wood Prod	Kingsford, MI	45,000
10	Valley Forest Prod	Marcell, MN	54,000
11	Ozark Hardwood Prod	Seymour, MO	68,000
12	Pennington Seed	Greenfield, MO	14,000
13	American Wood Fibers	Circleville, OH	23,000
14	Baderland Pellets	Sheboygan Falls, WI	5,000
15	Bay Lakes Cos	Oconto Falls, WI	18,000
16	Elkhorn Industries	Superior, WI	33,000
17	Great Lakes Renewable Energy	Hayward, WI	33,000
18	High Quality Shavings	Centuria, WI	-
19	Indexk Ladysmith BioFuel Center	Ladysmith, WI	36,000
20	Marth Wood Shaving Supply	Marathon, WI	68,000
21	Risley Pellet Solutions	Monticello, WI	-
22	Superior Wood Prod	Superior, WI	-
23	Wisconsin Wood Energy	Goodman, WI	-
24	Wood Residue Solutions	Montelo, WI	-
	Northeastern U.S.		
25	Corinith Wood Pellets	Corinth, ME	272,000
26	Geneva Wood Fuels	Strong, ME	23,000
27	Maine Wood Pellet	Athens, ME	165,000
28	Northease Pellets	Ashland,ME	23,000

29	Greenovia	Berlin, NH	-
30	Lakes Regions Pellets	Barnstead, NH	9,000
31	New England Wood Pellet	Jaffrey, NH	63,000
32	Presby Environmental	Whitefield, NH	50,000
33	Associated Harvest	LaFareville, NY	9,000
34	Curran Renewable Energy	Massena, NY	9,000
35	Dry Creek Prod	Arcade, NY	23,000
36	New England Wood Pellet	Schuyler, NY	82,000
37	Woodstone USA	Moreau, NY	-
38	AJ Stoves and Pellets	Marion, PA	-
39	Allegheny Pellet	Youngsville, PA	68,000
40	Bald Eagle Pellet	Tyrone, PA	6,000
41	Barefoot Pellet	Troy, PA	30,000
42	Energex Pellet Fuel	Mifflintown, PA	54,000
43	First Nation Wood Pellet	Cambria Co, PA	-
44	Greene Team Pellet Fuel	Garads Fort, PA	22,000
45	PA Pellets	Ulysses, PA	33,000
46	Penn Wood Prod	East Berlin, PA	4,000
47	Treecycle	Nazareth, PA	73,000
48	Wood Pellets	Summerhill, PA	29,000
49	Vermont Pellet Fuel	Island Pond, VT	11,000
50	Treecycle	Glen Gardener, NJ	-
	Western U.S.		
51	Forest Energy Corp	Show Low, AZ	45,000
52	Southwest Forest Prod	Phoenix, AZ	23,000
51	Sunizona Greenhouses	Wilcox, AZ	2,000
52	Confluence Energy	Kremmling, CO	63,000
53	Rocky Mountain Pellet Co	Walden, CO	73,000
54	Lignetics	Sandpoint, ID	68,000
55	Treasure Valley For Prod	Mt. Home, ID	33,000
56	North Idaho Energy Logs	Moyie Springs, ID	7,000

57	Eureka Pellet Mills	Missoula, MT	54,000
58	Eureka Pellet Mills	Superior, MT	50,000
59	Enchantment Biomass Prod	Ruidosos Downs, NM	14,000
60	Bear Mountain Forest Prod	Brownsville, OR	104,000
61	Roseburg For Prod	Dillard, OR	20,000
62	Dailey Wood Products	Reedsport, OR	-
63	West Oregon Wood Prod	Columbia City, OR	68,000
64	Woodgrain Millwork	Prineville, OR	27,000
65	Bear Mountain Forest Prod	Cascade Locks, OR	27,000
66	Heartland Pellet	Sperfish, SD	24,000
67	South & Jones Timber Co	Evanston, WY	9,000
	Southern U.S.		
68	Lee Energy Solutions	Crossville, AL	-
69	Nature's Earth Pellet Energy	Reform, AL	6,000
70	New Gas Concepts	Jackson, AL	-
71	New Gas Concepts	Selma, AL	454,000
72	Barnes Bros Hardwood Flooring	Hamburg, AR	9,000
73	Fiber Resources	Pine Bluff, AR	112,000
74	Green Circle BioEnergy	Cottondale, FL	454,000
75	Big Heat Wood Pellets	Sylvania, GA	9,000
76	Fram Renewable Fuels	Baxley, GA	132,000
77	Rock Wood Prod	The Rock, GA	18,000
78	Woodlands Alternative Fuels	Meigs, GA	68,000
79	Andersen Hardwood Pellets	Louisville, KY	18,000
80	S Kentucky Hardwood Flooring	Gamaliel, KY	18,000
81	Somerset Pellet Fuel	Somerset, KY	46,000
82	Bayou Wood Pellets	West Monroe, LA	54,000
83	CKS Energy	Amory, MS	45,000
84	Indeck Magnolia BioFuel Center	Magnolia, MS	-
85	Pinery Woods Pellets	Wiggins, MS	19,000
86	Carolina Wood Pellets	Franklin, NC	62,000

87	Hassell & Hughes Lumber	Collinwood, TN	18,000
88	Good Times Wood Prod	Rusk, TX	23,000
89	Northcutt Woodworks	Crockett, TX	14,000
90	Patterson Wood Prod	Nacogdoches, TX	18,000
91	American Wood Fibers	Marion, VA	-
92	V-1.1.1.1 Big Heat Wood Pellets/Equustock	Chester, VA	9,000
93	Lignetics Lunenburg	VA	45,000
94	O'Malley Lum Co	Tappannock, VA	32,000
95	Potomac Supply	Kinsale, VVA	18,000
96	Turman Hardwood Flooring	Galax, Va	14,000
97	Hamer Pellet Fuel	Kenova, WV	41,000
98	Hamer Pellet Fuel	Garden Grounds, WV	41,000
99	Lignetics	Glenville, WV	59,000

Table 3.11: Pellet Plants in United States (2011)

A number of new mills have been built recently to process chipped roundwood. Their independence from the sawmill industry has allowed a focus on export of wood pellets, and some of the newer plants have capacities of 300,000–400,000 tonnes/year [9]. In 2009, the US pellet industry was projected to have a total capacity of over 4.3 million tonnes, and recent additions have brought total capacity to around 6 million tonnes. The wood pellet industry and use of wood pellets as energy are in their relative infancy in North America, and the recent growth of both has been fueled by increases in the cost of fossil energy as well as government policies that will continue to shape the renewable energy market. Policies aimed at reducing carbon dioxide emissions also will impact rising pellet production in the future [9].

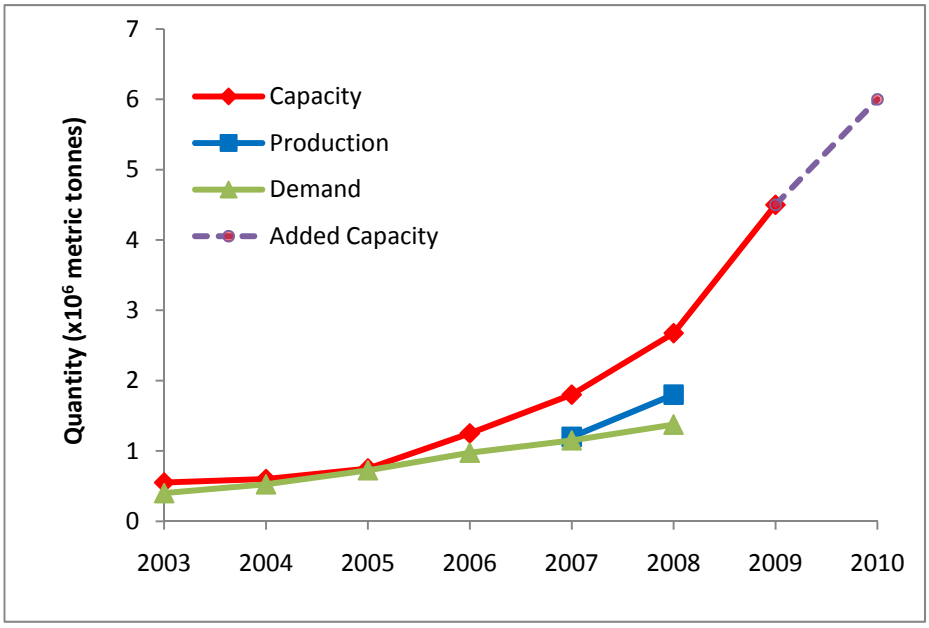


Figure 3.4: Capacity, Production and Demand for Wood Pellets in the US (Source: [9] with added data)

In order to support the increase export demand, a number of ports in the US are set to expand their capacities. This includes the East River Terminal at the Port of Brunswick in Georgia, Port of Eastport and the port of Portland both in Maine.

3.2.4 Proposed Pellet Plants

As stated above, the US pellet industry has grown rapidly in the past few years, and will continue to expand. More construction and new plants, or expansions will be built to support the push for an increase in renewable energy production. .5 shows the location and relative size of pellet producers in the United States.

Figure 1.5: US Wood Pellet Producers (Source: [9]).

The majority of pellet mills in the US are small scale in comparison to the pulp and paper or power industry. The average pellet mill in the US has a capacity of between 30,000-70,000 tonnes. Pellet plants are generally constrained due to a business model based on utilization of a waste product and

residue provided by sawmills. However, in the US southern region some mills are moving to roundwood for their supply and these mills feature some of the largest mills in the US Green Circle Bio Energy's 560,000 ton/year capacity plant, for example, is the largest wood pellet plant in the world. Its production is targeted mainly for export to the EU [10].

Magnolia Bio Power, in Georgia also has plans for a plant that, when fully operational, will reach 900,000 tons of torrefied wood pellets annually and produce 30 MWh of electrical power. The first phase is scheduled for 2011 and will produce 300,000 tons of pellets. Table 3.12 list the pellet plants that are currently under construction in the US. Table 3.12 gives a list of proposed new pellet plants in the US.

Plant Name	Location	Capacity (tons/y)
RWE Innogy	Waycross, Ga	750,000
Enviva	Ahoskie, NC	350,000
Westervelt Renewable Energy	Aliceville, Al	250,000
		1,350,000

Tab. 3.12 – United States Pellet Plants Under Construction

	Name	City	State	Capacity	Status
1	**Point Bio Energy**	Baton Rouge	La	400,000	2012
2	**German Pellets**	Tyler	Tx	550,000	2012
3	**Enviva LP**	Cortland	Va	454,000	2013
4	**F.E. Wood & Sons**	Baldwin	Ma	350,000	2013
5	**Enviva LP**	Northhampton	Nc	440,000	2012
6	**Fram Renewables**	Lumber City	Ga	350,000	2012
7	**Mt. Taylor Machine**	Milan	NM	25,000	2012
8	**MTM**	Albuquerque	NM	25,000	2012
9					
				2,594,000	

Table 3.13 Proposed US Pellet Plants

3.2.5 Consumption and Exports

Renewable energy represents 8.0 quadrillion Btus of the nation's 98.0 quadrillion Btu total energy consumption in 2010 (Figure 3.6) [11a]. In 2009 (the most recent available data) wood and wood wastes generated in primary wood processing mills account for a third of the total industrial biomass energy consumption (). The US biomass consumption profile has increased 8% from 2008 to 2009 and is forecasted to be the fastest-growing source of electricity through 2035 [11].

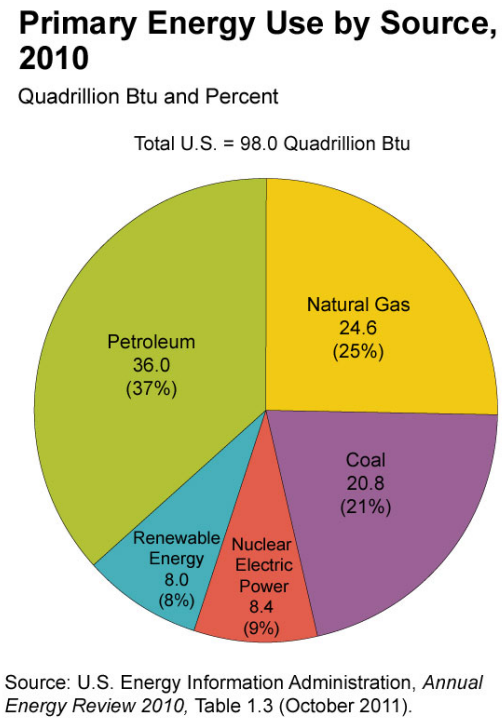


Figure 3.6: Primary Energy Use by Source, 2010 (source: [11a]).

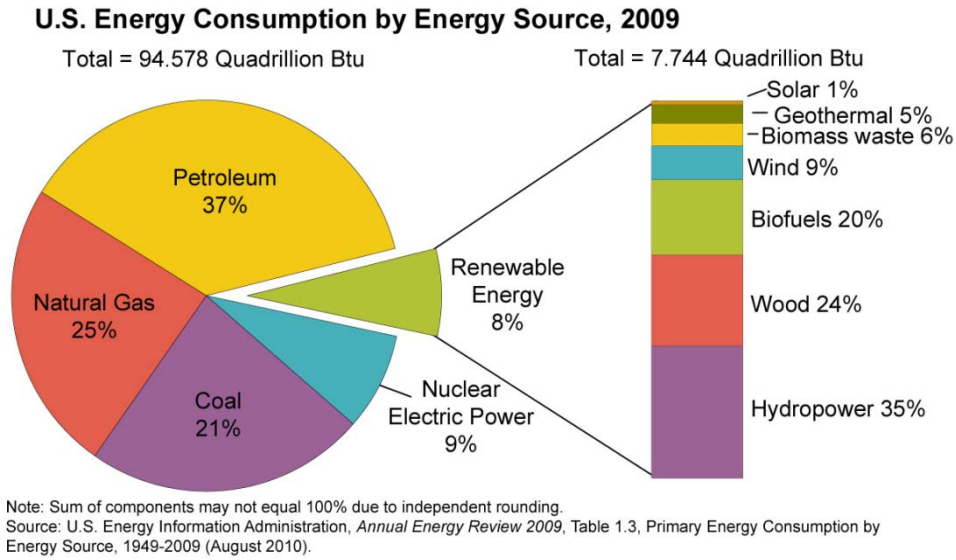


Figure 3.7: US Energy Consumption by Energy Source (Source: [11]).

In 2008, over 80% of pellets produced in the US were used domestically; of the remaining, about 19% were exported to Europe and 0.5% to Canada (Figure 3.8). By contrast, most Canadian pellets are shipped overseas [9].

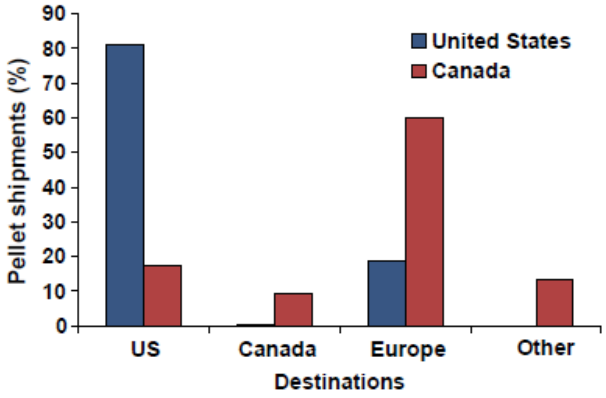


Figure 3.8: Destinations for Pellets Produced in US and Canada (Source: [9]).

The demand for biomass pellets in Europe has been rapidly increasing in recent years. In 2005, the EU experienced a 16% growth in electricity produced from biomass. This growth is expected to continue, which is attracting US industries to expand their production of wood pellets explicitly for export to the EU. The demand in the EU for wood pellets increased 7% in 2010, to 11 million tons [12]. North America has doubled its export volume to Europe over the past two years. In 2010, approximately 1.6 million tons of pellets were shipped from the US and Canada to the Netherlands, the UK, and Belgium [13], and exports are expected to continue to increase as the EU moves to obtain its mandates of 20% renewable energy by 2020.

Growth in North America put pressure on any new pellet production capacity for the Western Canadian Producers; as a result any extra volumes in the US are directed towards this market rather than towards Europe. More stringent carbon emissions regulations could increase co-firing efforts for coal plants in the US and Europe, resulting in a substantial need for pellets.

3.2.6 Prices

Prices for pellets in the US vary by season, region, and supply and demand in the same way other heating fuels do. In the US, pellets are sold by the bag (40 lb), by the ton (50 bags), and by the skid (60 bags). The selling price currently ranges from $219 to $280 per ton ($4.60 to $5.60 per bag) and averages $250 per ton ($5.20 per bag).

Because bags of pellets stack and store easily, many prudent customers take advantage of lower off-season prices and ensure their winter fuel supply by buying early. Selling price, of course, is only a part of the cost picture. The primary issue is the cost of energy, which is measured in dollars per million British thermal units. Pellets purchased at the average $150 per ton and burned in a typical pellet stove cost about $14.00 per million Btu, a figure that is less than the cost of electric heat (roughly $30 per million Btu) and competitive with average energy costs of some other fuels. Natural gas prices, however, are currently lower. Prices for natural gas range from $4.50–$5.50 per million Btu, and are likely to remain low for the foreseeable future. This will continue to be the main impediment to large-scale adoption of biomass for home heating, except in areas where it is not available.

3.2.7 Economic Drivers

There are a number of instruments in use in the US at either the federal or state level influencing biomass energy production or use.

Federal Biomass Economic Drivers

At the federal level two programs were introduced in the early 1990s as part of the Energy Policy Act of 1992. The Renewable Energy Production Incentive (REPI) provides incentives for electrical generation from green energy generation facilities. Qualifying facilities are eligible for annual incentive payments

of 1.5 cents per kWh (1993 dollars and indexed for inflation). The Renewable Energy Production Tax Credit allowed the same 1.5 cents per kWh (real 1993 currency) incentive to private facilities in the form of a tax credit available to facilities generating electricity from wind, closed-loop biomass, or poultry waste. This was initially a 10-year program, but was renewed in 2004 for another decade and the list of eligible energy sources has been expanded to include open-loop biomass, solar, municipal solid waste, geothermal, and small irrigation power.

Also at the federal level, and the foremost government driver pushing for renewable energy is the Energy Independence & Security Act of 2007 (EISA).EISA was signed by the President on December 19, 2007, after being announced in the State of the Union address as the "Twenty in Ten" plan to boost biofuel production. This Act set a timeline and goals that have since been expanded through 2022.EISA included the Renewable Fuel Standard 2 (RFS-2), enforced by the US Environmental Protection Agency, which mandates by law increasing the volume of biomass that must be used for renewable energy (See Table 3.11).RFS-2 mandates that by 2022 36 Billion gal/year biofuels must be produced in the US to offset petroleum use.Of the 36 billion gal/year, 21 billion gal/year will come from advanced biofuel production.Of that 21 billion gal/year, 16 billion gal/year will come from cellulosic biofuels, and the remainder from biomass-based diesel and other advanced biofuels [2].Advanced biofuels are essentially any biofuel other than corn starch ethanol, which also meet a 50% lifecycle Greenhouse Gas (GHG) threshold.

	Total Volume (Conventional + Advanced)	Conventional Biofuels	Advanced Biofuels Total	Advanced Biofuels by Type		
Year				**Cellulosic Biofuels**	**Biomass-Based Diesel [a]**	**Undifferentiated Advanced Biofuels**
2006	4.00	4.00				
2007	4.70	4.70				
2008	9.00	9.00				
2009	11.10	10.50	0.60		0.50	0.10
2010	12.95	12.00	0.95	0.10	0.65	0.20
2011	13.95	12.60	1.35	0.25	0.80	0.30
2012	15.20	13.20	2.00	0.50	1.00	0.50
2013	16.55	13.80	2.75	1.00	>1.000	0.75
2014	18.15	14.40	3.75	1.75	>1.000	1.00
2015	20.50	15.00	5.50	3.00	>1.000	1.50
2016	22.25	15.00	7.25	4.25	>1.000	2.00
2017	24.00	15.00	9.00	5.50	>1.000	2.50
2018	26.00	15.00	11.00	7.00	>1.000	3.00
2019	28.00	15.00	13.00	8.50	>1.000	3.50
2020	30.00	15.00	15.00	10.50	>1.000	3.50
2021	33.00	15.00	18.00	13.50	>1.000	3.50
2022	36.00	15.00	21.oo	16.00	>1.000	4.00
a. EPA Administrator determines minimum use allocation for "biomass-based diesel" beginning in 2013.						

Table 3.14: Biofuels Targets Mandated by EISA, Volume in Billion Gallons (Source: [2])

State Biomass Economic Drivers

Emission compliance strategies at the state level have also started to actively enforce Renewable Portfolio Standards (RPS). Each state has adopted its own, state-specific policy objectives with consideration to resources, expansion capabilities, and political considerations and varies widely among

states. As of June 2008, 29 states as well as DC and Puerto Rico have established mandatory RPS and additionally, seven states have renewable portfolio goals (Figure 3.9). Legislation for a federal RPS has been introduced that may force the states without a current RPS to conform to a national standard.

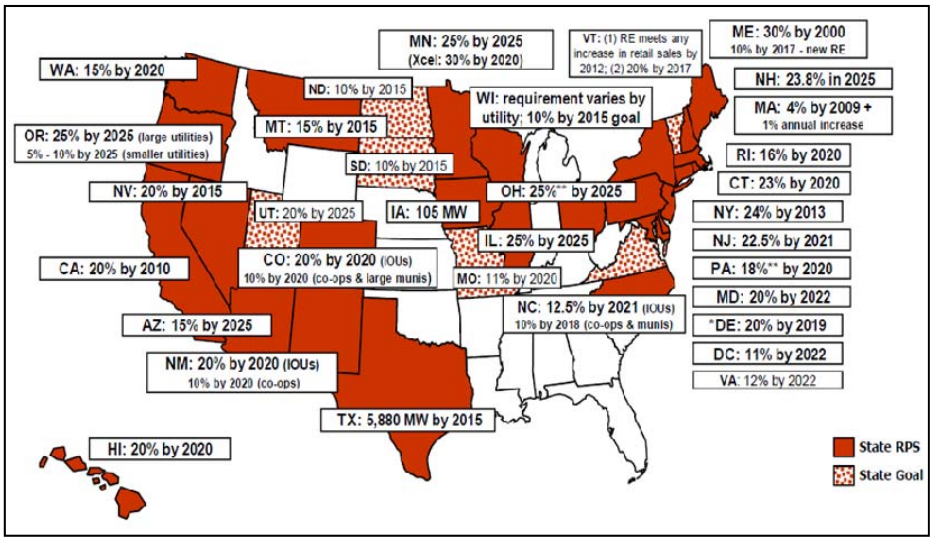


Figure 3.9: Renewables Portfolio Standards (Source: [14])

California has one of the most ambitious standards in the country, and according to the executive order; they will produce a minimum of 20% of their own liquid biofuels by 2010 and 40% by 2020. As of 2009, about 1 billion gallons of ethanol has been consumed in California per year as transportation fuel. Although California's liquid biofuels capacity is up, problems with corn-based fuels' economic competitiveness against mid-west producers have left a shortfall in actual production. To fill this need, the Energy Commission has funded several pilot- or full-scale demonstration projects for coproduction of ethanol and electricity from lignocellulosic biomass, and biomass-to-biofuel conversion continues to progress [15]. California is currently party to eight climate change and energy agreements with other states, nations, and Canadian provinces. These agreements, the Governor's office states, are important because they expand markets for clean fuel cars and emissions credits across borders, allowing emission reductions at the lowest possible cost. California is working with other governments so that reporting, measuring, verifying, and emissions markets have consistent protocols.

In addition to the RPS, a relatively common instrument for supporting environmentally friendly electricity generation is green pricing. These are voluntary programs where consumers pay a premium for electricity generated from environmentally friendly sources. These programs are available from over 500 utilities in 34 states, and over 50% of all US consumers can purchase green power, with the mean level of premium being 2.6 cents per kWh.

Other organizations have set targets that while not mandatory, have helped drive federal policy. One such group is the Biomass Research and Development Initiative's (BRDI) Technical Advisory Committee, which was established by the Biomass Research and Development Act of 2000. The BRDI Technical Advisory Committee has diverse representation from industry, academia, non-governmental organizations, and state governments. In its 2006 Vision Statement, the committee set a goal that by 2030 biofuels consumption would be equivalent to 5 billion gallons of gasoline, ~20% of the total market share, and biopower consumption would be 3.8 quadrillion Btu, or 7% of the market share. By 2030, the committee envisions bioproducts consumption to be 55.3 billion pounds [16].

Another organization, 25×'25, whose steering committee is comprised of leaders from industry and state governments, has released policy recommendations and strategies aimed toward producing 25% of America's energy needs by 2025 by utilizing the country's agricultural and forest resources, while still

meeting demands for food and feed [17]. They believe that this goal could increase the demand for cellulosic ethanol by 86 billion gallons a year and reduce the oil demand by 59 billion gallons.

State and federal agencies have set ambitious goals for renewable energy production. Ultimately, biomass will not be utilized for energy production if it is not economically viable. In order to decrease the cost of capture and utilization of biomass, it must be transportable in an economically viable form, and it must be commoditized. Pelleting increases bulk density and durability, and makes transport of biomass more efficient and economical. It also provides a uniform format which enables a standardized utilization of a variety of sources and types of biomass.

3.2.8 Future Projections

The biomass pellet industry is a nascent industry in the US; however, there has been a recent swell of interest in clean energy, including renewable biomass.

Individual states have set goals for biomass production, but the lack of federal mandates creates some uncertainty in the industry. Retiring coal will likely continue to be replaced with natural gas generation capacity; however, regulations will likely drive existing coal power plants to co-fire with biomass, which will create an increasing market for biomass pellets.

New technologies for torrefaction of biomass will enable power producers to transition from coal to biomass with little operational changes to the plants themselves. Torrefied pellets have a much higher energy density, lower moisture content, and are more stable for storage and transportation (more hydrophobic, immune to biological degradation, and are more physically durable). This will allow the use of torrefaction to create a stable commodity market for torrefied pellets [18]. The biggest challenge for pellet mills will be to match capacities needed for many power plants. Under current usage levels, a sudden coal to biomass conversion would likely overwhelm the current capabilities of the industry.

European exports may actually decrease in the future if the projected demand in the US is realized due to biopower and domestic pellet consumption. As stated above, the DOE target is to replace 30% of transportation fuel use with biofuels, leading to a consumption of 530 million dry tons/year of biomass [4]. This may be a real concern for the European markets as they work to achieve the mandated increases in biomass energy production to 20% by 2020 [12].

As the US develops a more established pellet plant capacity, opportunities in the power sector will continue to grow. Carbon dioxide mitigation policies that will increase fossil fuel costs will also help drive demand for biomass as an alternative fuel.

4 Perspectives of domestic use and trade of wood pellets in emerging markets (Asia and Latin America)

Martin Junginger, Douglas Bradley

4.1 Japan[8]

4.1.1 Raw Material

Japanese wood pellet mills utilise a variety of raw materials, as shown in table 4.1. Almost half of the total raw material consists of shavings, but also a significant amount of bark and forest residues is used. Interestingly, the use of saw dust is marginal compared to many other countries.

Type of raw material	Contribution to total production (%)	Nr of wood pellet mills utilising feedstock
Shavings	49	13
Saw dust	5	13
Bark	9	5
General by-products from sawmills	13	15
Forest thinning, forest residues	18	
Other sources (e.g. driftwood, cut trees from civil engineering work, tree prunings, road side trees)	5	11
Total	100	41*

Table 4.1 Overview of raw material used in Japanese wood pellet mills in 2009. Source: Japan Wood Pellet Association, March 2010 / Kojima (2010).

*A number of wood pellet mills utilise a mix of different feedstocks

4.1.2 Production and Consumption

In 2010, there were 111 wood pellet plants in Japan (see figure 4.1). There is a large variation in size, but in comparison to other countries, capacities are very small. The nine smallest mills only having a production capacity of 50 tonnes per year, whereas the three largest mills are only above 3000 tonnes per year, see also table 4.2 The total capacity of all wood pellet mills was about 209 ktonnes per year (based on 2400 full-load hours), compared to a production of 34 ktonnes in 2009, which means that the average load factor was a mere 16%.

[8] This section is largely based on a presentation from Ken Kojima (2010), Pellet Club Japan, whose help we gratefully acknowledge.

Capacity (tonne/year)	Number of wood pellet mills	Wood pellet type		
		Bark	White	Whole tree
<49	9		5	4
50-99	3		1	2
100-499	24		12	12
500-999	8	1	1	6
1000-2999	4	1	2	1
>3000	3	2	1	
Total	51	4	22	25

Table 4.2 Capacity of domestic wood pellet mills in Japan in 2008 and type of pellet produced.

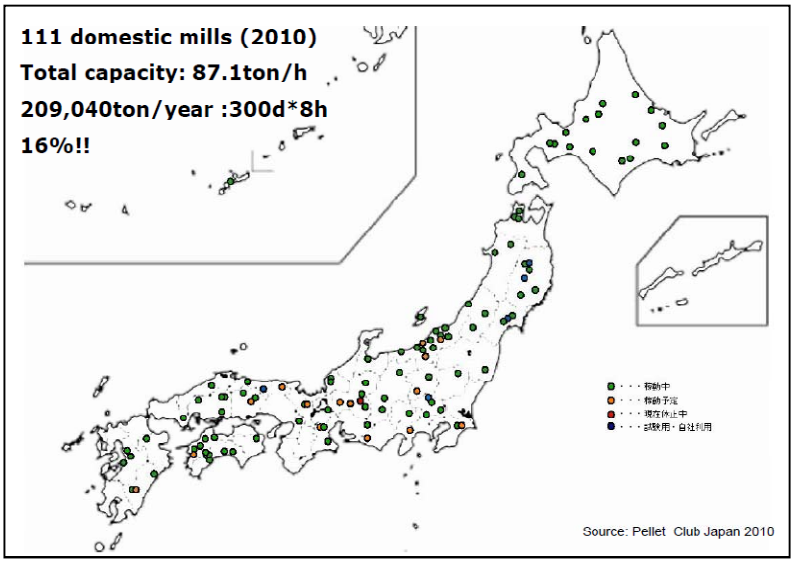


Figure 4.1 Overview of wood pellet mills in Japan as of end of 2010. Source: Pellet Club Japan, 2010 in Kojima (2010).

Source: Japan Wood Pellet Association, January 2009 in Kojima (2010).

There are two main markets for the domestic wood pellet production: residential wood stoves and small-scale boilers. Table 4.3 shows the total production from 2006 to 2010, and the end use. As follows from table 4.3, especially the use for residential stoves has almost quadrupled in 4 years' time, but with less than 12 ktonnes per year is still marginal compared to the utilisation of wood pellets for co-firing.

Year	Sales (ktonne/year)	For Stoves	For boilers
2006	20,1	16.5%	83.5%
2007	25,4	12.6%	87.4%
2008	23,7	26%	74%
2009*	34,0	35%	65%

*Estimated by the Japan Wood Pellet Association

Table 4.3. Domestic wood pellet sales 2006-2009. Source: Japan Wood Pellet Association (March, 2010) in Kojima (2010)

In stark contrast to the use domestic production and use of wood pellets (which started in the 1980,declined in the 1990, and saw a revival from 2000 onwards) is the recent increase of co-firing of biomass in large-scale power plants. About 40,000 tonnes of imported wool pellets were co-fired in 2008 (Mizuta, 2009), and about 60,000 tonnes in 2010, see also the next section.

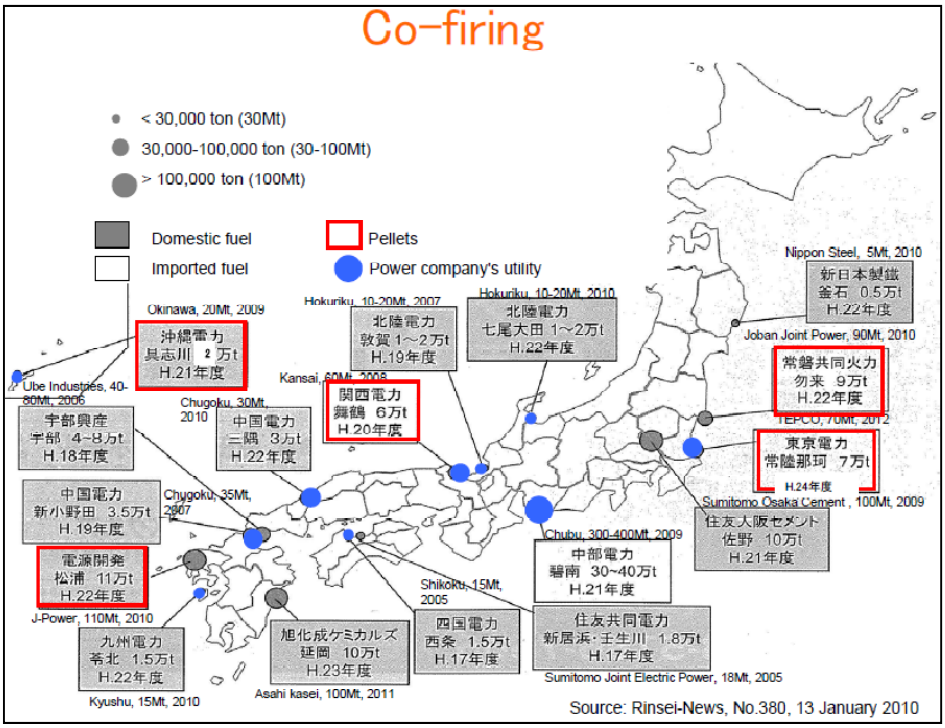


Figure 4.2. Overview of co-firing capacities in Japanese power plants. Source (Kojima (2010). Biomass stream include wood pellets (mainly by Kansai Electric), but also other biomass streams, such as wood residues, sewage sludge, paper sludge and others (Mizuta, 2009)

4.1.3 Imports and prices

Imports of wood pellets have strongly increased in recent years from 10-20 ktonnes per year to 60 kotnnes in 2009, see figure 4.3. Table 4.4. provide an overview of import volumes, countries of origin and prices. The vast majority of wood pellets was imported from British Columbia, Canada, with minor amounts from China, Vietnam and New Zealand, and a number of countries with imports lower than 100 tonnes, presumably for testing purposes.

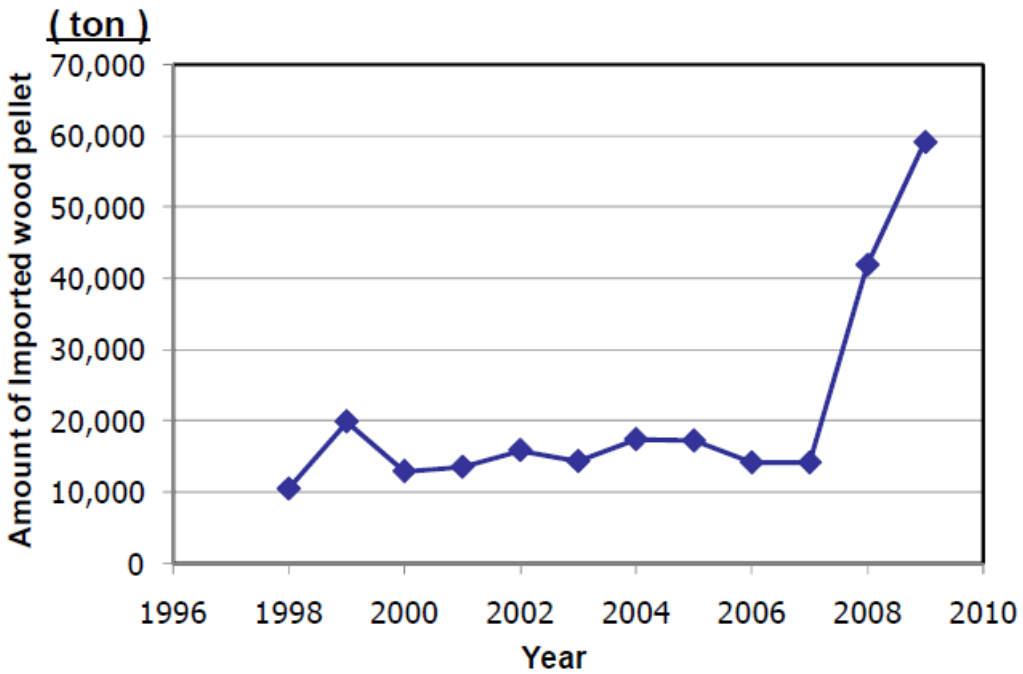


Figure 4.3. Amount of imported wood pellets to Japan 1996-2009. Source: Goto et al. (2011), based on data from the Japan Wood Pellet Association News, No. 2 (Aug. 2010).

Country	Volume (ton)	Price (€/tonne)
Canada	49498	129
China	4369	142
New Zealand	1919	155
Vietnam	1019	91
Netherlands	914	161
USA	731	146
Sri Lanka	158	171
Malaysia	146	147
Indonesia	80	142
Thailand	78	163
Total	59,143	131.4 (weighted average)

Table 4.4. Overview of imported wood pellet volumes, countries of origin and prices in 2009 (based on a Yen/Euro conversion factor of 0,077). Source: Coal and power report, 2010 in Kojima (2010)

Price levels of industrial wood pellets are comparable to CIF ARA prices: about 130 €/tonne (see table 4.5). Again, this is in stark contrast to prices of domestically produced pellets, which vary (depending on the type and quality) between 180 and 385 €/tonne, see table 4.5.

End-use	Pellet type	Price at the wood pellet mill (€/tonne)		
		high	average	Low
Stove	Bark	385	323.4	192.5
	White	354.2	284.9	277.2
	Whole tree	331.1	308	284.9
Boiler	Bark	254.1	215.6	184.8
	White	331.1	254.1	254.1
	Whole tree	292.6	261.8	238.7

Table 4.5 Overview of wood pellet prices at domestic pellet mills (i.e. excluding transport costs) June-December 2008. Source: Japan Wood Pellet association (2009) in Kojima (2010).

4.1.4 Discussion and outlook

The Japanese domestic wood pellet market is characterized by a strong relationship between local pellet production and forestry. The average size of wood pellet manufacturing plants are however extremely small, the feedstocks used are rather diverse and load factors are very low (16% based on 2400 full-load hours). Barriers for the further development of the domestic production are a lack of raw material, a lack of sufficient policy support, and a lack of technical quality standards.

The domestic market is in stark contrast to the recent imports large-scale imports of wood pellets, which in 2009 amounted to almost double the domestic production. Strong further growth is anticipated – according to Kojima (2010), Mitsui announced plans to import up to 400 ktonnes of pellets per year.

4.2 South Korea

4.2.1 Raw Material

Presumably residues form wood processing industry. The (presumably) only large-scale wood pellet plant is situated at the National Forestry Cooperatives Federation Wood Products Distribution Centre. The raw material used is saw dust supplied by the adjacent woodworking operation. All product is packaged in 20 kg bags. Annual production is 18,000 tonnes, all of which is sold in South Korea (Murray, 2011).

4.2.2 Production and Consumption

There are about 22/23 pellet plants in Korea in 2011, compared to only 11 plants in 2009 (Murray, 2011, Lee, 2011, Han 2009). All are extremely small scale, mostly attached to woodworking operations.

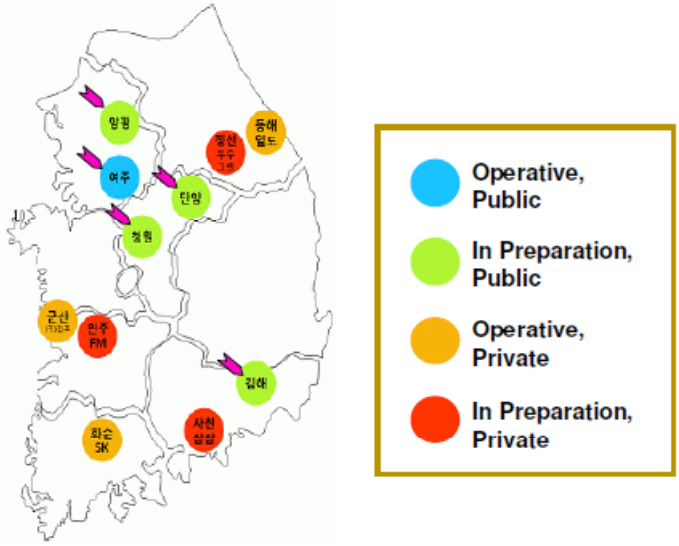


Figure 4.4. Wood pellet plants in South Korea in 2009. Source (Han, 2009)

The Korean pellet market began in 2007 when 150 domestic boilers were installed throughout the country. In Korea, domestic heating is accomplished by means of boilers heating hot water which is then circulated through in-floor pipes to create radiant heat. North American-style forced air heating is uncommon.

In 2008, the Korea Forest Service began subsidizing the purchase of domestic pellet boilers by 60% to 70%. About 600 boilers were installed in 2008, 3,000 in 2009, and 4,000 in 2010. About 6,000 boilers are expected to be installed in 2011. In 2010 commercial greenhouse operators began using pellet boilers for heat. Pellets are not yet used for power generation or for any other industrial purpose. According to Murray (2011), domestic pellet consumption in 2010 was estimated at 27,000 tonnes of which 15,000 tonnes were produced in Korea. Imports amounted to 12,000 tonnes according to Murray (2011).

4.2.3 Imports

Wood pellet imports to Korea have almost tripled over the past three years, from a little over 7000 tonnes in 2008 to more than 20,000 tonnes in 2010, mainly from China, Vietnam and Malaysia (Lee, 2011, see also Figure 4.5). However, it is unclear how much of this has been used for energy purposes, and how much for other purposes (such as animal bedding).

Figure 4.5. Wood pellet imports by country 2008-2010. Source: Korea Custom Service, in Lee (2011)

4.2.4 Policy and regulatory context

South Korea is the world's 10th largest energy consumer, 5th largest oil importer and 2nd largest coal importer. 64% of electricity of produced from fossil fuels. South Korean coal consumption – currently 122 million tons per year – is accelerating. South Korea is committed to a 30% reduction in CO_2 emissions from projected levels by 2020. The government has directed 374 of South Korea's largest companies reduce CO_2 emissions by 2020. Each company must submit a plan to government by mid-2011 and begin implementation in 2012. In addition, renewable portfolio standards for power generators are being implemented in 2012. Power companies must produce a minimum of 2% renewable energy in 2012, increasing by ½% per year until they are producing a minimum of 10% by 2020.

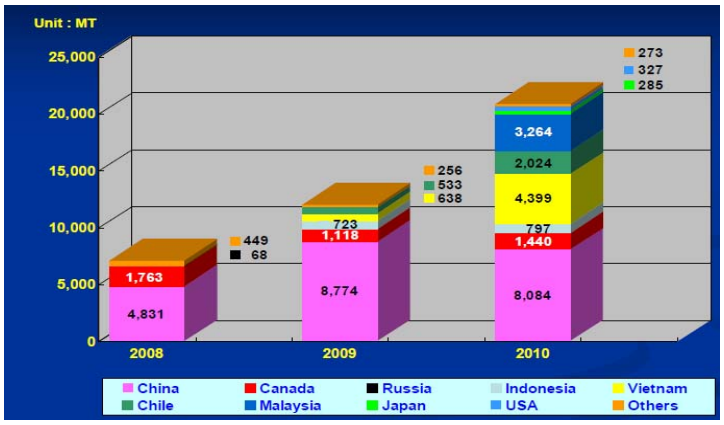
4.2.5 Prices

Wood pellet prices for imported pellets may vary from 90-185 Euro /tonne (see table 4.6). According to Lee (2011), the quality and heating value of imported wood pellets may vary substantially. Wood pellets from Vietnam are reported to have a heating value of 15,1 – 17,2 GJ/tonne, compared to 16,9 GJ/tonne for Canadian wood pellets. Higher priced, cosmetically better looking Canadian pellets have been primarily used for animal bedding so far (Lee, 2011). Interestingly, wood pellet prices reported for for Canadian pellets for 2010 are substantially higher (€/tonne) than prices for Canadian pellets exported to Japan (129 €/tonne, see section 4.1).

	China	Vietnam	Malaysia	Chile	Canada	Indonesia	Total
Amount (tonne)	8084	4399	3264	2024	1440	797	20008
Price[1] (€/tonne)	116	91	99	133	184	103	114[2]

Table 4.6. Overview of average import prices of wood pellets by key countries for 2010 (Lee, 2011)

1 Using a USD –Euro exchange rate of 0.755 (average for 2010)



2Weighed average

4.2.6 Future Projections

The pellet market is expected to grow rapidly starting in 2012 due to the government's newly introduced renewable portfolio standards requiring power companies to increase the proportion of renewable electricity production. It is expected that at least 60% of renewable energy will be from pellets.

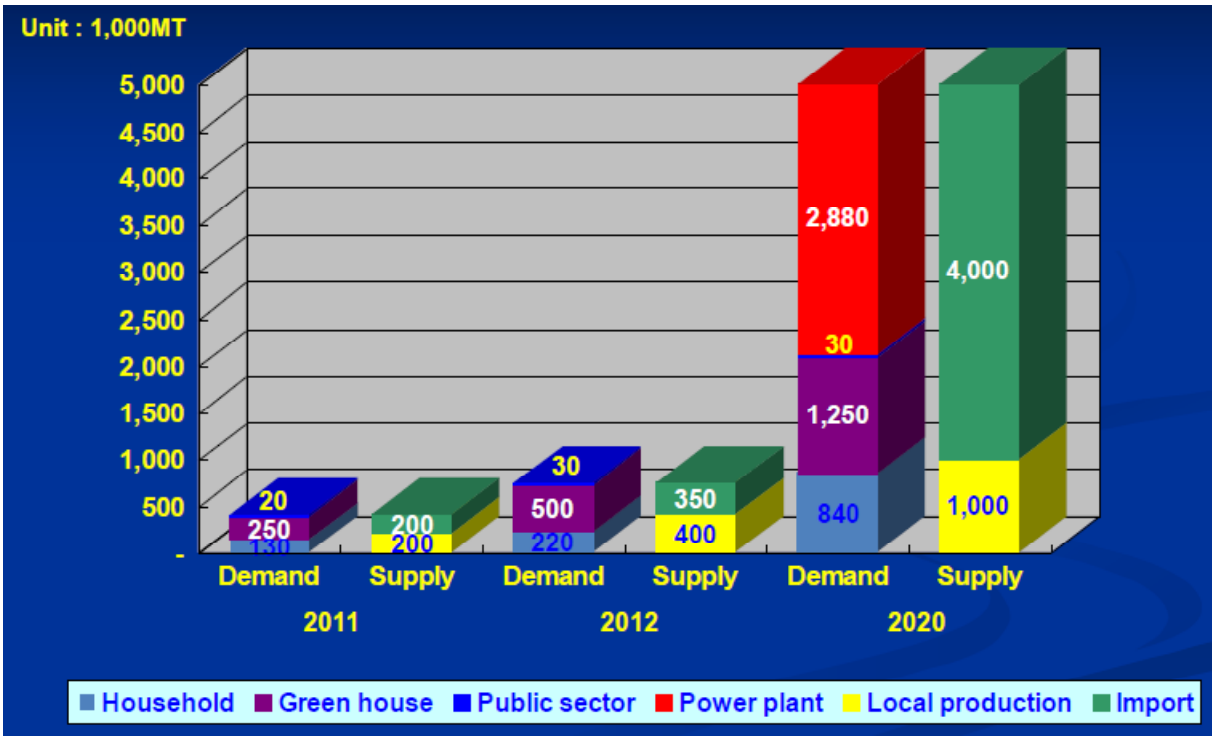


Figure 4.6. Wood pellet supply and demand projection until 2020. Source: Korea Forest Service, in Lee (2011)

South Korea presently uses about 75 million tons of coal per year. If some 2% of this is converted to pellets by 2012 at a ratio of 1.5 tons of pellets per ton of coal replaced, this would mean a market of 2.25 million tonnes of pellets. By 2020, after accounting for growth in energy consumption and ever increasing renewable energy requirements, the demand for pellets could exceed 15 million tons per year from the power sector alone.

According to the Korean Forest Service (KFS), the theoretical domestic maximum production potential in Korea could amount to about 1 million tonnes. The KFS expected a total demand of (only) 5 million tonnes in 2020, which would still require imports of up to 4 million tonnes (Lee, 2011). The KFS plans to secure wood pellet supply from Indonesia, New Zealand, and Myanmar by inducing them to install pellet operations. Indonesia is making available 200,000 ha of land for plantation to produce wood pellets for export to Korea, based on the Korea-Indonesia summit meeting (March, 2009) (lee, 2011).

4.3 China

4.3.1 Production and Consumption

The wood pellet market in China is still in its infancy, and very little coherent information was found on current wood pellet production, consumption and markets. Pöyry (2011) reports that China was the biggest consumer of pellets during 2010, (around 600,000 tonnes). However, 85%of these pellets are based on agricultural residues which differ significantly from wood pellets, both in termof fuel properties and market characteristics.

According to the Bioenergy International wood pellet map 2011 (BI, 2011), there were 19 (wood) pellet mills in China, all close to the Eastern coast. Capacities range between 12,000 and 120,000; total reported capacity is 750 ktonnes per year. The two plants with capacities >= 100 ktonnes are Xianhu, Shenyang, Liaoning (100 ktonnes/yr) and Huafeng agricultural biotechnology, Yangzhong, Jiangsu (120 ktonne/yr).

The anecdotal data found in literature is summarized below:

- Shen (2010) reports on a company in Zhejiang province (a few hours drive from Shanghai) utilizing bamboo sawdust to produce pellets – production in 2010 was reported to be 10,000 tonnes.
- China's largest bioenergy company Drag Power, led by Kai Johan has so far not published an y plans to build wood pellet pants in China.

4.4 Indonesia

Also on Indonesia, reports are extremely scarce. Bioenergy International reports on one wood pellet plant of 100 ktonne capacity on the Indonesian part of Papua New Guinee of 100 ktonnes (BI, 2011). Furthermore, in September 2010, the company Solar Park Indonesia reported that they have built a wood pellet plant situated on Java of 80 ktonne capacity, using sawdust from tropical hardwood, and focused 100% on export to the EU, Japan and Korea (Park, 2010).

4.5 Vietnam

With a large and rapidly expanding timber industry, Vietnam could potentially become an important wood pellet producer – the total technical potential of sawdust was estimated to be 5.8 million tonnes, of which the largest part is located in the western Highlands (2.5 million tonnes) and central Vietnam (1.15 million tonnes) (Phuong, 2011).

Vietnam has not been a large internationally-oriented wood pellet producer, although in 2009 and 2010, small-scale wood pellet exports were observed to Korea and Japan (see pervious sections). Total production capacity of the large wood pellet plants was reported to be between 120 and 140 ktonnes (see table 4.7 below), although it is unclear how much actual production was realized. Beside these companies, there are many small mills supplying pellets for local demand. However, due to lack of available information about these mills, they are not listed in the table below. Also shown in table 4.7 are several large producers of rice husk pellets.

Name of pellet plants	Type of pellet	Capacity	Location
Vinaconex	Wood pellets	49,000 tonnes/year	Yen Bai
Hà Thành group	Wood pellets	50,000 tonnes/year	Viet Tri- Phu Tho
Duy Dai corporation	Wood pellets	24,000 to 36,000 tonnes/year	Da Nang
Green Energy	Rice husk pellets	70,000 tonnes/year	Tien Giang
VINAFOOD 1	Rice husk pellets	140,000 tonnes/year	Dong Thap
Biomass Mekong	Rice husk pellets	24,000 tonnes/year	Dong Thap
Southern Resource Co.ltd	Rice husk pellets	120,000 to 180,000 tonnes/year	Ho Chi Minh

Table 4.7. Major wood pellet and rice husk pellet plants in Vietnam (source: Phuong, 2011)

4.6 Brazil

The main use of solid/woody biomass in Brazil is for the production of charcoal. According to the Brazilian association industry biomass and renewable energy (ABIB, 2011), there are 10 wood pellet plants in Brazil, using pine or eucalyptus wood (residues) as feedstock, which have a reported capacity of about 320 ktonnes per year (Brazil ABIB, 2011). However, to our knowledge, these are solely for domestic use; no wood pellets have been exported so far. In comparison, Brazil does have much larger wood briquette production capacity: 2.8 million tonnes according to Brazil ABIB (2011).

However, according to several press releases (Suzano 2010, 2011), Suzano Papel e Celulose is negotiating with the Brazil's Alagoas state authorities about the construction of one million tonne wood pellet plant. The production, which will reportedly start in 2013, will be based on forests planted exclusively for use in energy generation. The management for this segment is based on the selection of specific eucalyptus clones, planting a greater number of trees per hectare ("energy management"), and a reduced harvest cycle, from two to three years (eucalyptus planted for pulp and paper has a cycle of approximately seven years).Suzano Renewable Energy's goal is to achieve an annual capacity of three million tons of pellets by the end of 2014.To make the project feasible, the company estimates an investment of approximately US$ 800 million. Downey (2011) reports that two more plants may follow in 2018-2019. If these plants are to be realized, this would mean that Brazil would become a major producer and exporter of wood pellets to Europe. In august 2011, it was reported that GT Power Ltd. and Suzano Papel e Celulose S.A. have concluded a non-binding Memorandum of Understanding for the supply of biomass fuel for MGT's 300MW Tees Renewable Energy Plant project. First deliveries are expected in 2014.

In addition, Timber Creek Farms announced that they are going to build a wood pellet manufacturing facility near Pien, Brazil. The plant will have a capacity of 90,000 tonnes, and should be operational in the first quarter of 2012. The wood pellets will be traded by Cellmark Energy, and are likely to be shipped to Europe for industrial use.

4.7 Chile[9]

In the past years, three wood pellet mills existed in Chile, but nowadays, only two of them are operating:

- The company Ecopellets, situated close to Santiago de Chile, had two mills(from Andritz & La Meccanica), and was established about 6-8 years ago. The theoretical capacity of this planwas about 6 tonnes/hour, or about 30,000 tonnes per year[10], but this production level was never fully realized. The feedstock used was urban waste wood form Santiago. The wood pellets were destined for the domestic market. However, as this market was too small, the company recently ceased production.
- Andes biopellets, situated close to Santa Barbaras, belongs to a Swedish investor. It is located next to a saw mill, and uses saw dust as raw material. Bioenergy International (2011) reports a production capacity of 50,000 tonnes.
- The third wood pellet planned is run by Ecomas, a joint venture of the Chilean company Promasa and the Japanese Somitomo corporation. It is situated in the center-south of Chile, near the city of Los Angeles. The capacity mentioned by Bioenergy International (2011) is 10,000 tonnes. The company has a marketing strategy to sell wood pellet boilers to small-scale industries, and deliver pellets to them with long-term contracts.

The Chilean market has been struggling with the fact that the domestic market is very small. Chile is a very large user of firewood for heating (which causes large environmental problems in the winter). A wood pellet stove would be able to provide cleaner heat, but as (high-quality) stoves are expensive, and no subsidies are available either for stoves or for pellets, it is hard to compete with firewood. In recent years stoves from Rika and KWW are slowly entering the market, but total volumes are still small.

The current volumes are also too small for any meaningful export. Some minor amounts have been exported to Korea in the past, but in containers, which is very inefficient. Also, as Chile is facing the Pacific, and transport distances to the European markets are large, this makes export economics unfavorable.

The long term potential for wood pellet production in Chili is large: the country produces about 40 million cubic meters of industrial roundwood, and an additional 16 million cubic meters of firewood, so the sawdust and shaving potential is in theory large. However, these residues are currently utilized to a large extent to produce electricity and heat (as electricity prices are amongst the highest in Latin America). Also, most of the forest assets are owned by the pulp and paper industry, who are not enthusiastic about the opportunities to produce pellets, they prefer to produce electricity.

4.8 Argentina

No wood pellet plants have been reported so far in Argentina. While Uasuf (2010) reports that there may be significant potential to use wood residues from the wood processing industry in a number of provinces (especially Corrientes), no reports on production of wood pellets have been found.

[9] This entire section is based on personal communication with Alvaro Urzúa Moll, November 2011.

[10] based on 16 h per day and 300 working days. Note that Bioenergy international (2011) reports a capacity of 40,000 tonnes/year in their 2011 pellets map.

5 The challenges to ensure a sustainable pellet trade

5.1 Assessing the future potential global supply and demand

Martin Junginger

5.1.1 Potential demand

Demand for wood pellets has been increasing strongly over the past 10 years, as was also shown for individual countries in the previous chapters. However, whether this trend will continue, is depending on a number of factors and has been analyzed by various studies. Below, we give an overview these existing studies, and discuss some of the major factors that will influence possible demand up until 2020.

Existing analyses include forecasts by Pöyry (2011), Sikkema et al (2011), Ekman & Co., AEBIOM and NewEnergy Finance. Most projections are only for Europe, butestimates are for different years. Pöyry estimates 16.5 million tonnes in 2015 and 23.8 million tonnes by 2020 for EU only (Pöyry, 2011) ;AEBIOM expects between 50 and 80 million tonnes in 2020 (Rechberger 2010);and New Energy Finance expects about 28 million tonnesin 2025 (Herold, 2009).Sikkema et al. estimate that the maximum technically obtainable wood pellet demand could in theory reach up to 150 million tonnes by 2020, assuming that 50% of all heating oil boilers are replaced by 2020, and assuming an EU-wide average co-firing rate of 10% in all coal power plants in the EU. Most projections foresee however foresee a more modest growth, with an (EU-)average of 3% share of wood pellets replacing coal, although in individual plants, this share may be 20% or even higher. In case current consumption trends are extrapolated exponentially (as they have grown in the past), a consumption leveljust lower than 35 million tons could be reached in 2020,starting from 9.2 million tonnes in 2009.

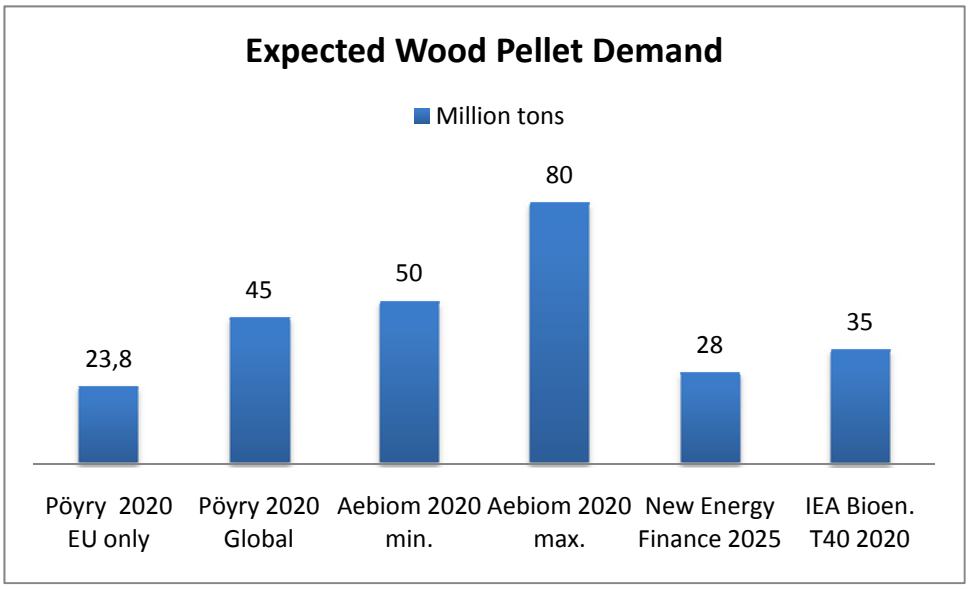


Fig. 5.1. Expected wood pellet demand in 2020 to 2025 according to different sources

Based on the expertise available within the Task 40 working group, we also devised two scenarios on the likely and maximum demand for industrial use of wood pellets in Northern Europe (see figures 5.2 and 5.3) From these figures, it is clear that under current expectations (including existing policies), total industrial demand is likely to increase from about 4 million tonnes in 2011 to a little over 10 million tonnes in 2015. In theory, industrial demand in Northern Europe could even increase to 20 million tonnes, but this is more of a hypothetical technical potential than what can be expected from current trends and policies.

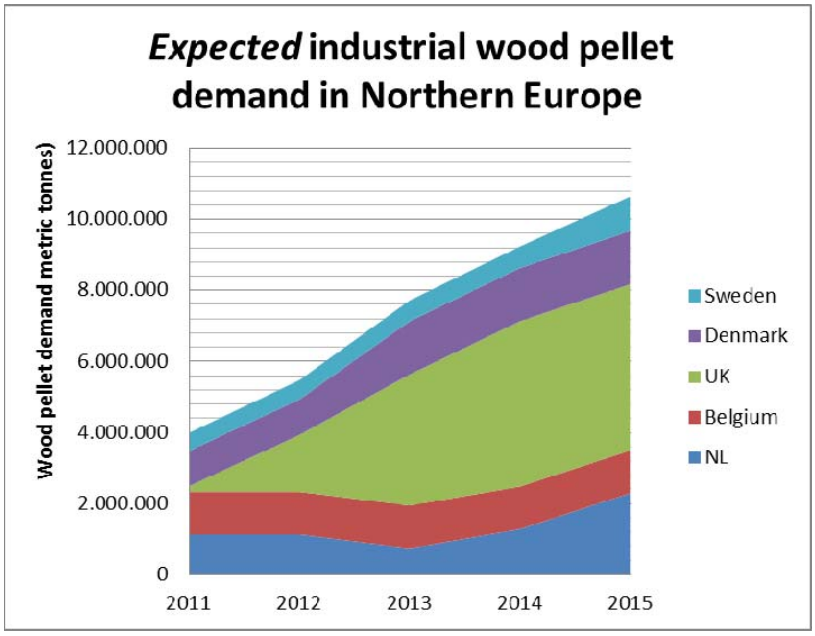


Figure 5.2. Expected industrial wood pellet demand in Northern Europe

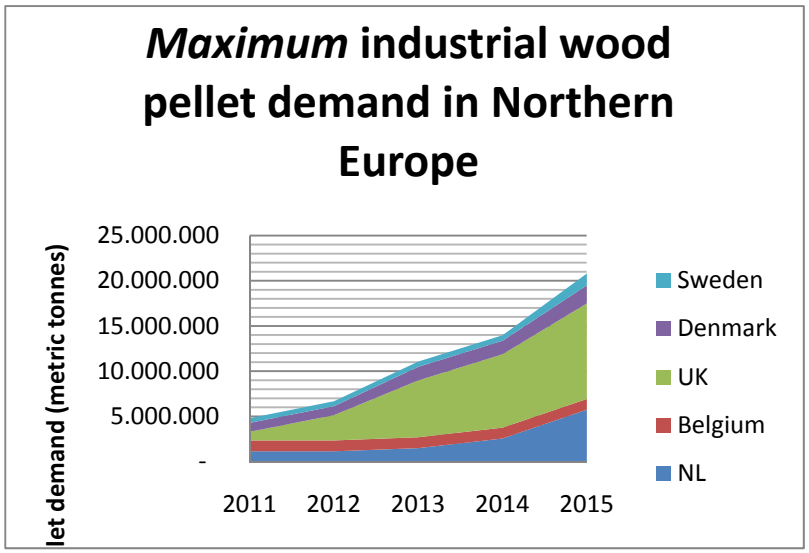


Figure 5.3. Maximum industrial wood pellet demand in Northern Europe.

The only comprehensive study found that makes detailed forecasts on the global demand development was published by Pöyry (2011), and is shown in figure 5.4. Pöyry expects the strong increase in the EU (as also shown by the other studies), a moderate increase in Northern America, and basically no or marginal demand in Latin America, Africa and Oceania. Most important is the expected demand in Japan and South Korea (see also section 4), and – probably as biggest wildcard – an expected increase in demand in China from 0.6 million tonnes now to 10 million tonnes in 2020. On a global level, the study shows an increase in demand from 15.6 million tonnes in 2010 to about 45 million tones in 2020.

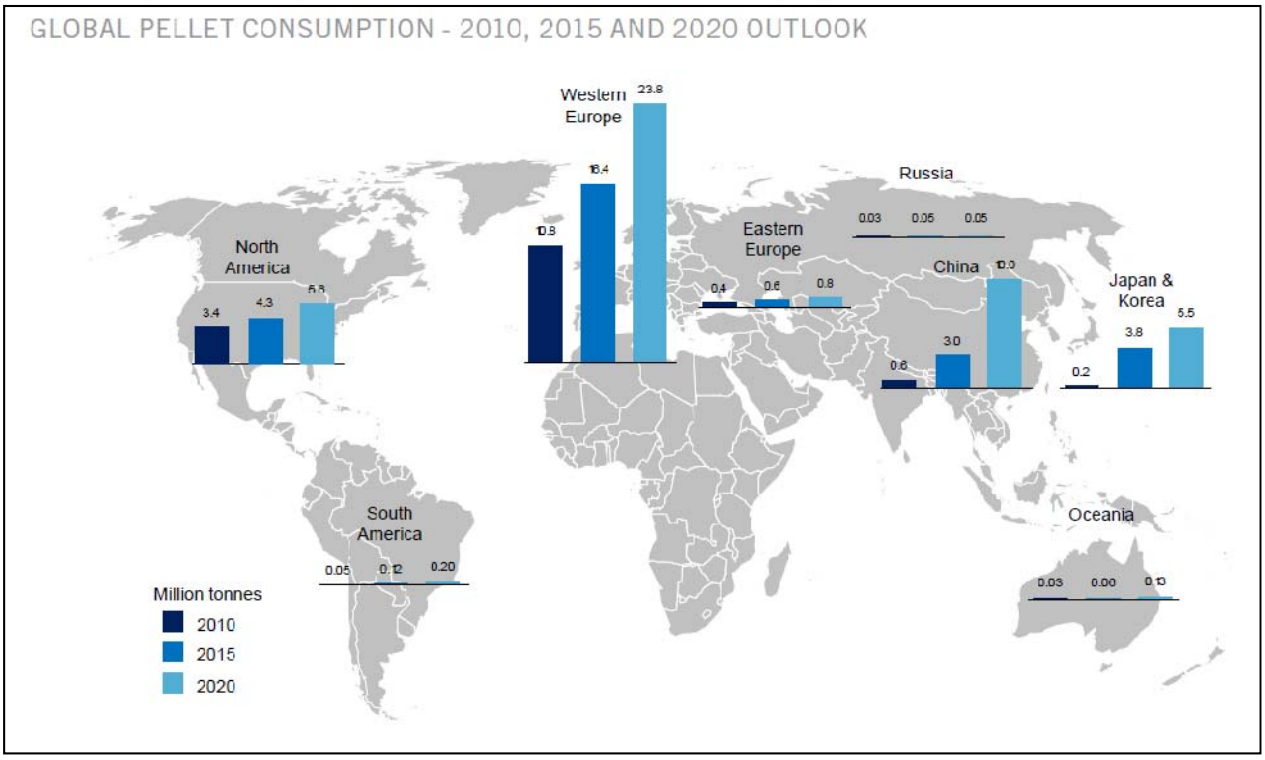


Figure 5.4. Overview of possible wood pellet consumption trends up until 2020 (Pöyry, 2011)

The main conclusions regarding the global development of wood pellet demand are:

- The EU is very likely to remain the largest wood pellet consumer in the world, but East Asia is going to show a very strong growth and may be a close second in 2020.
- EU demand could range between 20-50 million tonnes by 2020, depending to a large extent on a) the policies on co-firing in a.o. the UK, Netherlands, Germany, and Poland, and b) on the price of heating oil and the related attractiveness to switch to wood pellets for small-scale users (households an medium-sized residential buildings);
- East Asian demand strongly depends on policy developments in Japan and South Korea. How rapidly this demand will materialize will probably become more certain over the course of 2012, when more details on policy measures in both Japan and South Korea are expected. Regarding China very little useful information was available, and demand development is hard to anticipate.
- Demand in the US will probably remain limited to small scale use in households, and will not use pellets on a large scale for industrial purposes. Thus, one crucial factor will be the price of heating oil.

5.1.2 Potential supply

To meet the increasing demand projected in the previous section, wood pellet supply will need to increase as well. Moreover, while currently in most countries the majority of pellets consumed are produced domestically, in the future, the raw material resources will get increasingly scarce (see also section 5.3). For example, Sikkema et al. (2011) show that while in theory, the EU can be self-sufficient with regard to supplying enough wood to the forest industry and the energy sector until 2020, but is quite likely that the EU will to continue to increase their wood pellet imports. More in general, most likely within an decade or so, more than half of all wood pellets produced in the world will be traded internationally.

To illustrate this, in the following sections two scenarios are developed in which possible wood pellet production and export in different world regions is described[11]. These scenarios (especially the high trade scenario) should not be seen as accurate forecasts, but they sketch the range and the possible origin of wood pellet trade flows in the next 10 years or so.

1. A "business as usual / low trade" scenario. The main basis for the expected import flows for the short term (2011-2015) are based on industry expectations as presented in the first half of 2011 (e.g. Schouwenberg, 2011; de Wolff, 2011), announcement in trade journals (such as Bioenergy International) and on recent literature, such as the latest UNECE Forest products report (UNECE/FAO, 2010). These sources already take into account the ongoing investments in e.g. new pellet plants in many parts of the world, and take into account the maximum speed with which wood pellet production and trade can realistically grow in the coming years. In our opinion, they represent the most realistic outlook for the next 4 years. For the period of 2015-2020, potential further development is based on the (projected) availability of woody biomass (e.g. by Pöyry (2010)), and the specific availability of woody biomass in the main sourcing regions (e.g. van den Bos, 2010; De Wit et al. 2011 for Eucalyptus/Brazil, and Gerasimov & Karjalainen, 2011 for NW Russia).

2. An "optimistic / high trade" scenario. This scenario basically builds forth the conservative scenario, but assumes that from 2014 onwards, a number of world regions will use land for energy corps to produce additional wood pellets

In both scenarios, we only look at wood pellet trade. In other words, we do not analyse the trade in wood chips. Neither do we take into account production for domestic consumption, The available and predominant types of feedstock (either woody residues such as sawdust, discarded wood, bark, etc.) or roundwood (such as eucalyptus or pine trees from dedicated plantations) will be discussed in more detail in the following sections.

The projected supply of wood pellets in the sourcing regions is mainly dependent on sufficient demand, in the EU, (South-) East Asia, and possibly the US. If this demand is not met, it is very unlikely that new investments will be made.

The business as usual / low import scenario

Based on past and current import trends, press releases of individual companies, expert opinions and (especially) on scenario studies by Schouwenberg (2011) and de Wolff (2011), we identified a number of main future sourcing areas. In the following sections, for each of the sourcing regions, a short description of the current production capacity and anticipated growth in the next 10 years, and both currently sued and potential future feedstocks are briefly discussed.

[11] These scenarios have been adapted from earlier work carried out by Utrecht University for the European Commission within the Biobench project.

East and West Canada

The total capacity of the existing 34 wood pellet mills is 2.6 million tonnes (Murray 2011). About 71% of the Canadian capacity is located in the west, mainly British Columbia (BC). There are 16 plants, with an average capacity of 118 ktonnes per year, and the largest is 400 ktonnes/year. The total western capacity is 1 889 ktonnes. While the largest part of the feedstock is still based on wood residues form wood processing, it is notable that in past years, wood of trees killed by the Mountain Pine Beetle (MPB) has also become an important source of feedstock for wood pellet production. Currently, this share is about 30, but in 2020, it was estimated that up to 50% of the feedstock used for wood pellet production may be from MPB wood (Murray, 2011). The eastern part Canada currently contains 29% of the total wood pellet production capacity. The 18 plants have an average of 43 000 tonnes and the largest is 120 000 tonnes (Murray, 2011). The feedstock is basically 100% residues from the wood processing industry.

Almost all Canadian production is currently exported: in 2010, this amounted to about 1.35 Mtonnes to Europe, 0.9 Mtonnes to the US (mainly from the land-locked plants in the center of Canada), and 60 ktonnes from BC to Japan. Domestic use is about 100 ktonnes (Bradley, 2011). For 2011, expectations are that imports will increase to 1,75 MT and 100 ktonnes to the EU and Japan respectively, and will remain stable for the US (Murray, 2011). Regarding capacity and export developments, Bradley (2011) estimates that production capacity might increase from 2.6 to 3.5 million tonnes in 2014, and to 5.5 million tonnes/year in 2018. An estimated maximum export potential is 4.7 million tonnes, of which about 55% from British Columbia (Western Canada), and the remainder from Central and Eastern Canada. This scenario is based on the expectation that demand in South Korea will grow strongly to allow for the expansion in BC, but in theory, this amount could also become available for Europe, depending on sufficient demand and economic feasibility.The feedstock base for this expansion is likely partially going to be further residues from sawmills, but possibly also increasingly forest residues (collected at the roadside) and (in BC) also MPB wood, which would require an additional collection effort. Verkerk estimates for BC that in BC alone, a total of 1.3 oven-dry tonnes of sawmill residues may be available, which would in theory suffice to supply roughly half of all wood pellets produced in BC in 2018. The remainder may likely be produced from MPB trees (Murray, 2011). For eastern Canada, we assume that production for export may increase to 920 ktonnes in 2020, but the feedstock source will remain 100% sawdust.

South East USA

The 'fibre-basket' in the South-East of the USA encompasses (parts of) the states of Georgia, North Carolina, South Carolina, Alabama and Florida. This area has been a major producer of wood for the pulp and paper and construction sector for decades. Due to the housing crises and decreasing demand for roundwood for construction, large amounts of wood are currently un(der)utilized in this region. According to Bioenergy International (2011) the total capacity in this area was about 1.1Mtonnes at the end of 2010 (Bioenergy International 2011). Capacities of individual plants ranged between a few small ones (<50 ktonnes), several medium sized ones (50-160 ktonnes), and one very large plant (500 ktonnes, GreenCircle, Florida). These plants typically utilize wood residues from the existing saw mills, except for the GreenCircle plant which utilizes roundwood from southern pine. In May 2011, one of the largest wood pellet plants in the world has started operation in Waycross, Georgia, with a capacity of 750 ktonnes per year – solely using southern pine roundwood as feedstock, and utilizing the bark to produce the required heat for drying. Also for the years to come, further plants are planned using southern yellow pine as feedstock, e.g. a 250 ktonnes plant planned to open early in 2012 in Western Alabama, expandable to 500 ktonnes, destined for export and domestic use (Westerveld, 2011). Nevertheless, it is also likely that further woody residue streams will be utilized for wood pellet production as well. US-based consultancy Forisk (2011) estimates that in the coming 5 years, the total demand for wood as raw material for wood pellet production may rise from about 20 million (short &

wet) tonnes in 2011 to about 30 million short tonnes in 2015. While the projected demand for 2011 is higher than current capacities, this still supports the projected rapid increase in production as assumed by Schouwenberg (2011) and de Wolff (2011).

North-West Russia

In the past years, the Russian wood pellet market was rather turbulent and erratic. Pioneer companies, which started the development of pellet production withdrew from the market several years ago. A second generation of pellet mills are also on the stage of closing or business diversification. The third generation of pellet plants, which are constructed on a base of big woodworking factories work stable. There are a number of medium siozed planst (between 80-130 ktonnes/year), and a few smaller plants that produce each about 20-40 ktonnes per year and export the major part of it. Several large projects have been announced in the Leningrad region as well as in other regions. For example, the new company Russian Wood Pellets (RWP) plans to construct several pellet mills with total capacity of 3 million tons of pellets per year.For these wood pellet plants, it was assumed that sawdust is the (main) feedstock. However, the biggest plant by far (in fact the biggest plant in the world) is the recently commissioned Vyborgskaya wood pellet plant, situated close to the Finnish border, in the vicinity of St. Petersburg. This plant has a capacity of 900 ktonnes of wood pellets. According to Lesprom (2010), the raw material for pellets consists primarily of logs from Russia and Belarus, which is partly FSC-certified.

North-East Brazil

Production capacity and feedstock: Up till 2011, no meaningful wood pellet production capacity in Brazil exists, and no wood pellets have been exported so far. However, according to several press releases (Suzano 2010, 2011), Suzano Papel e Celulose is negotiating with the Brazil's Alagoas state authorities about the construction of one million tonne wood pellet plant, requiring about 30,000 ha of eucalyptus plantations to deliver the feedstock. In the state of Alagoas, investments in eucalyptus plantations have been ongoing in recent years. Downey (2011) reports that two more plants may follow in 2018-2019. This is in contrast to the scenario given by de Wolff (2011), which assumes 3 million tonnes of wood pellet production from 2015 onwards. As the plant sites are not clear yet, it is difficult to estimate transport distances. Distances form plantations to the pellet mill are likely 50 km on average. Distance to a port is difficult to estimate, but as the state of Alagoas is not reaching further inland than 300 km and has a well-developed road-network, it seems reasonable to assume that average transport distances will not exceed 200 km.

Australia and New Zealand

Based on the information provided in chapter 4, we estimate that Australia could expand production (and export) capacity to 1 million tonnes per year by 2020, whereas New Zealand could increase exports to 0.5 million tonnes in 2020.

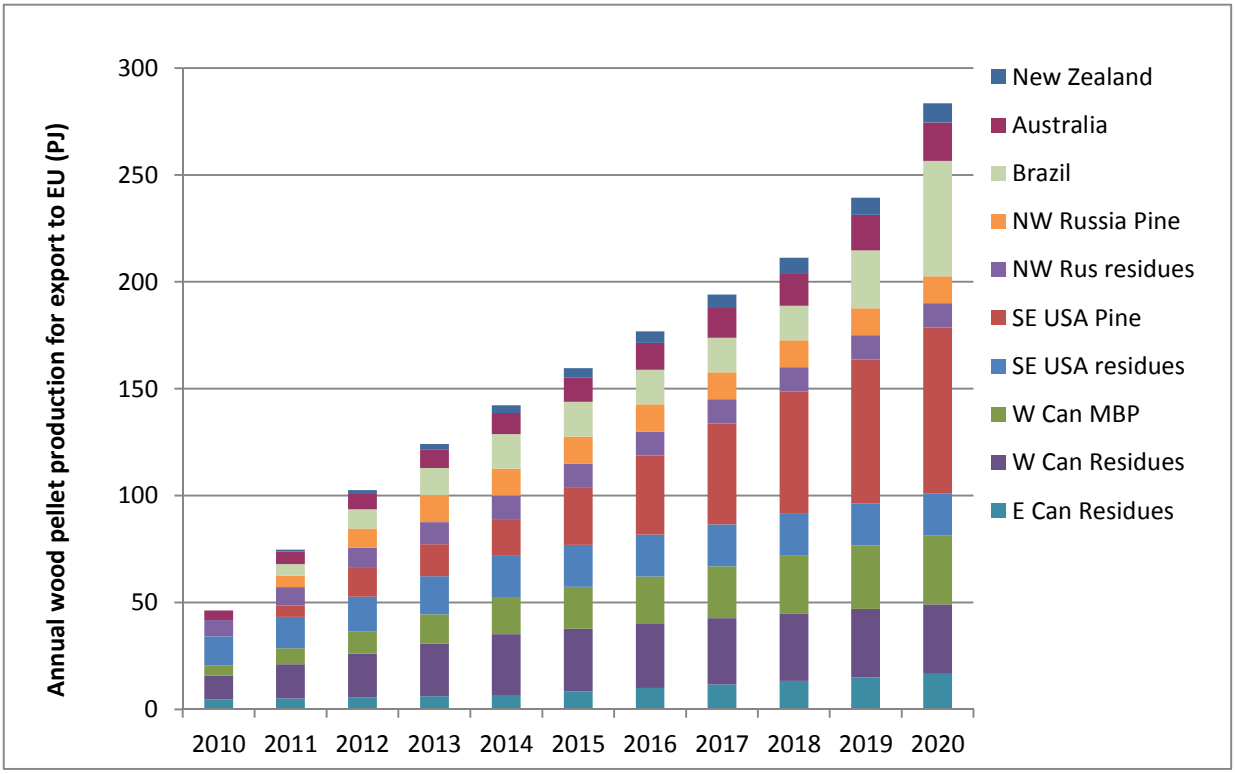


Figure 5.5: anticipated growth in available solid biomass supply from the various sourcing regions. residues = woody industry residues (e.g. sawdust), MPB = Mountain pine beetle affected wood. For comparison: 1 million tonnes of wood pellets equals about 18 PJ.

As can be seen in figure 5.5, the total potential available for import to the EU under the business as usual scenario may increase drastically from about 42 PJ in 2010 to over 280 PJ in 2020 (almost 16 million tonnes) – under all conditions as stated above. This scenario is based on existing projects, project currently being built and announced projects. Naturally, especially assumptions regarding the 2nd half of the decade become increasingly uncertain. For example, it is very uncertain whether the large-scale production of pellets from eucalyptus in Brazil will occur, and if the anticipated continued growth in wood pellets from pine wood in the US can actually be sustained until 2020.

The high import scenario

The scenario developed in the previous section is mainly based on industry expectations. In the high import scenario, we assume that demand for wood pellets in the EU and abroad increases rapidly, triggering investments in additional wood pellet plants based on feedstock from new plantations using short rotation crops. We base this high import scenario on the following assumptions:

We assume that short rotation woody energy crops will likely be established in the same regions as currently pulp plantations are established. Based on the selection criteria mentioned in the previous bullet point, Brazil is by far the country with the largest expanding pulp sector. At the end of 2009, the forecasts expected a capacity expansion of almost 8 million tonnes per year (Pulpmill watch 2011). Other countries would be Uruguay (3 million tonnes/year) and South Africa (almost 600,000 tonnes/year).Additionally, it is quite possible that new plantations will be established in the western cost countries of Sub-saharan Africa such Liberia, Sierra Leone and Ghana. These regions have been in the news lately mainly with regard to projects for biofuel production (e.g. a 57,000 ha project in Sierra Leone for the production of ethanol, (Johnson 2011), it is deemed reasonable to assume that these countries may also produce woody biomass for export (see also AfricaInvestor, 2011). Similarly,

Mozambique has received a lot of attention in past years regarding the possibilities to produce biofuels (e.g. Jatropha) or wood (e.g. Eucalyptus). Batidzirai et al. (2006) have pointed out that the technical production potential for wood pellets (or advanced biofuels) from eucalyptus may reach up to 6.7 EJ (equivalent of approximately 270 million tonnes of wood pellets). While this is a hypothetical number, the study shows that Mozambique could in theory produce large amounts of lignocellulose in highly-productive, rain-fed areas, and that also efficient logistics for export of wood pellets can be established.

Finally, it is also possible that (given the geographic vicinity) additional roundwood from Russia may be used for energy purpose. Especially under the current export tax system, it is plausible that additional roundwood is harvested for wood pellet production.

Based on these assumptions, we postulate the following additional sourcing areas under a high-demand scenario:

- Brazil rapidly increases production of (additional) short-rotation (i.e. 2-3 years) eucalyptus plantations from 2014 onwards to produce 2 million tonnes of wood pellets in each of the following states: Bahia, Rio Grande do Sul and Minas Gerais.
- Similarly, in Uruguay, 2 million additional tonnes are produced from eucalyptus plantations.
- In the Western African countries of Liberia, Sierra Leone, Cote d'Ivoire and Ghana, it is assumed that a total of 3 million tonnes of wood pellets will be produced by 2020 from fast growing plantations.
- Similarly, we assume that also in Mozambique a supply of 3 million tonnes of wood pellets could be established between 2014 and 2020.
- Finally, it is assumed that up to 3 million tonnes of wood pellets may be sourced from (managed or unmanaged) forests in North-west Russia.

These assumptions lead to an additional amount of 17 million tonnes of wood pellets in 2020 compared to the low trade scenario, bringing the total to almost 33 million tonnes /almost 600 PJ, i.e. roughly twice as much as assumed in the low trade scenario. Figure 5.6 shows the anticipated growth in available solid biomass supply from the various sourcing regions in the high import scenario from 2010 to 2020.

Note that the assumptions of the amounts is to some extent arbitrary, but reflects the current dominant position of Latin America, the expected rise of Sub-Saharan production potential, and the large (existing) potential from standing forests is North-West Russia. While all developments are not deemed unrealistic, they are highly speculative, and would depend amongst others on a strong demand for solid biomass in the EU and elsewhere, and (very) rapid investments in the sourcing areas.

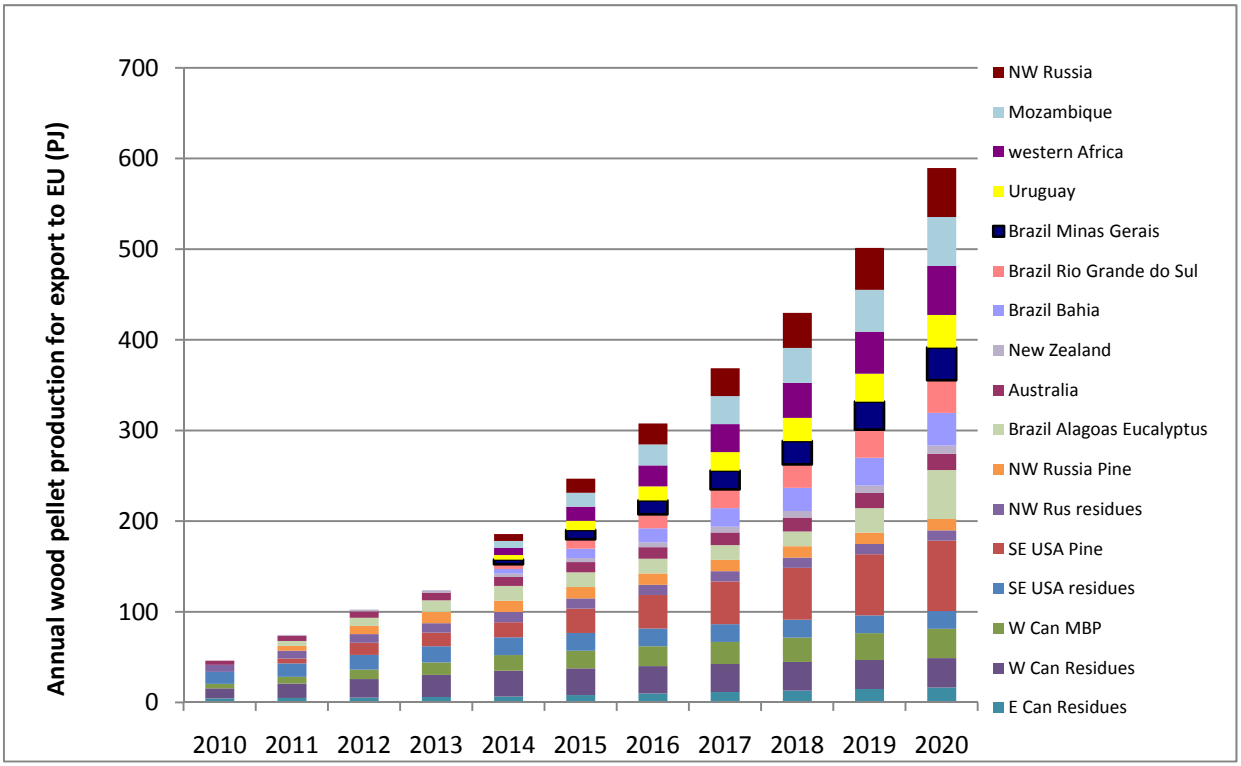


Figure 5.6.: anticipated growth in available solid biomass supply from the various sourcing regions in the high import scenario from 2010 to 2020. For comparison: 1 million tonnes of wood pellets equals about 18 PJ.

5.1.3 Comparison with other studies and discussion

Figure 5.7 indicates the expected total production in 2010, 2015 and 2020 according to the estimation of the study published by Poyry in 2011

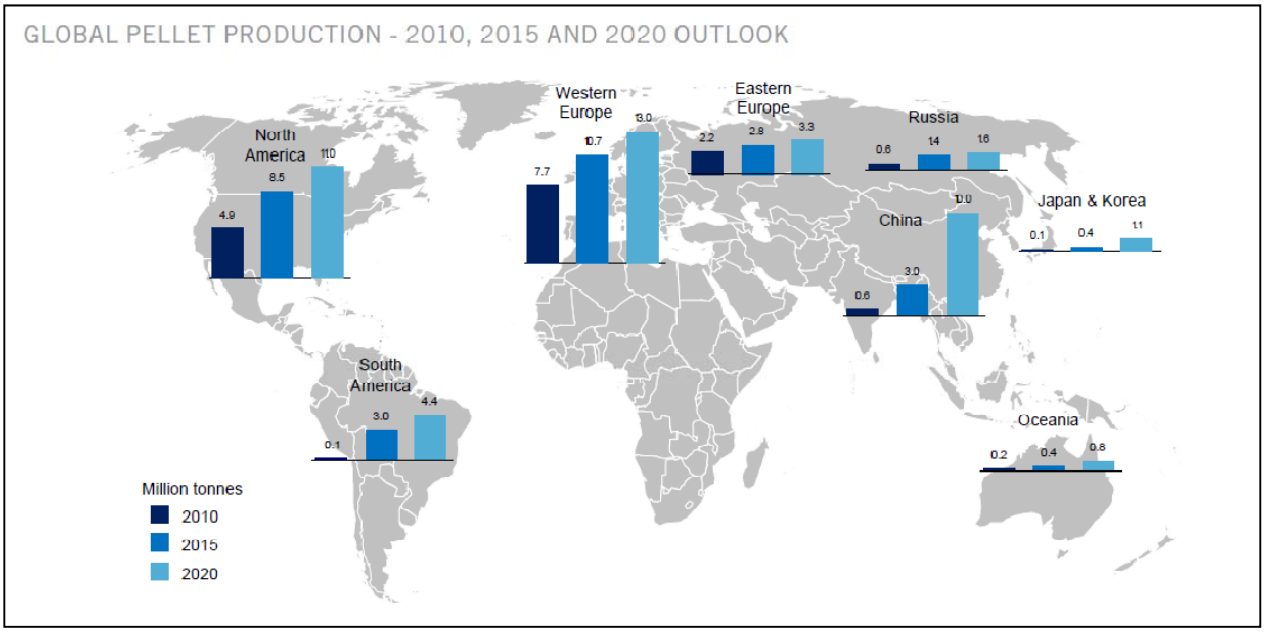


Figure 5.7. Overview of possible wood pellet production trends up until 2020 (Pöyry, 2011)

When comparing figures 5.7 (production) with 5.4. (consumption), this study expects that North America could produce a surplus of 5.4 million tonnes, Latin America of 4.2 million tonnes, Russia 1.5 million tons and Eastern Europe 2.5 million tons, adding to a total of about 13.6 million tons that could be exported – basically all to the EU and East Asia.

The "business as usual" model proposed in the present study indicates a higher possible export from the US and Canada (9.9 million tonnes) compared to the study by Pöyry, have about the same expectations of exports from Russia (1.3 vs. 1.5 million tonnes), but lower expectations about Latin America, where export potential of 3 million tons is assumed. In total, a possible export volume of about 16 million tons is assumed, about 17% higher than Pöyry.

Despite these minor differences, the analysis of expected supply and demand has shown that the global wood pellet market will drastically change until 2020. Total internationally traded volumes of wood pellets may increase from roughly 3 million tonnes in 2010 to 13-16 million tonnes under business as usual scenarios – or in an speculative extreme case up to 33 million tonnes. While the EU will remain to be the single largest area consuming wood pellets, Eastern Asia will rapidly follow as second major demand area. Global trade patterns may change, with Western Canada exporting to East Asia instead of Europe, and Latin America, Russia (and possibly Sub-Saharan Africa) may fill this gap. Major drivers for this trade will be renewable energy policies, and possibly high oil prices. On the other hand, recently voiced sustainability concerns regarding the use of whole trees for wood pellets, and the possible introduction of sustainability criteria for solid biomass in the EU may also have an dampening effect on these trade flow, but may also be required to assure that feedstocks are produced sustainably.

5.2 Enlarging the feedstock base for wood pellets: from sawdust to alternative wood based feedstock

Michael Deutmeyer

Energy pellets based on woody biomass are still the preferred commoditized feedstock for the bio-energy sector based on solid biomass. Their compact form and geometry allow for good bulk properties and a comparably high energy density, as well as stability and suitability for existing handling and storage infrastructure.

Especially when based on woody biomass, energy pellets come with a high feedstock quality due to their low ash content, high ash melting temperature and unproblematic ash composition. The combustion of wood pellets does not cause any significant fouling, corrosion, slacking or even nutrient withdrawal from the biomass growing area.

In the early days of energy pellet production the feedstock supply was based on saw mill residues such as saw dust or wood shavings. Their conversion into energy pellets generated an additional income stream and value added to an often no cost or low cost and low price side product. On the other hand saw dust and more so dry wood shavings are an ideal feedstock for the production of wood pellets. They come with already low particle sizes and in the case of shavings they are already dry.

Based on the continuously increasing demand for energy pellets due to a growing bio-energy sector in mainly Europe and North America a totally new industry of energy pellet manufacturing is being created – mainly driven by the demand side and less by the supply side. In several parts of the world demand for wood pellets already outstripped the supply of those saw mill residues such as saw dust and shavings.

Pellet producers have started to source additional and/or alternative sorts of woody feedstock. These include wood chips from saw mills, forest industrial round wood, forest residues, bark, used wood and wood produced from short rotation forestry plantations for the production of either residential grade or industrial grade pellets. (see tables below, CEN/TS 14961: 2005 solid bio-fuels specifications)But there is also another increasingly important reason for pellet mill operators to diversify their feedstock base. Large scale pellet consumers such as European or North American power plants are increasingly looking for medium and long term supply agreements with well defined volumes and prices that mirror their domestic feed in tariffs. This growing need for stability on the feedstock side in both price and volume conflicts with the volatile supply situation of the residue stream of the saw milling industry.

E.g. during the economic downturn in 2008/2009, Canadian pellet mills that had not yet diversified its feedstock base and were not yet able to process whole industrial round wood at their site including debarking and chipping, consequently ran out of feedstock from their saw mill suppliers and had to default partly on their long term supply contracts.

Some pellet manufacturer not only diversify their feedstock portfolio they even integrate further into the supply chain and are trying to secure their feedstock base – mostly back to back with existing pellet supply contracts – by securing their feedstock also on a long term basis through either long term forest concessions or long term supply agreements by forest owners.

A case in point is the Plantation Energy Australia Pty Ltd with a feedstock concept mainly based on “non-commercial timber and harvest residues from sustainably managed timber plantations”.

Also the feedstock concept of the US American pellet mill developed by the German utility RWE at Waycross, Georgia, with a capacity of 750,000 tons of pellets per year, is primarily based on unused pulp wood that has been contracted for a longer period of time with regional forest owners.

But also major European pellet manufacturer, such as German Pellets, are already sourcing significant volumes of industrial round wood as a feedstock for both pellet and heat production.

Looking at the different “new” woody biomass feedstock source in particular it can be stated that for the production of high quality residential grade pellets (see table: summary of several pellet norms) mostly white saw mill wood chips, larger diameter round wood that still can be debarked and totally untreated and uncontaminated used wood – such as from pallet wood – can be used as the main feedstock source.

All other woody biomass sources carry to much inerts and contaminants and will therefore be used for the production of industrial grade energy pellets.

The future use of chemical and thermal preconditioning technologies (torrefaction , leaching, etc.) in addition to densification will allow for a broader feedstock portfolio for the production of “on spec” energy pellets.

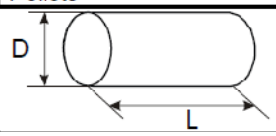
Table 1 — Classification of origin and sources of solid biofuels

1. Woody biomass	1.1 Forest and plantation wood	1.1.1 Whole trees	1.1.1.1 Deciduous
			1.1.1.2 Coniferous
			1.1.1.3 Short rotation coppice
			1.1.1.4 Bushes
			1.1.1.5 Blends and mixtures
		1.1.2 Stemwood	1.1.2.1 Deciduous
			1.1.2.2 Coniferous
			1.1.2.3 Blends and mixtures
		1.1.3 Logging residues	1.1.3.1 Fresh/Green (including leaves/needles)
			1.1.3.2 Stored
			1.1.3.3 Blends and mixtures
		1.1.4 Stumps	1.1.4.1 Deciduous
			1.1.4.2 Coniferous
			1.1.4.3 Short rotation coppice
			1.1.4.4 Bushes
			1.1.4.5 Blends and mixtures
		1.1.5 Bark (from forestry operations)*	
		1.1.6 Landscape management woody biomass	
	1.2 Wood processing industry, by-products and residues	1.2.1 Chemically untreated wood residues	1.2.1.1 Without bark
			1.2.1.2 With bark *
			1.2.1.3 Bark (from industry operations)*
			1.2.1.4 Blends and mixtures
		1.2.2 Chemically treated wood residues	1.2.2.1 Without bark
			1.2.2.2 With bark *
			1.2.2.3 Bark (from industry operations) *
			1.2.2.4 Blends and mixtures
		1.2.3 Fibrous waste from the pulp and paper industry	1.2.3.1 Chemically untreated fibrous waste
			1.2.3.2 Chemically treated fibrous waste
	1.3 Used wood	1.3.1 Chemically untreated wood	1.3.1.1 Without bark
			1.3.1.2 Bark*
			1.3.1.3 Blends and mixtures
		1.3.2 Chemically treated wood	1.3.2.1 Without bark
			1.3.2.2 Bark*
			1.3.2.3 Blends and mixtures
	1.4 Blends and mixtures		

NOTE 1 Cork waste is included in bark sub-groups.

NOTE 2 For the avoidance of doubt, demolition wood is not included in the scope of this Technical Specification. Demolition wood is "used wood arising from demolition of buildings or civil engineering installations" (see CEN/TS 14588).

Table 5 —Specification of properties for pellets

	Master table		
	Origin: According to 6.1 and Table 1		Woody biomass (1), Herbaceous biomass (2), Fruit biomass (3), Blends and mixtures (4)
	Traded Form (see Table 2)		Pellets
Normative	**Dimensions** (mm)		
	Diameter (D) and Length (L) [a]		
	D06	≤ 6 mm ± 0,5 mm and L ≤ 5 x Diameter	
	D08	≤ 8 mm ± 0,5 mm, and L ≤ 4 x Diameter	
	D10	≤ 10 mm ± 0,5 mm, and L ≤ 4 x Diameter	
	D12	≤ 12 mm ± 1,0 mm, and L ≤ 4 x Diameter	
	D25	≤ 25 mm ± 1,0 mm, and L ≤ 4 x Diameter	
	Moisture (w-% as received)		
	M10	≤ 10 %	
	M15	≤ 15 %	
	M20	≤ 20 %	
	Ash(w-% of dry basis)		
	A0.7	≤ 0,7%	
	A1.5	≤ 1,5 %	
	A3.0	≤ 3,0 %	
	A6.0	≤ 6,0 %	
	A6.0+	> 6,0 % (actual value to be stated)	
	Sulphur (w-% of dry basis)		
	S0.05	≤ 0,05 %	Sulphur is normative only for chemically treated biomass and if sulphur containing additives have been used
	S0.08	≤ 0,08 %	
	S0.10	≤ 0,10 %	
	S0.20+	> 0,20 % (actual value to be stated)	
	Mechanical durability [a] (w-% of pellets after testing)		
	DU97.5	≥ 97,5 %	
	DU95.0	≥ 95,0 %	
	DU90.0	≥ 90,0 %	
	Amount of fines (w-%, < 3,15 mm) after production at factory gate		
	F1.0	≤ 1,0 %	[a] At the last possible place in the production site
	F2.0	≤ 2,0 %	
	F2.0+	> 2,0 % (actual value to be stated)	
	Additives (w-% of pressing mass)		
	Type and content of pressing aids, slagging inhibitors or any other additives have to be stated		
	Nitrogen, N (w-% of dry basis)		
	N0.3	≤ 0,3 %	Nitrogen is normative only for chemically treated biomass
	N0.5	≤ 0,5 %	
	N1.0	≤ 1,0 %	
	N3.0	≤ 3,0 %	
	N3.0+	> 3,0 % (actual value to be stated)	
Informative	Net calorific value, $q_{p,net,ar}$ (MJ/kg as received) or energy density, E_{ar} (kWh/ m^3 loose)		Recommended to be informed by retailer.
	Bulk density as received (kg/m^3 loose)		Recommended to be stated if traded by volume basis
	Chlorine, Cl (weight of dry basis, w-%)		Recommended to be stated as a category Cl 0.03, Cl 0.07, Cl 0.10 and Cl 0.10+ (if Cl > 0,10 % the actual value to be stated)

[a] Maximum 20 w % of the pellets may have a length of 7,5 x Diameter.

Examples of specifications for high quality classes of solid biofuels recommended for household usage

A.2 Wood pellets (selected from Table 5)

Origin:	1.2.1.1 Chemically untreated wood without bark
Moisture content:	M10
Mechanical durability:	DU97.5
Amount of fines:	F1.0 or F2.0
Dimensions:	D06 or D08
Ash content:	A0.7
Sulphur content:	S0.05
Additives:	< 2 w-% of dry basis. Only products from the primarily agricultural and forest biomass that are not chemically modified are approved to be added as a pressing aids. Type and amount of additive has to be stated.
Energy density:	E4.7 [kWh/kg] ($q_{p,net,ar} \geq$ 4,7 kWh/kg = 16,9 MJ/kg)

5.3 Exploiting the basin of agricultural feedstock with agropellets

Daniela Thrän - Christiane Hennig

Next to woody biomass as feedstock for the pellet production alternative resources are becoming more prominent. This development results on the one hand from an untapped potential of agricultural residues and on the other hand from a globally increasing use of wood residues and by-products for the provision of energy e.g. in the form of pellets and as raw material in the pulp and paper industry. Agricultural residuals as straw, hay and husks as well as energy crops like miscanthus are the most popular raw materials for the agropellets production today. Further interesting resources are different types of grains and grass, olive kernels, rape cake and coffee husks, what presents a wide range of raw materials. The following description shall provide an overview on the most important agropellet markets in Europe as well as give a brief outlook on the future development and related challenges.

Main studies that have been looked at concerning the agropellet production and use in Europe are the pellets@las project providing an overall picture of the European markets and the MixBioPells project with a focus on alternative raw materials for the pellet production in 7 European countries and regions respectively (both projects have been supported by the European IEE-programme). In some cases regional experts could provide estimates what supported the results.

Countries with significant developments and activities in this area so far, even though they are small in comparison to the wood pellet market, are Denmark, Poland, the Czech Republic, the Ukraine, and the United Kingdom. Besides, various Eastern and Southern European countries as Slovakia, Hungary and Italy show increased activities in this field. However, in the majority of the European countries an agropellet market does not exist yet. In general it can be observed that countries with a distinct agricultural sector and little forested areas qualify for a development and expansion of an agropellet market. In the following section the most important markets are briefly described and general conclusions on the state of development are drawn.

5.3.1 Market Overview

The beginning of the production of agropellets in the Czech Republic dates back to the early 2000s. Since then the market has experienced a steady growth. Today the production amounts to 110,000 t (2009). Agropellets are produced and consumed locally. So far little trading activities can be observed, thus in 2009 10,000 t have been imported The main raw materials are straw, hay and other grain residues. The market is expected to grow further and the future plantation of energy crops is also conceivable on the Czech market.

In Denmark the yearly production of straw pellets is about 100,000 t. This volume is produced by one large manufacturer and is dedicated to one power plant. The utilization of biomass especially straw and wooden residues in large power plants has been stimulated by the Biomass Agreement of 1993 and its adjustment in 2008. Besides, there are a few small agropellet producers without a significant throughput. Due to this setting, market structures like the introduction of further producers (medium- and large-scale) and consumers and the price formation for straw pellets could not establish properly yet.

As in Denmark there is also one main straw pellet production plant (production volume 100,000 t) in the United Kingdom, which directly supplies a coal power plant where the straw pellets are co-fired. Moreover there are a few producers with comparably small production quantities of agropellets based on miscanthus and straw. In the UK co-firing of biomass is incentivised under the Renewables Obligation Certificates Scheme what supports the use of pellets for the electricity production. Furthermore, the limited availability of woody biomass in the UK also gave an impetus for the development of alternative resources.

Next to Denmark and the UK also Poland uses agropellets for electricity production in co-firing plants. As in the UK the use of biomass for co-firing is promoted under the so-called Green Certificate Scheme. There the focus is especially on the predominant use of agricultural residues and products. The utilized pellets are made from especially sunflower husks and miscanthus. For the supply of the power plants considerably amounts of sunflower pellets are imported from the Ukraine. The local production of agropellets is estimated to 40,000 t

In 2009 the production volume of agropellets made from sunflower husks amounted to 190,000 t in the Ukraine. For 2010 a doubling of this number was estimated. So far only sunflower husks are used as a raw material for agropellets. However, a huge future potential is seen in straw. 90 % of the production volume is exported, mainly to Poland. The domestic market is not developed yet and pellets are hardly used on national level.

Further interesting and significant agropellet markets with a still unexploited potential are Hungary, France and Germany; countries that are traditionally shaped by agriculture. In Hungary several activities on the usage of agropellets for energetic purposes could be noticed in the past 3 years. In 2009, 4,000 t of agropellets have been produced; a still small amount. 90 % of the production volume was consumed within the country. Also in France the annual production quantity is very little (8,500 t in 2009) and fully supplied to the domestic market and applied in small-scale heating systems. However, a larger amount of agropellets is produced for the utilization as animal feed. Thus, the expertise of agropellet production already exists within the country. The market structure in Germany is pretty similar to the one in France. The overall production volume of agropellets for energy provision is very little and some producers supply agropellets only as animal feed.

Summarizing the activities concerning agropellets in Europe an overview on the different markets is given in Figure 5.8. There the state of development of the considered agropellet markets is divided into 3 categories: major activities (actual and significant production and/or consumption of agropellets for energetic purposes), few activities (production and/or consumption on demonstration level or rather small production and/or consumption volumes) and no activities so far. Besides, figures for the production volume (if known) and the most significant raw materials have been assigned to the countries with major and few activities.

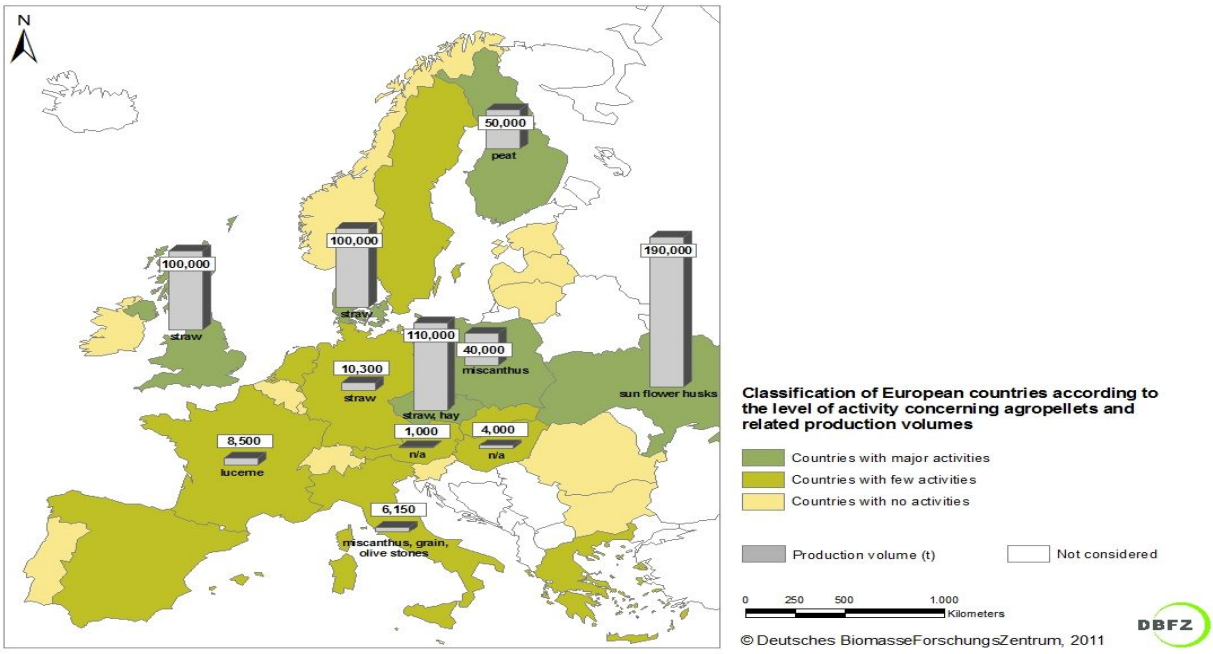


Figure 5.8. Classification of European countries according to the level of activity concerning agropellets and related production volumes 2009[12].

5.3.2 Trading Flows

The main trading activities are directly taking place between the producer and consumer within countries. As presented often the agropellet production is linked to a dedicated coal power plant where the pellets are co-fired. Hence production and consumption happen primarily locally. Of course, this is also due to the fact that in most of the countries with an agropellet usage governmental support programmes have incentivised and supported the emergence of such a market.

Among countries a few trading streams can be noticed in particular between bordering regions. The trading figures for agropellets between countries are very small so far and in most of the cases not known. A significant stream can be noticed between the Ukraine and Poland. The export of sunflower husks from the Ukraine to Poland amounted to approximately 150,000 t in 2009. Further smaller streams are in the Mediterranean region and South East Europe.

5.3.3 Summary and Prospects

The research has revealed that statistics on market figures like production, consumption and trade of agropellets are hardly available. Many producers and consumers are small companies with corresponding small volumes making the collection of reliable figures difficult. At the moment agricultural residues especially straw and miscanthus are the most common raw materials for the agropellet production. Dedicated plantations of energy crops for the pellet production are still in their infancy.

Agropellets are currently mainly used for co-firing in coal power plants. The use of agropellets in small-scale heating systems is not an option yet, what is mainly due to technical problems. However this lack of demand has resulted in unused installed production capacities. In particular in Italy and Spain facilities that can process various alternative feedstock for the pellet production have little output or even stand still.

[12] The volume for Germany comprises of both agropellets and mixed biomass pellets and represents the output of a questionnaire at the beginning of 2011. No explicit figure for agropellets has been available. However, predominantly agropellets were produced.

The agropellet production for the co-firing in power plants primarily takes place regionally. Besides, a few markets export the entire production quantity to this dedicated market. They do not have a national consumption. Markets that produce both for the national demand and for export are not in place since a sufficient international demand does not exist. Hence significant trading flows have not established so far.

The mentioned facts on the status of the agropellet market in Europe underline the immaturity of the market.However, the use of available agricultural residues and by-products for energy purposes is a great opportunity to increase the supply to the market. Thus in the following paragraph the opportunities and threats to the agropellet market are discussed.

5.3.4 Prospects (opportunities and threats)

Considering an increasing competition for wood residues and by-products alternative resources can expand the supply for a sufficient pellet production. Especially the growing interest in co-incineration may provide an increasing demand for alternative raw materials as a substitute or complement to woody biomass. Hence the market of agricultural residues and energy crops in the form of a pellet can experience a growth. In particular the already existing knowledge and facilities for pelletizing herbaceous biomass for the animal feed industry supports a fast introduction of agropellets for energy generation.

However, there are threats towards a growth of the agropellet market.

The utilization of agropellets in large heat and power plants turns out to be technically feasible and is practised. According to the European quality standard EN 14961 for solid biofuels the density of pellets is three to six times higher (550 to 600 kg/m^3) in comparison to bales (100 to 220 kg/m^3), what implies a higher energy density whereby noticeable reduced costs per transported ton can be realized **[8]**, **[9]**. Nevertheless, the direct usage for example of straw bales is in many cases more efficient and outweighs the higher transportation costs and additional preparation steps before combustion in comparison to the processing costs for the production of pellets **[1]**. Therefore, agricultural residues tend to experience some basic pre-treatment steps but not a complex pelletizing process. However with increasing transportation distances pellets become a more attractive alternative.

Considering the combustion in small-scale boilers the properties of the agricultural material pose in the currently available boilers a challenge concerning slagging, corrosion and emissions. In some countries regulations on the threshold values for the emissions of combustion installations constrain the utilization of agropellets, which are associated with higher emissions than for example the combustion of woody biomass. These aspects have hindered an appropriate use, and hence present a barrier to the diffusion of this application **[2]**. There the development of the combustion technology is needed. Main activities can be observed from Austrian boiler manufacturers. They already offer boilers for the dedicated combustion of agricultural material **[4]**.

Currently, there are activities concerning a general standardisation of the quality of agropellets. The new European multipart-standard EN 14961 defines quality specifications for solid biofuels. Part six of the standard specifies five quality classes for non-woody pellets for non-industrial use (utilization in small- and medium-scale heating boilers) – one class for pellets made from cereal straw, miscanthus and reed canary grass respectively and two classes for pellets made from other agricultural raw material assortments. This part of the standard is going to be published within this year. Concerning the industrial use (utilization in power plants) of agropellets no standard is in place yet. However, part one of the EN standard contains general requirements on solid biofuels including a system for the classification of different quality parameters. This has already been published in 2010. The system could be quite useful to describe the properties of solid bioenergy carriers for industrial use. Besides, the international standardisation organisation ISO is currently working on a worldwide quality standard for solid biofuels that is based on the new EN standards.

Summarising, the introduction and utilization of agropellets for energy generation will happen in the short run on markets where co-firing plays a role. This is due to the quality properties of the alternative resources. Countries as Denmark, Poland and the United Kingdom already apply alternative pellets in significant volumes. Future markets for agropellets in co-firing could be Belgium and the Netherlands. On the mid run agropellets could play a more important role for heat supply in households and municipalities after overcoming the current difficulties of combusting agropellets in small- to medium-scale heating boilers.

5.4 Adapting Logistic and Transportation Infrastructures

Douglas Bradley

5.4.1 Existing Trade

While long distance trade in ethanol, wood pellets, vegetable oils and biodiesel has been going on for years, trade in bio-products is now experiencing explosive growth, both in volumes, sources, and destinations. In the last 10 years Brazil has dominated ethanol exports, shipping an estimated 4.255 billion litres in 2010, or 97% of world ethanol trade[13]. An estimated 27% of ethanol went to the EU, 19% to the US, 17% to Canada, and 29% going to Japan, South Korea and India. There were essentially no exports of biodiesel in 2005, but by 2010 818 million litres were traded, dominated by Argentina with 64% of exports. The EU imported fully 80% of traded biodiesel[14]. Canada has long dominated long-distance pellet exports, shipping large volumes 16,500 km from BC on the west coast through the Panama Canal to Europe. In 2010 pellet capacity in Canada grew an astounding 1 MT, or 50%, in one year to reach 3.1 MT[15]. Expectedly, 62% of Canada's production comes from BC, but now 36% comes from Eastern provinces. All Atlantic Canada exports formerly came from one plant in Nova Scotia, exporting from Halifax. Now other plants from New Brunswick have been built, exporting from Belledune, and exports are soon expected from Montreal. The last five years has seen major capacity building in the US South East, mostly for export, and also Australia. Plantation energy in West Australia produced 250,000 tonnes in 2010, and plans to add another 500,000 tonnes capacity for export. Pellet exports have gone almost entirely to the EU, primarily to the Netherlands and Denmark, and increasingly to Belgium and the UK. The Baltic became a major source for pellets 2005-07, shipping in the Baltic to Western Europe, but wood shortages reduced volumes.

5.4.2 Future Demand and Trade Patterns

As indicated in Chapters 2-4, the implementation of 20-20-20 renewable energy targets in the EU and subsequent development of national energy plans will result in major increases in biomass demand. Spain, France and Italy combined will need 6 times more biomass in 2020 than in 2010, while the UK and Belgium will more than double. Korea just released its energy plan that requires 20% renewable energy in power plants by 2020, resulting in a projected new biomass demand of 15 MT, almost as much as the entire EU today.

Also noted in Chapters 2-4, new sources of biomass are being considered to meet the burgeoning demand. Russia has almost limitless biomass potential, but getting it to market on time and at the right price may be a challenge. A new 900,000 tonne pellet plant just ramping up production in Viborg, near the Finland border, will be a good test case for Russian biomass supply. If consistent supply of quality pellets is proven, more and more Russian pellets would be transported from Baltic ports. In Canada there are 18 proposals for pellet plants in Ontario and an equal number in Quebec. Sufficient volumes of pellets in these provinces could enable reduced rail costs to the ports of Montreal, Quebec City and Saguenay, opening up the St. Lawrence River as a new export corridor, only 5,000 km from European markets. In the west the BC ports of Vancouver and Prince Rupert see 1.5 million tonnes pellets reach Europe, but Korea is only 10,000 km away and the huge anticipated demand for pellets by Korea could see all BC pellets head to Asia. Brazil has traditionally focused its bioenergy efforts on sugar cane to ethanol.

The last 1-2 years has seen development of pellet plants, with the prospect of many more, creating a yet another new trade route to Europe. Australia and New Zealand have little pellet capacity, but plantation potential could see both countries vie for Asian and even European pellet markets. Biomass studies have been aware of biomass potential in the Caribbean, South Saharan Africa, Malaysia, and South America. Many of these sources have been previously ignored owing to risks of investment, however, with the right

[13] FAPRI- 2010 Agricultural Outlook
[14] FAPRI- 2010 Agricultural Outlook
[15] CanBio Data Study 2011

investment incentives places like Namibia, Mozambique, and Argentina could find themselves major suppliers by 2020.

5.4.3 Competing Energy Mediums: Torrefied Wood

Large-scale coal fired power plants in Europe have increasingly been co-firing with wood pellets to increase the proportion of renewable energy and reduce GHG emissions, guided by local legislation and regulations. In most plants, pellets are mixed with coal and sent together through grinders. However, pellets have different properties than coal, and can only be added up to 5-10% before they begin to gum up the grinders. In order to increase the proportion of biomass, these coal plants have to put in considerable capital equipment. For them, a viable alternative is to use torrefied wood, which like pellets is renewable, but has properties much more similar to coal, and can be added to coal in power plants without limitation. Torrefied wood pellets are denser than standard pellets and thus can be transported at lower cost per GJ. Power plants are always on the lookout to reduce costs, and feedstock costs are a chief target, thus torrefied wood is attractive in this regard. Torrefied wood is also water-repellent, thus more easily handled and stored. Some torrefied pellets may not even require covered storage. The market expectation is that torrefied pellets will be sold at a premium to standard pellets on a GJ basis, reflecting savings in transport, handling and storage and the convenience of power generators not having to commit capital upgrades.

Although the process for manufacturing pellets is well known and fairly simple, and years of shipping pellets has exposed transport issues, most of which have been successfully resolved through safety guidelines and procedures, torrefied wood has such advantages that it has the potential to entirely replace pellets in the industrial market in the years to come. In 2011 several torrefied wood plants are either under construction or are operating and ramping up production. Examples include Topell Energie in the Netherlands and Keyflame in Misissippi. Even many of today's pellet plants can be retrofitted to produce torrefied pellets, at an additional capital cost. In terms of transportation logistics, it is understood that to transport torrefied wood long distances it also must be pelletized to increase density. It is expected that torrefied pellets can use the same supply chains that exist for pellets, but transport logistics issues will only really surface when such transportation begins.

5.4.4 Competing Energy Mediums: Pyrolysis Oil

Pyrolysis Oil is a dark-brown liquid made from plant material by a thermo-chemical process called fast pyrolysis, whereby biomass particles are heated in the absence of oxygen, vapourized, and condensed into liquid. Pyrolysis Oil can be stored, pumped and transported like petroleum products and can be combusted directly in boilers, gas turbines and slow to medium speed diesels for heat and power. It can be substituted for heavy fuel oil (HFO), light fuel oil (LFO) or natural gas in a number of applications, including pulp mill lime kilns, power plants and district heating. Pyrolysis oil has approximately the same heating value as wood pellets at 18 GJ/tonne, however at 1.2 tonnes/m^3 it is more than twice as dense as pellets. Since volume, not weight, is the normal limiting factor for shipping, pyrolysis oil has the potential for significantly lower shipping costs than pellets. Pyrolysis Oil is CO_2 neutral, contains no sulphur and therefore does not produce sulphur dioxide emissions during combustion.

Canada is the world leader in Pyrolysis oil production. Only Canada has commercial scale pyrolysis oil plants, all in Ontario. Both Dynamotive plants are now closed; a 200-tpd plant in Guelph idle due to loss of customers during the recession and lengthy environmental assessment to change feedstocks, and a 130-tpd commercial demonstration plant in West Lorne. Ensyn's largest plant, a 100-tpd plant in Renfrew, has been running since 2005 exporting virtually all its production to the US, some into the food and chemicals market, some for building heat. In June 2010 Ensyn announced a partnership with Tolko Industries where Ensyn would build and operate a pyrolysis plant of capacity up to 400-tpd at the Tolko sawmill in High Level Alberta. The plant would be the largest pyrolysis plant in the world. All the pyrolysis oil would be used to make power and heat for Tolko operations, with excess power being fed into the grid. Pyrolysis Oil used to be acidic, with pH 2-3, however both Dynamotive and Ensyn have succeeded in increasing the pH so that it is no longer necessary to store and transport pyrolysis oil in stainless steel or similar containers.

The new economic size for a pyrolysis plant that balances size and manufacturing efficiency with increasing cost of feedstock with distance is 400 tpd. Ensyn has indicated that this size of plant could produce pyrolysis oil at $6.11/GJ (€4.36/GJ) at the plant gate. Pyrolysis oil tests are being undertaken now by Essent Energie, the largest user of biomass amongst European power producers. OPG (Ontario Power Generation) has also commissioned studies on torrefied pellets and pyrolysis oil. While pyrolysis oil will not be competing with pellets for the residential heating market in the near future, it is a viable option to fuel some power plants, and also for production of power using small diesel engines. Far flung biomass sources such as South Africa, Argentina, or SE Asia may consider producing and shipping pyrolysis oil as an alternative to pellets.

5.4.5 Bio-Coal

Torrefied wood pellets will use essentially the same supply chains as regular wood pellets, with some modifications, and pyrolysis oil, being a liquid, will use chemical tankers, chemical rail cars and dedicated storage tanks at ports. Bio-coal will require no great changes to existing supply chains. Bio-coal is a torrefied wood product, but it avoids the added cost and technological difficulty of pelletizing torrefied wood. Instead, bio-coal is simply added to coal in proportions specified by the customer, and employs existing extensive, low-cost, coal supply chains. Global Bio-coal Energy of Vancouver, in partnership with the Coast Tsimshian First Nation, is now developing its first commercial sized bio-coal plant in Terrace BC, Canada, approximately 80 km from Ridley coal terminal at the ocean port of Prince Rupert.

The plant will produce 25 tph bio-coal using the Wyssmont process, or 120,000 tonnes per year. Product will be put into gondolas at the plant and picked up every evening for the 80 km road trip to the Ridley terminal where it will be mixed with coal. Global Bio-coal has made an agreement whereby Vitol Broking Ltd of London will buy all the bio-coal the plant can produce. The product has been thoroughly tested and accepted by coal-fired power producers in the UK.

No changes to power company infrastructure is required. European customers may choose to take a mixture of 20% bio-coal and 80% coal to meet local regulations, with Deloitte supplying certification. Korean customers may choose 2% bio-coal in 2012, 4% in 2013 etc since these are the stepped renewable energy targets stipulated in the new energy plan. The second plant will be located in the BC interior, and Global Bio-coal Inc has indicated that BC can easily support 30 such facilities, or 3.6 million tonnes bio-coal. While wood pellets have a general preference for white wood with perhaps a small component of bark, an advantage of bio-coal is that it can be made from almost any woody substance; bark, industrial wood, forest residue.

Ridley ships 9 million tonnes coal annually, the Neptune terminal 12.5 million tonnes, and Westshore-Roberts Bank 21 million tonnes. 79% of coal exports from these terminals go to Asia, primarily Japan and Korea. Though exports total 42.5 million tonnes, port capacity is 50 million tonnes, sufficient to handle 8.5 million tonnes bio-coal. The ports are contemplating increasing capacity to 65 million tonnes. While wood pellets must arrange their own ships, often limited to 40,000 tonne Handimax, and bear the full cost of transport, bio-coal is simply added to the coal supply chain, which warrants a low cost because of large volumes. The coal/bio-coal mix would utilize 80,000dwt Panamax ships to Europe, and 350,000dwt Capesize ships to Asia. Supply chain costs for bio-coal are estimated at $33/t (€23.6/t), including feedstock to Terrace Bay, loading, and shipping to Europe.

5.4.6 Infrastructures Required

To accommodate quickly growing pellet markets, infrastructure requirements for **existing** major suppliers such as BC and the US South will chiefly be reduction of bottlenecks and other simple capacity increases. For example, in Canada the Port of Prince Rupert in northern BC has storage capacity for 14,000 tonnes pellets, but it is considering 5 new storage silos not only to accommodate increased production volumes

from the interior, but also to enable completely filling Handymax ships. Other investments include a better loader to limit dust and preserve pellet integrity, and rail siding for efficiency. Even these minor changes are estimated to cost $40-60 million (€29-43 million), but rates of return are projected to be quite high and the risk relatively low. In the Port of Vancouver additional storage silos are needed for both the Kinder Morgan and Fibreco terminals, and Kinder Morgan may need to replace its fixed loader to load ships faster.

In the South East US the pellet business is growing exponentially, partly to take advantage of European energy markets, but also to take advantage of a large sustainable feedstock source from plantations and an extensive road and rail system to transport pellets to ports. The region produced 2 million tonnes in 2009. In June 2011, the first 23,000 tonne shipment was made from the 750,000 tonne Waycross US plant through the Port of Savannah to RWE-Essent's Amercentral power station in the Netherlands[16]. US entrepreneurs, understanding that developing a financially successful pellet business also means ensuring efficient, low-cost supply chains, have begun investing in necessary infrastructure. In an agreement between the Georgia Port Authority and Logistec-USA, Logistec will invest $5 million to modernize the East River Terminal at the Port of New Brunswick to expand the biofuel export market[17]. Enviva will double capacity at its Amory facility to 100,000 tonnes and ship through the Port of Mobile, also used by the former Piney Wood Pellets plant that Enviva acquired and expanded to 150,000 tonnes. Enviva announced a new 330,000 tonne plant in North Carolina, and two months later acquired a port terminal in Chesapeake Virginia from a cement company, which it will develop to receive, store, and load in excess of 3 million tonnes annually.

Canada and the US are the major suppliers, and with large wood baskets combined with market-oriented economic systems; it is common either for pellet plants to integrate downward to invest in supply chains, or for entrepreneurs to invest in such infrastructure. While there is market risk, political risk of investing is relatively low. But what about new sources of biomass? Australia has large plantation potential and Western financial systems, but distance from Europe has hindered growth. New Asian markets may boost investment both in plantations, ground supply chains and ports. Similarly with New Zealand. Russia has a large wood basket, but doing business in Russia creates many difficulties. Investing in the largest pellet plant in the world carries great risks with biomass supply and also political risks. There is a whole different tier of potential suppliers, such as Namibia, Mozambique, and the Caribbean, all with large sources of biomass, but development would have to start from scratch; investing in plants, training a workforce, integrating new ground supply chains with non-existent supply systems, possible but only feasible if the entire supply chain were addressed. How to fund these investments?

5.4.7 How to pay for it all

Many regions rich in biomass resources do not have the financial capability of developing the resource, so they would have to turn to international sources. The World Bank has a Climate Investment Fund consisting of the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). CTF promotes financing for demonstration, deployment and transfer of low carbon technologies, and SCF supports developing country efforts to reduce deforestation and scale up renewable energy. These funds can help fund pellet infrastructure, but not lead. Similarly the Copenhagen Climate Fund has the potential to support infrastructure, but it may be mired in politics for a long time before it can contribute. Venture capital companies don't even have regions like Africa on its radar, and even with next-tier regions like Argentina, may not consider investing in pellet capacity with no domestic market and uncertain supply chains. It has been suggested that a new Bio-trade Equity Fund could be created to fill the investment gap and enable development in new biomass supplies and reducing risk by investing in the whole supply chain; secure fibre supply contracts, efficient ground transport, large conversion plants, efficient ports, and secured off-take agreements[18][19].

[16] Georgia Biomass- www,gabiomass.com
[17] Forest Business Network
[18] World Bio-trade Equity Fund Study- IEA Task 40 April 2010- Bradley D, Hektor B, Schouwenberg P
[19] A Proposed Bio-trade Equity Fund- IEA Task 40 June 2011- Bradley D, Hektor B, Deutmeyer M

5.5 Ensuring sustainability along the value chain

Chun Sheng Goh and Martin Junginger

Ensuring the sustainable production, trade and use of wood pellets has gained increasing attention in the EU in recent years. To our knowledge, in none of the international wood pellet producing regions, so far, no specific criteria for the production or use have been established. Therefore, in this section, we solely focus on developments in the EU. In the next section, a concise description of the existing legislation in EU member countries is given as far as they cover criteria for solid biomass than encompass the entire chain from producers to end-users, especially focussing on GHG emissions. This followed by an overview of currently existing voluntary certification systems that may be employed by producers, traders and consumers. Parts of this overview have also been written for the Solidstandards project.

5.5.1 Overview of ongoing legislation in EU countries

As the use of biomass to generate energy has been highly promoted across the Europe, it is important to ensure that bioenergy is produced in a sustainable manner. The current legal framework (related to agriculture and forest management) in many EU countries may provide certain assurances to sustainability production of biomass within the EU, but countries outside the EU may lack such a framework. Establishment of proper standards and certification schemes is important to ensure biomass imported is produced in a sustainable way. However, few of the countries have taken initiatives to develop mandatory biomass certification system and regulations that cover the whole supply chain. To build consensus among its member states, the European commission is considering reviewing and implementing sustainability criteria on solid biomass. The forerunning member states are Belgium and the United Kingdom. Both countries have promulgated regulations cover the whole biomass chain in an integrated way. The Netherlands, Italy and Spain has also shown some initiatives but still at infancy. Up to date, most certifications of solid biomass are carried out on voluntary basis, which are discussed in Section 5.5.2. Please note that this content is based on the situation as of December 2011 and may subject to change.

5.5.1.1 European Commission

At the time of writing (December 2011), there are no binding sustainability criteria for solid biomass on an EU level. In a publication of February 2010 [1] the EC announced that for the time being, it would not introduce mandatory sustainability criteria for solid biomass, but it would review this decision at the end of 2011. In the meantime, the commission recommends that the same criteria as for liquid biofuels should be used in case member states consider implementing national binding sustainability criteria for solid biomass. The EU biofuels sustainability criteria described in the Renewable Energy Directives (RED) exclude liquid biofuel production on land with high carbon stocks and land with high biodiversity values. Furthermore a GHG saving of at least 35 % (50 - 60% from 2017/18), compared to fossil fuel is needed. Those criteria have to be met to enable counting towards the renewable energy targets and obligations and to be eligible for financial support. Current ongoing work by the Commission includes execution of external studies on benchmarking biomass sustainability criteria for energy purposes, evaluating the impacts of a national or an EU approach on biomass costs and availability. The Commission also received around 160 contributions from public consultation by end of spring 2011. The key messages conveyed are:

- Biomass imports will increase and raise additional sustainability issues
- The national approach (which is executed so far) can be problematic for an internal market perspective.
- A general message is the need of consistency / coherence across sectors using biomass (e.g. transport heat and power). Some stakeholders called for sustainable forest management requirements;
- Stakeholders have diverging views concerning the scope of possible EU sustainability criteria:

- Criteria should apply for all energy producers, regardless of their size (mainly pointed out by NGO's and biofuel industry)
- Small and large scale bioenergy producers would like to see an exemption for small bioenergy producers (1 MW)
- Binding criteria only for large energy producers above 20 MW capacity

A decision if binding criteria will be introduced on an EU-wide level (and if so, which) is now expected in the spring of 2012.

5.5.1.2 Belgium

The certification systems in Belgium are implemented at regional level. Brussels, Flanders and Wallonia employed different approaches in certification of solid biomass. The system in Flanders, namely Flemish Green Power Certificates s based upon the energy balance. The energy input in transport, biomass treatment, and on-site electricity need has to be deducted from gross electricity production for the assignment of green certificates. On the other hand, the systems in Wallonia (Walloon Green certificate granting system) and Brussels (Brussels Green certificate granting system) are compatible. They are based upon avoided GHG emissions of the entire chain. The reference for electricity generation is a steam and gas turbine combined cycle power plant with 55% efficiency, while for heat it is gas boiler with 90% efficiency.

5.5.1.3 United Kingdom

The UK's regulation for renewable energy, namely The Renewables Obligation (Amend.) Order 2010 is basically based upon full chain reporting on feedstock source and origin, with the total GHG savings according to the Renewable Energy Directive (RED). A similar regulation specified for heat generation, namely Renewable Heat Incentive, was also drafted. On the other hand, Scottish Biomass Heat Scheme employs an emission evaluation using CO_2 balance.

5.5.1.4 The Netherlands

In 2006, the Dutch Cramer committee developed six principles for biomass sustainability: (1) greenhouse gas emissions, (2) competition with food, local energy supply, medicine and construction materials, (3) biodiversity, (4) environment, (5) prosperity and (6) social well-being (social, human and property rights). The Netherlands currently have no binding criteria for solid biomass, but in the future, it may well be possible that new policy support for wood pellets is linked to legislation based on these principles.

5.5.2 Overview of currently existing sustainability certification systems

Besides legislations and regulations by national government and European Commission, various efforts have been undertaken as steps towards certification for biomass trading by electricity suppliers. In response of sustainability considerations, electricity suppliers had started initiatives to develop voluntary biomass certification system concerning the sustainability criteria. These are often based on existing systems, particularly Sustainable Forest Management systems, SFMs, such as forest certification by Forest Stewardship Council (FSC) and Programme for the Endorsement of Forest Certification (PEFC) were also used as a base to develop more comprehensive certification systems[20]. We describe the most important systems currently in operation in the sections below.

[20] Both FSC and PEFC are called meta-standards. They provide guidelines and rigorous assessment for forest management, and hence ensure the import of woody biomass certified by FSC and PEFC does not violate sustainability concept (the criteria are constantly reviewed). As these systems are not specifically focussing on woody biomass for energy, we do not discuss them in more detail here.

In addition to these market based systems, CEN and ISO also have started up activities:

- Within CEN, the European Committee for Standardization, TC 383 "Sustainably produced biomass for energy applications" deals with standards development. Final publication of these standards is expected in the course of 2012.
- Within ISO, the International Organization for Standardization, PC 248 "Sustainability criteria for bioenergy" is developing an international standard (ISO 13065) with a similar title as the project committee. This standard will describe the sustainability criteria for production, supply chain and application of bioenergy and includes terminology and aspects related to the sustainability (e.g. environmental, social and economic) of bioenergy. The standard is expected to be published in April 2014.

5.5.2.1 Green Gold Label

The Green Gold Label was established by Dutch energy company Essent and Control Union Certifications. GGL employs the track and trace system in the certification programme. It covers standards for specific activities in the supply chain of solid biomass, as well as for the supply chain as a whole. This includes production, processing, transport and final energy transformation. GGL requires the tracking custody of the biomass. Currently there are 8 GGL standards and 2 Clean Raw Material (CRM) certificates, different standards are specified for either producer of raw materials, user of biomass for power generation or power plant. GGL Standard 8 is prepared for compliance with greenhouse gas reduction targets, while CRM is the specific clean wood certificate for pretreated biomass. GGL also provides additional guidelines for pellets manufacturing and transportation on existing certification systems for forest management (FSC, PEFC and etc.) and agricultural certification systems (Organic and EUREGAP) which had been approved by GGL. The details of the GGL standards can be found on GGL websites (refer to the reference below the section).

5.5.2.2 The Electrabel Label

The Electrabel Label was developed by Laborelec (Electrabel, a European utilities company, is the major shareholder) to allow the potential suppliers to fulfill the auditing requirements for being accepted within the Belgian green certificate systems and the technical specifications of the product for firing it in a thermal plant. This is the only certification system that had been legally recognized by national government in Europe, but it was only within Belgium. Similar to GGL, track and trace system is also enforced at company level for the pellet product. The label was presented in a document called "Supplier Declaration" with signature and stamp by producer and certified inspection body. Following that, the inspection company SGS will carry out full audit of the plant and of the supply chain within the 6 months following the first time the biomass is fired [6]. Flemish certificates require the supplier to provide information of: (1) sourcing and management: origin of biomass, (2) production chain, including energy consumptions and (3) transport and storage, including rail and sea transport. It should be noted that IWPB also focus on analysis of ash.

5.5.2.3 Drax Power Sustainability Policy

Drax Power from the UK has promulgated sustainability policy based on the developing regulatory and policy initiatives of the UK. The GHG calculation has to be carried out before contract signed using actual supply chain information, and it should be audited annually. Many Drax requirements are also addressed by sustainable resource management standards such as FSC and PEFC. It also touches social aspect by addressing business ethics, fair labour practices, fundamental human rights and community health and safety issues that could be quite different scenarios in different countries.

5.5. 2.4 NTA 8080 certification system

With the NTA 8080 certificate an organization can demonstrate that the biomass it produces, processes, converts, trades or uses complies with international criteria for sustainability. With the support of NEN, the Netherlands Standardization Institute, a broad stakeholder panel representing market players, government and civil society organizations has determined the sustainability requirements with regard to biomass in the form the NTA 8080, Sustainability criteria for biomass for energy purposes. On the basis of this voluntary agreement a certification system has been developed. NTA 8080 certification system addresses solid, liquid and gaseous biomass for energy purposes (e.g. transport, electricity, heating and cooling) all over the world. NTA 8080 is based on the so-called Cramer criteria:

- greenhouse gases (emissions and carbon stock);
- competition with other applications;
- biodiversity;
- environment (soil, water and air);
- prosperity;
- social well-being.

More information about the NTA 8080 certification system is available at www.nta8080.org.

5.5.2.5 Industrial Wood Pellets Buyer (IWPB) initiatives

A number of major utilities companies, certification experts, traders and media representives, including Laborelec / Electrabel, RWE-Essent, E.On, Delta, Drax Power, Dong Energy, Peterson Control Union, Vattenfall, SGS, and Argus Media are currently working together untied in the Initiative of Wood Pellet Buyers (IWPB) (see also section 5.7). In their meeting in September 2011, also wood pellet rpoducers from th EU, Canada and the US were presented at the meeting. The objective of this initiative is to facilitate trade between utilities through uniform contracting, amongst others through uniform sustainability criteria. To this end, they are developing a meta-system, which cover most of the existing voluntary schemes. The new system is focusing on wood, but will not exclude agricultural biomass (like cultivated wood). It focuses on 8 sustainability principles: 3 being verified in details (base RED Directive) and 5 being assessed and improved in time (environment + socio-econ), see also figure 5.9 below. The work base includes a check-list based on 8 sustainability principles, and verification and report by independent body. The aim is to establish cross-compliance of meta-standards and legislation in country of origin (although it yet to be clarified how this would limit or change verification procedure). The final output will be a voluntary scheme, which is transparent (documented on a webpage) and compatible with obligations / recommendations by EC and key member states. For the latter aim, the initiative also plans to prepare a roadmap to move the harmonized scheme to an official EU standard. See also chapter 5.7 for further details.

5.6 Refining the quality of pellets: the promise of torrefaction

Michael Deutmeyer

The biomass preconditioning technology called “torrefaction” offers both several challenges and advantages along the biomass to pellet to end user value chain.

Technically, all biomass resources are suitable for torrefaction, and studies (Bridgeman et al., 2008) have found that the physical and chemical properties of both woody and herbaceous biomass significantly improve after torrefaction.

Torrefied biomass becomes hydrophobic and can therefore be stored in the open and is easier to dry. The torrefaction process also increases the energy density of the biomass in respect to its overall weight and - once densified e.g. via pelletization - also in respect to volume in comparison with normal biomass pellets. For torrefied wood pellets the volumetric energy density can double from formerly around 9 GJ per cubic metre up to 18 GJ per cubic metre. Especially for long haul transportation chains - where mainly volume is the limiting factor - this higher energy density can drastically reduce logistical costs.

Through torrefaction the hemi-cellulose and cellulose is partly being destroyed and allows therefore for better grinding. This enhanced feedstock property is not only an advantage for the ensuing pelletization process, it also increases the end use performance and hence its market value and market price for downstream processes such as powder burning in large scale (or in the future also small scale) coal (biomass) power plants as well as for dense flow dry feed systems in gasification plants.

The use of torrefied biomass increases substantially the potential share of co-firing in standard coal power plant (up to 100 percent in comparison to about 10 percent based on wood pellets) and allows to co-feed woody biomass in industrial sized coal gasifiers.

Theoretically the torrefaction process can be applied to all kind of biomass since its main constituents of hemi-cellulose, cellulose and lignin all react during the torrefaction process.

Biomass resources that have more homogenous, uniform ultra-structure in terms of distribution of tissues (Esau, 1964), such as debarked, woody biomass, produce a more uniformly torrefied product compared with other agricultural and mixed species of biomass. Today, torrefaction targets several sources for feedstock: woody biomass from mills, from urban waste, from forests, and from plantations as well as agricultural biomass, from residues and energy crops.

Figure 5.9: torrefied pellets

Initially key sources are expected to be woody biomass from mills and urban wood, as they are available at relatively low cost now and year-round. Forest wood is available now, but it is more costly, and sustainability issues have to be resolved.

Energy crops and plantations will be a major source of biomass in the future, but it will take time to consolidate land, arrange planting, confirm sustainability, and establish new supply chains and to compete with currently low prices from residue sources.

Especially herbaceous biomass that could be far more difficult to pelletize improves it suitability for the pelletization process after torrefaction. Other feedstock characteristics important to the end user such as e.g. ash content, ash melting behaviour and chlorine content do not alter through torrefaction and could still impede its use as a feedstock. The future application of additional chemical pre-treatment technologies (such as leaching) can significantly

improve their feedstock characteristics.

The torrefaction process can easily be described as a heat treatment of biomass in the temperature range between 240 and 300 degrees C° in the absence of oxygen. Engineering a process that allows for such a treatment at large scale and low costs is less simple, however.

Such a process has to tackle issues such as sluicing the feedstock in and the ready product out of an inert atmosphere, dealing with tars and other volatiles both within the process and as a potential air or water pollutant, exothermic reactions and self ignition as well as producing a homogenous product based on a biomass feedstock with a varying particle size distribution. At the same time only a well designed heat integration can minimize the overall energy loss or energy input for the torrefaction process.

There are a number of initiatives at different development stages currently working on such torrefaction technologies – mainly based in Europe or North America. The most promising technological approaches are based on continuous processes such as vertical moving bed reactors, screw reactors, drum reactor or fluidized bed reactors.

A number of demonstration plants will be commissioned by the end of 2012 (e.g.: Thermya, Bioendev, Stramproy Green Invest, Topell, Foxcoal, etc.) and the entrance of world scale engineering companies such as Andritz and Metso in the arena of torrefaction (and pelletization) will most certainly lead to commercially available torrefaction technologies in the not so distant future.

The future combination of thermal pre-treatment (such as torrefaction) and densification (such as pelletization) of biomass will certainly lead to a new commodity in the area of biomass based energy carriers. Especially large scale pellet plants geared towards servicing distant energy markets will most certainly focus on the production of torrefied pellets since their value chain profits the most through torrefaction. Vattenfall, for example, is already now focusing on the production of torrefied pellets within its pellet plant project in New Brunswick, Canada.

5.7 Transforming wood pellets into a global commodity

Peter Paul Schouwenberg

5.7.1 Why standardization ?

Traders are working via screens. So less paperwork for the same number of trades will face a huge support.

Transparent prices and products gives more comfort up- as well as downstream investors, encouraging investments and hence growth of the market.

Less risks means in practice lower prices.

Transparent prices and products gives also comfort to various other stakeholders, important as renewable business depends on the trust of a wide range of stakeholders (ultimately the tax payer or energy consumer is the customer, often de facto represented by a regulator and NGO's).

Furthermore like any investment, bioenergy has to deal with technology risk, market risk etc. The most important risk to mitigate is the supply of biomass feedstock. Wind turbines are regarded as safe investments, though wind availability is uncontrollable. Biomass supply is controllable, storable, and can be guaranteed if based on dedicated production. Sawmill residue is low-cost, homogeneous, and often close-by, but supply depends on long term viability of the sawmill. Harvest residues may be plentiful, but often are not homogeneous, and supply systems are complex. Standing timber is often not owned, but available under licenses or market conditions.

Wood plantations provide for long-term supply, but are at risk to sustainability issues. Agricultural residues are usually available only for a short period after harvest. Any bioenergy project must accept complex agreements to limit biomass supply risk as much as possible.

Bioenergy is perceived to have high technology risk by investors, but that is only the case with new non-commercial technologies. Most bioenergy projects have low technology risk; they use proven processes and equipment and have well understood supply chains. Pellet manufacturing is well known, whereas torrefying wood and subsequently pelletizing is still in its infancy. Worldwide 3-4 companies claim they are producing at commercial scale, but most are still at the pilot stage.

Only one company has proven consistent production of pyrolysis oil at the commercial scale, while a second has produced for lengthy runs, but not over several years. Transportation risk can be significant, evidenced by the volatility in maritime shipping prices 2006-09 due to demand for shipping by the Chinese economy. Such risk can be mitigated by long term shipping contracts, or dedicated specialized ships. Regulatory risk is a major factor. The economics of renewable energy, including wind solar and bioenergy, is supported by government incentives and renewable portfolio standards. Occasionally government policies may be reversed, evidenced by the withdrawal of feed-in-tariffs in the Netherlands.

The safest markets are those in which economics of bioenergy are still acceptable in a regulation-free market. Market risk can be a factor. Pyrolysis oil is a very dense energy medium, but it is a new product not well known by potential markets. Bioenergy data is often scarce and public information poor, professional education and training is in its infancy. Like wind power, bio-energy is vulnerable to disinformation and adverse lobbying by competing stakeholders and by a misinformed environmental community. Counterparty risk, the risk of either party not being able to live up to its contractual obligations, can be significant, as in any business. For example, sawmill closures in Western Canada forced pellet suppliers to reduce production due to shortfalls in mill reside supply, and requiring pellet mills to find new sources of fibre. Pellet buyers had to secure volumes from an illiquid pellet market at high prices.

5.7.2 Biomass standardization

Biomass standardization has 3 elements:

- Legal text/framework;

- technical specifications, including how to measure them;
- Sustainability.

Sustainability is something which is unique to the wood pellets market, which is still not a commodity. It is a not transparent market with huge risks involved.

A Steering committee in which the largest wood pellets consumers (Dong, Drax, Electrabel, Eon, , RWE and Vattenfall) participating, supported by technical partners (SGS, CU, Inspectorate) and Argus as key publisher, are working on the three elements mentioned above.

The Steering committee is in charge of the following working groups:

1. Legal (including representatives of traders and EFET, to assure that a balanced contract will be developed);
2. Sustainability;
3. Technical specifications + sampling standards.

5.7.3 Why does it take so long ?

It is a very complex subject. Other commodities needed also several years to become a commodity.

Consensus is necessary to start up a daily trades.

It's a new "territory", so it is important to think twice on various subjects and all arguments has to be considered carefully.

In principle it is going very fast comparing with the development of other commodities.

The commitment of the players involved is very high. It is a good mixture of senior commercial people who know where they talking about. Also legal experts are involved. The players involved have an open mindset.

The focus is very clear : only wood pellets and three work streams; technical, legal and sustainability.

The participants choose for a "proof of principle" approach. For example a sustainable working group was started it was proven that the participants could agree on a technical standard.

Participants acknowledge the relevance of transforming of the wood pellets market into a global commodity (harmonization and standardization, contractual and financial measures to increase market liquidity and price stability, etc.), as the ultimate objective.

5.7.4 What has been achieved until now?

- Agreement on technical specifications;
- Agreement on sampling standards;
- Agreement on key principles in the legal text (force majeure, failure to deliver, how to deal with out f specs cargo's etc);
- Comparison of the three main sustainability standards (Drax, Electrabel, Green Gold Label) and concluding that the similarities are much larger than the differences; see also chapter 5.5.
- Confidence that an agreement can be reached on a common sustainability scheme before the end of 2011;
- The initiative seems to be right places, on the right time and welcomed by all stakeholders;

5.7.5 The world's first biomass exchange

An important step forward towards the transformation of biomass into a global commodity is represented by the first biomass exchange that was launched in November 2011 by APX-ENDEX, a provider of power and gas exchange services, in partnership with the Port of Rotterdam. The initial steps towards the launch of a biomass trading platform were taken when APX-ENDEX launched the Industrial Wood Pellets price index in 2008 in response to the market's need for price transparency. The new exchange allows market participants to trade standard contracts in a transparent environment. APX-ENDEX establishes reference and settlement prices for all contracts listed on its futures markets.

Currently 13 members participate in the market and 9 contracts are offeredoffered: 3 months, 3 quarters and 3 calendars. The Wood Pellets exchange will start with the Wood Pellets contracts as a non-cleared contract. Clearing services will be added at a later stage. Wood Pellets are listed on Trayport Global Vision Exchange open every Monday and Thursday from 13:00 to 18:00 CET.

The functional roles within the new wood pellets exchange are divided between the trading aspect and the operational aspect. APX-ENDEX will provide the trading platform for trading biomass products, while Port of Rotterdam will contribute its expertise with regard to shipping, storage and distribution of biomass products.

The new biomass exchange will also help to set common market standards for pellets, indeed a series of product quality requirements for the traded goods are specified by APX-ENDEX. In this regard, besides quality parameters an important aspect is represented by the mandatory sustainability requirement for biomass. In order to be included into the exchange system, all the pellets delivered by cargos to specified delivery points will be accompanied with the necessary documents to prove that the product is in compliance with the guidelines as described in one of the following sustainability schemes:

- Green Gold Label;
- Laborelec-SGS Solid Biomass Sustainability Scheme;
- Drax Biomass Sustainability Implementation Process.

5.7.6 Background on the Industrial Wood Pellet Buyers Group

The IWPB was initiated by 6 companies which are all large purchasers of wood pellets, with the purpose of generating renewable electricity. With the increased demand of wood pellets, also the need to buy and sell volumes of wood pellets has increased. Trade has now became essential to secure flexibility in supply and demand of pellets, e.g. power stations have unplanned maintenance periods, suppliers of pellets can have technical problems, investors want to hedge price risk, ships can be delayed etc. And trade is also essential for the suppliers. Therefore, it is important that the product be to a certain degree standardized. The more standardized the product is, the more transparent the market and the more competitive the product will be. The development of the coal market is a good example; that market has become much more standardized and transparent thanks to the so-called API2 and API4 standards.

Hence the IWPB was formed in June 2010 to facilitate the trading of wood pellets through the design of common product specifications and sustainability principles. Where for the standardization of most commodities it is sufficient to describe the technical/physical characteristics and the legal framework, in the case of wood pellets there is a third element being of utmost importance; sustainability.

The biomass industry has a responsibility to avoid and reduce the potential negative impacts of its activities. On the other hand, public opinion through communities and NGO's plays a key role in the permitting process of our power assets. For those reasons, all of IWPG members see a critical risk for every company itself but also for the whole biomass market if there is no common and transparent standard/definition for sustainable solid biomass like wood pellets. It is therefore very important to have a common understanding on "what is sustainable and how it has to be verified/documented".

IWPB members are aware that the better the sustainability of biomass is assured and accepted by a wide range of stakeholders, the more robust and stable this "energy from biomass" industry becomes. This in return will attract new investments and enable a further growth of the biomass industry, is very important to contribute to the EU 2020 energy targets. This target is very significant for the power market since 34% of electricity is expected to come from renewable sources by 2020, of which biomass is expected to cover about one half.

Current status

The draft principles that Initiative Wood Pellets Buyers has defined for wood pellets deliveries are summarized hereafter. In addition to the defined draft principles, the agreement of the State Berlin with Vattenfall on Sustainable Biomass Sourcing, constitutes and already applicable binding agreement with experience in respect to sustainable biomass, which is supported by various public and private stakeholders.

- Principle 1: GREENHOUSE GAS BALANCE;
- Principle 2: CARBON STOCK;
- Principle 3: BIODIVERSITY;
- Principle 4: PROTECTION OF SOIL QUALITY;
- Principle 5: PROTECTION OF WATER QUALITY;
- Principle 6: PROTECTION OF AIR QUALITY;
- Principle 7: COMPETITION WITH LOCAL FOOD AND WATER SUPPLY;
- Principle 8: LOCAL SOCIO-ECONOMIC PERFORMANCE;
- Principle 9: CORPORATE RESPONSIBILITY(covered by *Corporate Codes of Conduct for Suppliers* of the member utilities).

The principles are numbered but there is no priority rank related to their numbering. IWPB requests full transparency on the realization level of all the 8 principles for sustainable biomass.

A distinction is made between "WILL" and "AIM TO" principles as follows.

The first three sustainability principles are fundamental issues: they are mandatory criteria listed in the RED Directive EC 2009/28 for bio-liquids and biofuels. Wood pellets deliveries must always be consistent with those principles. Compliance with the sustainability principles must be verified by independent inspection companies. Those principles are therefore meant as "WILL".

The last six sustainability principles are important issues that must be considered for sustainable solid woody biomass but they appear to be more difficult to verify extensively. Therefore the aim is for those principles to be taken into consideration, and a report is made by an independent body providing transparency on the way those principles are fulfilled. Feed-back of this report to the suppliers will allow them to improve their performance over time. Those principles are therefore meant as "AIM TO". This does not mean that they are less important than those listed as "WILL". It does however mean that the thinking on those subjects is still evolving; it is therefore important to promote a continuous circle of improvement, rather than to adhere to a standard which is reasonable today, but outdated tomorrow.

Suggestions for the near future

Regarding the ongoing RED/sustainability discussion IWPB has expressed its views and recommendations as follows:

- The binding criteria should be meant for all uses of biomass since producers of raw materials do not necessarily know about their end users.

- The implementation of sustainability criteria must avoid unnecessary burdens on companies and market.
- Cross-compliance of available certification systems for forestry like PEFC/FSC or existing and well applied national legislation can be used to demonstrate conformity with some of our principles, but it is very important to note that they generally do not cover GHG balance and carbon stock change that are fundamentally important issues for bio-energy applications.
- In order to come to a level playing field and an efficient European market, the sustainability criteria should be uniform and set at European level.
- It is important to realize that non-binding (voluntary) sustainability criteria allow room for the use of non-sustainable biomass; and this is damaging the business by deteriorating the acceptance of biomass as a cost efficient substitute for carbon heavy fossil fuels. Therefore IWPG recommends binding criteria on sustainability.
- criteria for sustainable production of liquid, solid and gaseous biomass should ideally be based on the same concepts. However, mandatory sustainability criteria should be implemented in a very careful and practical way and based on clear and measurable indicators only. They should take into account the widely different environmental issues in different Member States and climatic zones, bearing in mind two key purposes – to ensure the sustainable production of biomass and an acceptable greenhouse gas balance for biomass utilized for energy production. Eurelectric considered that a useful basis was established with the guidelines s in the EC report (SEC)2010, but also that those guidelines based on the criteria for liquid biomass set up in the RED (COM)2009/28would require significant modification in order to develop mandatory sustainability criteria for bio-solids.

IWPB	SUSTAINABILITY PRINCIPLES
WILL	**Principle 1: GREENHOUSE GAS BALANCE (GHG)** The GHG balance of the production, processing and transport supply chain and application of the biomass is lower than 130 kgCO2/MWhp, insuring that GHG savings taking into account the whole chain of custody are at least 60% with respect to reference fossil fuels for the end use.
WILL	**Principle 2: CARBON STOCK** Biomass production does not take place at the expense of significant carbon reservoirs in vegetation and in the soil.
WILL	**Principle 3: BIODIVERSITY** Biomass production may not take place in areas with high biodiversity value, unless evidence is provided that the production of that raw material did not interfere with those nature protection purposes.
AIM TO	**Principle 4: PROTECTION OF SOIL QUALITY** Biomass production and processing should maintain or improve the soil quality.
AIM TO	**Principle 5: PROTECTION OF WATER QUALITY** With the production and processing of biomass, ground and surface water should not be exhausted and the water should be managed such as to avoid negative impact or to significantly limit impact on water.
AIM TO	**Principle 6: PROTECTION OF AIR QUALITY** Production and processing of biomass should avoid negative impact or significantly reduce impact on air quality.
AIM TO	**Principle 7: COMPETITION WITH LOCAL FOOD AND WATER SUPPLY** Biomass production for energy should not endanger food and water supply or communities where the use of this specific biomass is essential for subsistence.
AIM TO	**Principle 8: LOCAL SOCIO-ECONOMIC PERFORMANCE** Biomass production should respect property rights and contribute to local prosperity and to the welfare of the employees and the local population.
COVERED SEPARATELY	**Principle 9: CORPORATE RESPONSIBILITY** Generic sustainability principles not directly related to biomass are covered by the Codes of Conduct or Policies of the utilities participating to IWPB covering all types of commodities.

(*)see also report EC SEC (2010)65 & 66

Figure5.9. Overview of IWPB sustainability principles.

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