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Pellet market, raw materials, handling and logistics in Northern Periphery. PELLETime.

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Abstract

Wood pellets have become an important fuel in heat and power production. The pellet market and supply structures are currently undergoing rapid development. Ensuring the quality of pellets through the whole production, delivery and handling chain is important in order to increase the use of pellets and sustain its ability to compete with other fuels. This study focuses on the development of the pellet market, raw materials and supply structures mainly in Sweden and Finland.

Sweden has a highly developed pellet market, where fuel taxation has promoted the use of wood pellets especially in large scale boilers of >2MW, where more than half of the pellets are combusted. There are about 120 000 households using pellet heating systems in addition to the 20 000 households using pellet stoves. Sweden is the world's largest producer and consumer of pellets. In 2007 a total of 94 pellet plants/ producers were producing 1.4 million tonnes of pellets, while at the same time the consumption was 1.7 million tonnes. In addition, about 400 000 tonnes of pellets were imported to meet domestic demand.

In Finland, pellet production has been growing steadily despite the fact that domestic consumption has remained relatively small until recently. Today there are 24 pellet plants/producers. In 2007 production was around 330 000 tonnes while the domestic consumption was 117 000 tonnes. The pellet market in Finland has long been export oriented; with 75% and 58% of production being exported in 2006 and 2007, respectively. Domestic consumption has been growing mainly in the small scale consumer sector; it is estimated that 15 000 households had pellet heating systems in 2008.

Concerning supply structures, Sweden has well established pellet distribution networks, for domestic household consumers pellets are mainly delivered in sacks (80%) directly from the plant or through extensive network of retailers while bulk deliveries are less common (20%). In Finland pellets are delivered to users mainly in bulk (71%) using pneumatic or normal trucks when the share of sack deliveries is much smaller, large sacks (25.5%) and small sacks (3.5%). In the future, the increasing number of pellet users requires an organized delivery network and good equipment for bulk pellet deliveries, currently the equipment used varies significantly.

Keywords
pellet, market, handling, logistic, delivery methods

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1 Introduction

Wood pellets have become an important fuel in heat and power production since they do not add any CO_2 emissions, have high energy content and are the first wood based fuels which are profitable to transport even overseas (Sikanen et al. 2008). Pelletizing condenses the raw materials into compact cylindrical pieces, which typically have a low moisture content and high calorific value. Regular geometric size allows automatic feeding into the boiler and makes the maintenance as easy as oil-heating but cheaper and more environmentally friendly. The compact size is also advantage in storing and transportation compared with other wood fuels (Egger et al. 2003, Sikanen et al. 2008).

Pellets have become popular in many countries, especially in Europe, where the pellet market is nowadays a large business. The pellet market and supply structures are currently undergoing rapid development. As the pellet markets develop, also the supply side is growing constantly. In some countries, the supply side is growing faster than the domestic use, while others need to import pellets to satisfy demand. The growing demand for pellets has naturally increased the pellet supply in terms of increased number of pellet plants and the production capacities (Peksa–Blanchard 2007, Sikanen et al. 2008). Ensuring the good quality of pellets through the whole production, delivery and handling chain is important in order to increase the use of pellets and sustain its ability to compete with other fuels. The quality of the raw materials is one of the factors affecting the quality of the final products, pellets. The main raw materials used are by-products from the wood industry, cutter chips and sawdust, which are currently utilized so efficiently that alternative raw materials are needed in order for pellet production to continue to grow (Peksa–Blanchard et al. 2007, Höglund 2008a). Some countries with large wood pellet markets have developed national pellet standards, but while pellet markets were becoming more international, a need for a common standard has arisen (Hahn 2004). Currently the European Standard for solid biofuels is being developed and will be soon implemented.

This report aims to present the current situation regarding the pellet market, raw materials and supply structures in Finland and Sweden. Furthermore, bottlenecks and major drawbacks are highlighted and finally, opportunities and future developments of the pellet market are presented.

1.1 PELLETime project

The PELLETime project is aiming to provide new tools for designing sustainable pellet supply chain and examining the new potential raw materials for pelletizing. The project's aim is to encourage local entrepreneurs to utilise local renewable resources and promote the energy self-sufficiency within the northern periphery area, which includes Finland, Sweden, Scotland and Iceland. The focus is on small and medium scale pellet producers. Currently the small scale production of pellets faces both technological limitations, as well as a lack of knowledge. The project addresses those challenges by offering a holistic approach for small and medium scale enterprises reaching from identification and estimation of available resources, raw material procurement, and the design of the entire pellet production process to the final product. PELLETime will encourage sustainable expansion of the raw material resource, and carry out widespread increasing of awareness and information dissemination to facilitate market development (PELLETime 2009).

2 Pellet market situation

The growing demand for pellets has naturally increased the pellet supply. The world's ten largest pellet producing countries (Sweden, Canada, USA, Germany, Austria, Finland, Italy, Poland, Denmark and Russia) together produced approximately 8.5 million tonnes of pellets in 2007. In Europe, the leading pellet countries are Sweden, Germany and Austria, where pellet production, as well as consumption is large. Other countries, such as Denmark and Italy, are large consumers but their production is small, so they are dependent on pellet imports. On the other hand in Finland, Poland and Russia the domestic consumption is small with the pellet markets being export oriented. Pellets' trading within Europe has increased steadily and the growing demands have also increased the imports from Canada, where about 765 000 tonnes of pellets were exported in 2007. The largest flows of pellets are from Austria, Finland, Germany, Poland and Russian towards Sweden, Denmark and Italy (Alakangas et al. 2007, Sikanen et al. 2008).

Sweden is the biggest producer, as well as consumer, of wood pellets in the world (Peksa–Blanchard et al. 2007, Sikanen et al. 2008). In Sweden three factors have been identified affecting the rapid development of the pellet industry: availability of raw materials, taxation system favourable to biofuels and extended district heating networks (Egger et al. 2003, Höglund 2008a). The pellet markets are well developed and pellet users cover all customer sectors; small, medium and large scale. In the early stages of pellet production, pellets were mainly used in large heat and power plants, but in recent years the small scale sector has grown remarkably. In 2001, large scale users burnt 83% and small scale 17% of the total pellet consumption, while in 2008 the shares are 47% and 37%, respectively and the remainder was consumed by medium scale users (Pellet@tlas 2008, PiR 2008). Increasing demand for pellets has also increased the number of pellet producers in the country, as well as imports from overseas.

In Finland, the pellet market has been, from the beginning, export oriented. However, recently the domestic consumption has started to increase. Still about 58% of the total pellet production was exported in 2007, while in 2006 the share was 75% of the production (Ylitalo 2008). The number of pellet users has been increasing slowly but steadily, the pellet market is undergoing constant development, however, there still is unutilised market potential. The cheap price of pellets has been used as a marketing tool which is now threatened due to the rising raw material price. Furthermore, the lack of subsidies for converting to pellet heating system is slowing the establishment of new pellet boilers (Sikanen et al. 2008). In the domestic market 52% of the pellets are used in households, the rest (48%) in medium and large scale boilers (Ylitalo 2008).

2.1 Pellet standards

Several countries have developed national standards for pellets. Some countries have also introduced standards for pellet logistics and storages. Standardisation of pellets is securing the uniformity of quality, which is important for fluent combustion especially in small scale boilers. The common European standard for solid biofuels, CEN335, is being developed and will replace the national standards in the near future. Some pellet producers are already following the new European standard CEN/TS 14961 which is the pre-standard for pellets quality classes.

The Swedish Pellet Standard (SS 18 71 20), established in 1998, was the first pellet standard developed in Europe. In the Swedish standard, pellets are classified into three categories according to their quality standards, these differ mainly in size and ash content (Hahn 2004, Peksa–Blanchard et al. 2007). Around 74% of the produced pellets in Sweden are produced according to the Swedish standard;

however, among small scale producers the use of standardization is low. Also more than 21%, about 300 000 tonnes, of the pellet production is certified according to FSC (Forest Stewardship Council) and PEFC (Programme for Endorsement of Forest Certification schemes). Some of the producers are using the new European standard CEN/TS 14961; around 22% of the total production is now following that standard. Many small scale producers do not follow any standards however, those with a production capacity of over 10 000 t are following one of the standards (Höglund 2008a).

The Bioenergy Association of Finland was developing a national standard system but stopped the project in 2002 and instead focused on developing standards on a European level. So far the largest producers have followed Swedish standards for pellet classification SS 18 71 20, since most of the pellets have been exported to Sweden (Paju & Alakangas 2001). Currently, a few pellet producers are following the European standard CEN/TS 14961.

The Trade Association for the United Kingdom's bioenergy industry, British BioGen, developed the Code of Good Practice for pellets which works as a guideline to the customers. Scottish producers also follow the Code of Good practice and one follows the European standard CEN/TS 14961 (Hahn 2004).

2.2 Pellet raw materials

2.2.1 Existing raw materials

Existing raw materials are the by-products of the wood industry; sawdust, cutter chips and wood chips, mainly from spruce and pine. In Sweden, around 97% of the pellets are made from these raw materials, the rest are from bark and peat (New ways 2008). Thin stem wood has started to be used as a raw material in two pellet production sites in Sweden (Kallio & Kallio 2004, Näslund 2007). Raw materials used for pellet production in Sweden were: 830 000 t fresh sawdust, 420 000 t dry sawdust and cutter shavings and 50 000 t of bark in 2005 (Näslund 2007). Additionally two pellet producers in Sweden and one in Finland are currently producing peat pellets and mixed wood/peat pellets.

2.2.2 Potential raw materials

There are many potential raw materials for pellets, though some are already in use, however, the whole potential is not being utilized. In Sweden several plants are aiming to use round wood for pellet production in the near future (New Ways 2008) also short rotation coppice, which is currently used only in district heating, could be used also for pelletizing. Currently only 50 000 t of bark is used for pellet production, however, the potential production is estimated to be around 3 000 000 t. The limiting factor is that most of the bark is combusted in the places where it is produced, mainly in the saw mills and pulp mills. Bark pellets are mainly combusted in large heat and district heating plants as its ash content (3.5%) is too high for small scale boilers (Näslund 2007). In Finland one producer is planning to start producing pellets from conifers bark (Lappalainen et al. 2007). Research, as part of the PELLETime project in Finland, has resulted in pellets being made from first thinning pine, chips from spruce logging residuals and whole birches from first thinning. In the same project also pelletizing of reed canary grass *(Phalaris Arundinacea)* and straw is being researched in Oulu University of Applied Sciences (PELLETime 2009). Other possible raw materials for pelletizing could be rejected adjusted wood, pulp wood, hydride aspen and salix as well as forest residues (tree tops and branches). In Sweden, there are large volumes of forest residues not being utilized, mainly because of the long distances from the origin to places with demand (Hismark 2002, Peksa–Blachard et al. 2007, Höglund 2008a).

3 Pellet production and consumption

3.1 Pellet plants in Northern Periphery region

In Sweden, the first pellet plant started wood pellet production in 1982, since then the number of pellet plants has increased to 94. Today Sweden is the world leader with regards to pellet production in addition to being the largest wood pellet consumer (Peksa–Blanchard et al. 2007, Sikanen et al. 2008). Out of the 94 pellet producers, the production capacity of six of the plants is 100 000 t or over while 15 plants have a capacity of between 50 000 – 100 000 t. Additionally there are around 50 small scale pellet producers whose production capacity is from a few hundred tons to several thousand tons a year (Figure 1). The total capacity of the small scale producers is under 100 000 tons/year, which is around 5% of the total capacity of the pellet industry in Sweden (Bioenergi 2008a). A pellet plant with a capacity of 160 000 t is currently being built, which would increase the country's total pellet production capacity to over 2 million tons.

In Finland, the first pellet plant was built in 1998, since then the number of producers increased to 24; with the total production capacity being around 750 000 t. There are six plants with a capacity of over 50 000 t, of which one is 100 000 t, and four small scale producers (capacity under 5000 t annually) (Figure 1). Additionally five new plants are planned; when operational the total production capacity could reach up to 1.1 million tons.

In December 2007, there was established in Scotland the first commercial pellet plant; with a capacity of 15 000 t, besides that there are two other plants operating and one large scale plant (capacity 100 000 t) is under construction which should be in operation by summer 2009 (Figure 1). In the near future the total production capacity is going to be around 148 000 t.

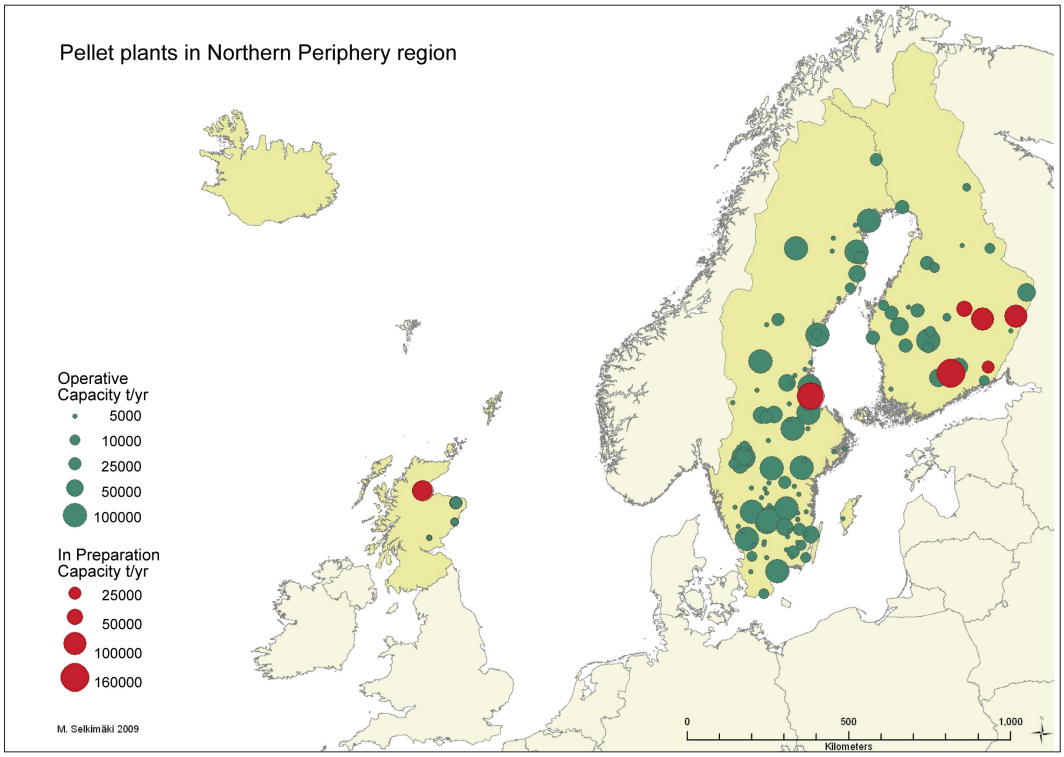

Figure 1. Location of existing and forthcoming pellet plants in Northern Periphery region.

3.2 Pellet production

The actual pellet production figures are often lower than the pellet plants production capacities for various reasons. Many pellet plants, both in Sweden and Finland, are not using their full production capacity; the main reason is the lack of good quality raw materials. Cutter chips and sawdust is also used for example in fibreboard and particleboard industries as well as for animal bedding (Hirsmark 2002). For Scotland there is no available production figures, since the wood pellet production has just recently started.

3.2.1 Sweden

Swedish pellet plants produced around 1.6 million tons of pellets in 2009, though the production capacity would have been close to 2,2 million tons. Domestic production is not enough to meet the demand for pellets, as a result 360 000 t of pellets were imported in 2008 and 430 000 t in 2009 (Figure 2). Imports are mainly coming in bulk by large cargo ships from Canada, Poland and Finland. A small amount of pellets are exported; mainly to Norway and Denmark; around 54 000 t in 2007, this almost doubled in 2008 to 91 500 t before exports decreased again to 88 000 t in 2009. (Peksa–Blanchard et al. 2007, Höglund 2008a, PiR 2010).

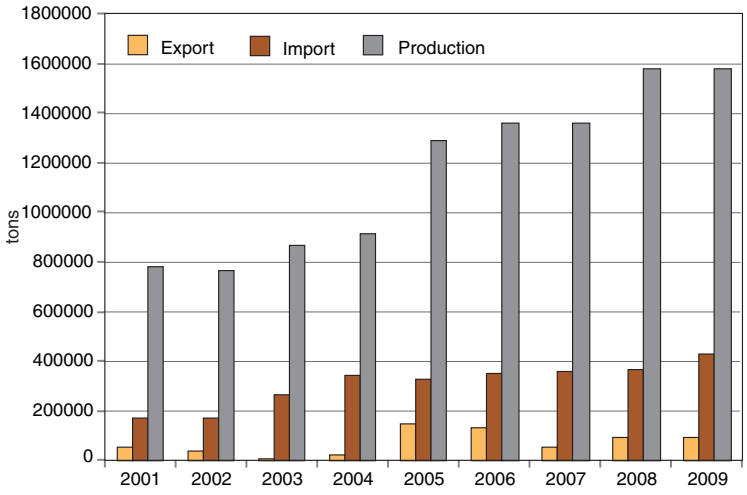

Figure 2. Production, exportation and importation of pellets in Sweden (PiR 2010).

3.2.2 Finland

In 2008, pellet production was 373 000 t, the production in 2009 decreased by 20% to 299 000 t mainly due to the low availability of raw materials like sawdust from sawmills. Since the domestic consumption is relatively small, most of the pellets are exported (see Figure 3). In 2006, around 75% of pellets produced were exported, however, due to the rise in domestic consumption, the share of the exports decreased to 58% in 2007. In 2008 the export increased again to 227 000 t before it dropped by 40% to 136 000 t in 2009. Pellets were mainly exported to Sweden, Denmark and to the Netherlands (Heinimö & Alakangas 2006, Maaseudun tulevaisuus 2008, Ylitalo 2008, Ylitalo 2010). Before 2008 no pellet imports were recorded, in 2008 10 000 t and in 2009 50 000 t were importet to Finland (Ylitalo 2010).

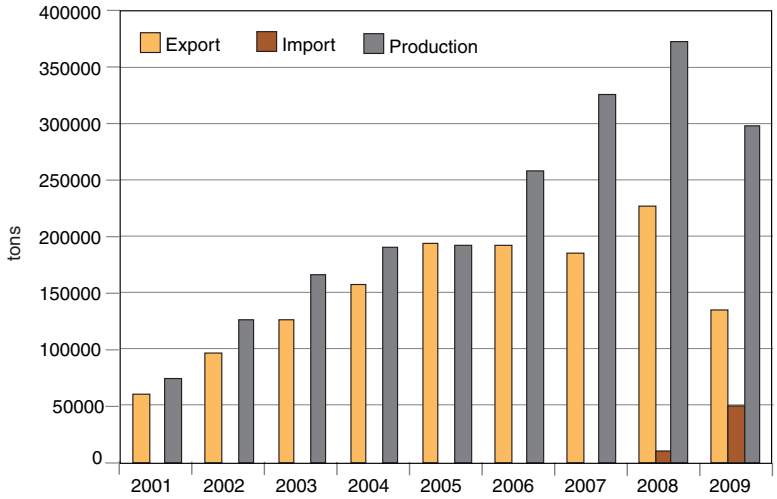

Figure 3. Production and exports of pellets in Finland (Ylitalo 2010).

3.3 Pellet users and consumption

Pellet users can be divided into three groups; small, medium and large scale. Small scale users are private houses and cottages where pellets are used as the primary heating system or burnt in fireplaces. Small scale users, mainly households, are using mainly pellet boilers under 25kW or pellet stoves, medium scale users include public buildings, commercial and industrial premises such as schools, greenhouses, health centres, administrative buildings, as well as airports, whose boiler size is 25kW–2MW and large scale users are districts heating plants and CHP-plants whose boiler size is >2MW, pellets are usually combusted together with other fuels (Heinimö & Alakangas 2006, Höglund 2008a, PiR 2008).

3.3.1 Sweden

In Sweden, in 2007, the total domestic consumption of pellets was 1 715 000 t of which 635 000 t were used in small scale boilers (<25kW), 280 000 t in medium size boilers (25kW–2MW) and 800 000 t in heat plants and CHP plants. Large scale users account for about half of all pellet consumption, however, the share of small scale users has grown quickly (Figure 4) (PiR 2008, Pellet@las 2008).

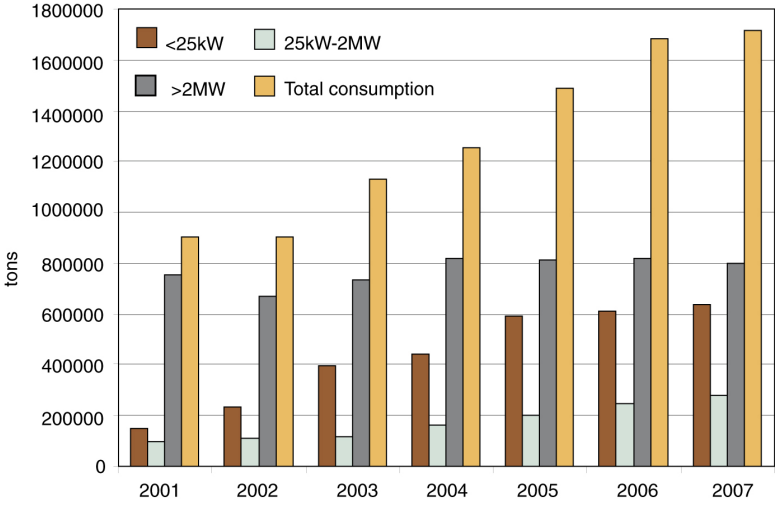

Figure 4. Annual consumption of pellet in small (<25kW), medium (25kW–2MW) and large (>2MW) scale boilers and the total consumption in Sweden (PiR 2008, Pellet@las 2008).

In 1996, about 95 % of pellets were mainly used in district heating plants while the number of households using pellets was very low; around 1800 houses throughout the country (Davidsson 2008). In 2004–2006 the State was subsidizing small and medium scale heating systems working with biofuels, which increased also the number of pellet users (Parikka 2005). In 2005, around 80 000 households were using pellet heating systems. The number of small scale users has grown quickly during recent years, for example, 32 000 pellet boilers and stoves were installed during 2006. In 2008, about 120 000 detached houses are using a pellet heating system, in addition to there being about 20 000 pellet stoves in Sweden. The number of private households using pellets has been growing the fastest, but also the number of medium scale users has also grown; there were over 4000 medium scale users in 2008 (Peksa–Blanchard et al. 2007, Bioenergi 2008b, Pellet@las 2008). About 200 district heating plants use biofuels in heat production, for many of them the main fuel is pellets (Hillring 2006).

3.3.2 Finland

In 2007, the total domestic consumption of pellets was 117 000 t of which 61 000 t were used in small scale boilers (<25kW) and 56 000 t in medium size and large scale boilers (>25kW). In the same year the total production was 326 000 t (Ylitalo 2008). So far the domestic consumption of pellets has been small compared with other countries using pellets. The consumption of pellets is expected to grow fast in the near future. According to Finnish Pellet Energy Association estimates for consumption in 2012 are: small scale users ~300 000 t, medium scale users ~500 000 t and the large scale users ~300 000 t, which means, altogether, consumption is estimated to be over one million tons more than what it is today. The development of pellet consumption and production in 2001–2007 can be seen in figure 5.

In Finland the number of pellet users has been growing slowly. In 2001, about 300 households were using pellets (Paju & Alakangas 2002). In 2003 the number of small scale pellet users was 1000–2000 users, with the number growing by 400–500 new users per year. Approximately 15 000 households were using pellets in 2008, additionally a few hundred public buildings, schools and industrial buildings are using pellet heating systems and a few dozen heat and CHP plants are combusting pellets for energy production (Maaseudun tulevaisuus 2008, Saastamoinen 2008).

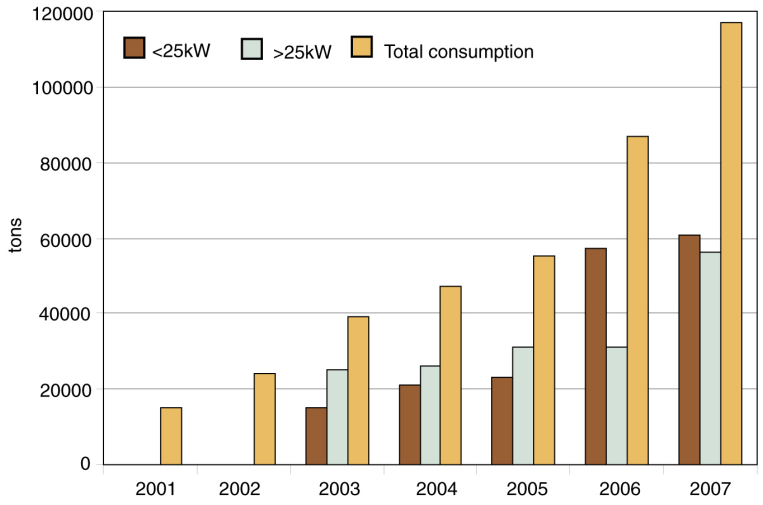

Figure 5. Annual consumption of pellet in small (<25kW), medium/large (>25kW) scale boilers and the total consumption in Finland (Ylitalo 2008).

4 Existing pellet supply structures

4.1 Raw material handling and transportation

Raw materials are mainly domestic, by-products of the wood processing industry (cutter chips and sawdust). Most of the pellet plants are next to their raw material supply (sawmill, wood industry, furniture industry etc.) which is lowering the raw material transportation costs. In addition, a small amount of sawdust is imported to Finland from Russia and to Sweden from Finland by trucks (Alakangas et al. 2007, Höglund 2008a). Many small and medium scale pellet plants are working together with other activities, such as planning mill or carpentry, which are the source of raw materials, often meaning that short distance transportation of the material is done by conveyors or pneumatically in a tube (Figure 6) to the pelletizing lines. Larger producers are mainly collecting the raw materials from several wood processing places in the locality of the pellet plant, transportation is done mainly by trucks. Raw materials arriving to the pellet plant are stored inside if the plant does not have dryers and outside if there is a dryer. Typically only the largest pellet plants have dryers, while the small and medium scale producers are mainly using dry raw materials. At least one Swedish small scale producer uses fresh sawdust and therefore has a dryer. Raw materials are emptied from the trucks to open air field storages which are asphalted (Figure 7) or to warehouses, from where they are moved to the production line with loading shovels or by conveyors. If the raw material is coming from several places by trucks, it is usually sieved and a magnetic separator is used to remove the foreign particles, such as stones and metallic pieces.

4.2 Handling of pellets at the pellet plant

Handling of the pellets at the plant site is similar in Finland and Sweden. The share of different delivery types is probably determined by the equipment used in the pellet packing process. Pellets are stored at the plant site in large silos or in warehouses for bulk deliveries and packed into small and large sacks. Pellets' packing in large (500–1000kg) and small (10–20kg) sacks is usually done straight from the pelletizing line or if the pellets are packed later, in the warehouse, in this case they are sieved again before packing.

Figure 6. Raw material transported pneumatically in a tube (Metla).

Figure 7. Raw material transported in trucks (SCA).

In Finland, the share of small sacks of all pellet deliveries is very small, they are mainly done according to customer orders, as a result in most of the pellet plants small sack packaging is not automated, and therefore needs to be done manually. Some pellet plants do not pack small sacks at all. Many pellet producers have not invested in packing devices since most of the production is sold in bulk. One large pellet producer has a subcontractor to pack pellets, a local farmer collects pellets with a tractor from the plant. Before pellets packaging the fines are separated with a wind separator. The subcontractor is mainly packing large sacks (500kg) since the demand for small sacks is low and they are also more time consuming to do. Small sacks are packed to order, filling is done with the same machinery (Figure 8), as used for large sacks, but the small sacks are closed with a machine (Figure 9) while the large sacks are closed manually.

Figure 8. Large sacks filling machine (Metla).

Figure 9. Small sacks closing machine (Metla).

Newer pellet plants have invested in packaging machines to cover all delivery types. A recently established medium scale pellet plant has equipment for pellet packaging for large sacks (Figure 10), small sacks (Figure 11) and two silo storages for bulk deliveries (Figure 12). The packing of small sacks is not fully automated, small sacks are packed inside a large sack since placing them on a pallet and wrapping them with stretch film would require more manual work.

In Sweden, small sacks are the most common way of pellet deliveries. The packing of pellets in the large plants, as well as in small plants, is efficient and automated. Some of the small producers only pack pellets into sacks and do not have bulk deliveries. Since small sacks are made of polythene, which is water-resistant, they can be stored outside and no special storage needs to be built. Large sacks are stored in warehouses on top of the loading pallet, to ensure that water is not absorbed from the floor. Medium and large pellet producers are storing pellets for bulk deliveries to silos or to warehouses. Small sacks are filled with pellets and sealed automatically, a roller conveyor moves the sacks to an automatic palletizer which places the sacks on a pallet (often 52 sacks on one pallet) (Figure 13), and finally wraps them with stretch film. Large sacks are filled from the storage bin then moved by conveyor belt to the storage (Figure 14) or with a fork-lift.

In Finland and Sweden bulk pellets are stored at the pellet plant in silo storages and/or in warehouses. Bulk deliveries are loaded from the silo storage to pneumatic trucks or with a loading shovel onto normal trucks (Figure 15). Overseas transportation is done by train from the pellet

Figure 10. Large sack packing (Metla).

Figure 11. Small sack packing (Metla).

Figure 12. Silo storages (Metla).

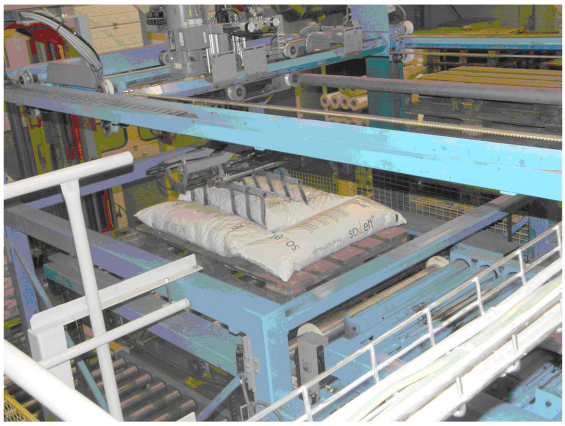

Figure 13. Automatic small sacks palletizer (NKUAS).

Figure 14. Large sack handling (Metla).

plants which have a rail connection (Figure 16), the train transports the pellets to the harbour where they are shipped. In Sweden, many plants are located on the coast and pellets are shipped straight from the plants for export as well as for domestic markets.

Figure 15. Loading pellet to pneumatic truck from silo and warehouse (Metla).

Figure 16. Loading pellets to railroad carriage for export (Metla).

4.3 Delivery methods

In Finland, the main delivery method for the pellets is bulk delivery. In 2008 this method of delivery accounted for 71% of all the deliveries, this includes both pneumatic truck and normal truck deliveries. The share of sacks deliveries was small; large sacks accounted for 25.5% while small sacks share was only 3.5% of all deliveries in 2008 (Saastamoinen 2008). Vapo's biggest retailer is the Agrimarket chain, while other pellet producers are selling directly from the plant, or via small retailers which are often selling pellet boilers and other pellet related equipment. Retailers are only selling the pellets in sacks (both small and large sacks). Exports are mainly done in bulk by ships from the main harbours; both sea and lake harbours from Inkoo, Loviisa, Joensuu, Oulu, Kokkola and Kaskinen, typically shipping size is 2000–4000 tonnes (Heinimö & Alakangas 2006). A small amount of sacks are exported by trucks mainly from Northern Finland through the main roads to Sweden (Savolainen 2008).

Figure 17. Vapo's pneumatic truck for pellet deliveries (Vapo).

Pneumatic trucks are used for delivering pellets to households or medium size customers. For large scale users, pellets are delivered mainly by normal trucks. The equipment for bulk deliveries varies; from normal trucks and specially designed pellet tanker trucks (Figure 17), to existing machinery used for animal feed deliveries (Figure 18). New trucks have an integrated weighing scale which allows accurate delivery and billing, the minimum amount of bulk deliveries is typically 3 tons. The container of older trucks can be divided into sections for suitable delivery amounts (Figure 19). The length of the unloading pipe, pressure and power used during unloading and the model and conditions of the delivery trucks, as well as the experience of the driver, affect the quality of the pellets during transport and delivery (Tuomi 2007, Vapo 2008).

Figure 18. Filling customer's pellet storage (NKUAS).

Figure 19. Divided sections in the truck (NKUAS).

In Sweden, for domestic household consumers, about 80% of pellets are delivered in sacks (Figure 20), while only 20% are delivered in bulk with pneumatic trucks (Figure 21). For medium and large scale consumers all pellets are delivered in bulk by trucks or large cargo ships (Höglund 2008b). Large producers are delivering bulk pellets as well as sacks, while many of the small scale producers are only delivering pellets in small sacks, some pellet producers do not sell pellets straight from the plant. In Sweden there is an extensive retailer network: pellet sacks are sold in places such as pellet heating specialists, chimney-sweeping companies, oil-distributors, do-it-yourself stores, farmers' equipment stores, and plumbing firms. Pellets prices of different delivery types and producers are easy to compare since most of the information is available on a webpage (www.pelletspris.com), where the prices of over 100 retailers and pellet producer are collated. Pellet heat can also be delivered straight to the customer from a small scale centralized pellet heating centre, a container solution, in which case the customer does not need to do maintenance work or to buy pellets.

For large scale Swedish consumers, such as heat plants located on the coast, pellets are transported by cargo ships from abroad as well as from Swedish pellet plants. Most of the pellet imports to Sweden are done by cargo ships. In the European market area ship loads are typically 4000–6000 tonnes, with the overseas shipments being done in large volumes of usually 20 000–30 000 tonnes. In Sweden a small share of the imported bulk pellets are sieved to remove fines and packed into sacks (Vesterinen & Alakangas 2005, New Ways 2008).

Figure 20. Neova's small pellet sacks (NKUAS).

Figure 21. Neova's tanker truck for bulk pellet deliveries (NKUAS).

5 Trends in the pellet market development

5.1 Sweden

5.1.1 Expected number of pellet users in the next 5–10 year period

In the future the new small scale pellet users are expected to be households moving from direct electricity and water-distributed electricity heating to the pellet heating systems. The potential is significant since altogether there are almost 570 000 households using these heating systems which means, in the near future, there could be almost 700 000 households using pellets (SCB 2005, Höglund 2008a). The number of small and medium scale pellet users is expected to continue to grow in the near future, though the number of large scale users is not expected to grow significantly. Furthermore, the large scale CHP-plants might replace part of the fuel pellets with forest residues (Näslund 2007).

5.1.2 Expected number of pellet producers in the next 5–10 years period

Although there are already nearly 100 pellet producers, some new plants are planned. As previously mentioned one plant will start operating sometime during 2009 (Puu & Tekniikka 2008) and according to Svebio's estimation 3–4 large scale pellet plants could be built during the next 5–10 year period, in addition to a number of small scale producers (Höglund 2008b).

5.2 Finland

5.2.1 Expected number of pellet users in the next 5–10 year period

In Finland a large share of the pellet users are private households. According to the Finnish Pellet Energy Association the number of households using pellets could be five times more than at present: At present only around 15 000 households are using pellets. There is a growing interest in pellet heating and it is estimated that there will be 50 000 households using pellets by 2012 (Heinimö & Alakangas 2006, Maaseudun tulevaisuus 2008). Most of the new users would come through restoring the old oil heated houses as well as the builders of new houses choosing to install a pellet heating system. Additionally, because of the high price of the electricity some of the electrically heated houses could be encouraged to change to pellet heating. In 2006 there were around 290 000 residential buildings using oil heating and around 470 000 were heated with electricity (Statistical Yearbook of Finland 2007). Pellets are expected to replace some of the firewood used in the fireplaces; this is supported by the increase in sales of pellet stoves and pellet baskets for use in fireplaces. The development of pellet users is also depending on the level of taxation of fossil fuels. Currently the total heating cost difference between the pellets and fossil fuels is relatively small (Peksa–Blanchard et al. 2007). The state is not providing subsidies to private households for changing to pellet heating systems, which is partly slowing the pellet heating system development. Without subsidies the investment cost of changing to pellet heating system can be very high (Maaseudun tulevaisuus 2008).

There are currently a few hundred medium scale users including public buildings, schools, airports and a monastery. There are a few building projects of terrace houses which will have a centralized pellet heating system (Vapo Viesti 2008). Large scale users are the heat plants and district heating

plants. In Finland, the number of district heating plants is not likely to grow since the network is already economically efficient, instead the number of plants using pellets and the share of pellets used in the plants can be higher (Röser et al. 2003).

According to the vision of the Finnish Pellet Energy Association, pellet users in 2012 would include 50 000 small scale users (households), around 2000 medium size users (public buildings, industry etc.) and 100 large scale users (heat plants), the use of pellets is estimated to be 300 000 t, 500 000 t and 300 000 t respectively. The estimate for the heat plants (large scale users) is for the ones using mostly pellets as fuel or mixed with other wood fuels.

5.2.2 Expected number of pellet producers in the next 5–10 year period

As of the end of 2008 there were 24 pellet plants operating, with a further five plants planned or being constructed. With all these plants being online the total pellet production capacity is estimated to be around 1.16 million tons. The Finnish Pellet Energy Association estimates one million tons will be reached in 2010. Reaching this level can be done with the existing and forthcoming pellet plants if they work to their full capacity. The total production estimate for 2020 is 1.5 million tons of pellets which would require establishing new pellet plants or enlarging the existing ones (Hetemäki et al. 2006, Maaseudun tulevaisuus 2008).

6 Bottlenecks

6.1 Sweden

6.1.1 Bottlenecks related to pellet raw materials

There is strong competition between pellet producers and other forestry industries, such as the board industry, for good quality raw material. Furthermore, raw material is also used for animal bedding (Hirsmark 2002). Currently there is a shortage of raw materials, with many pellet plants not using their full production capacities. Raw material prices have risen due to increased demand; this has an effect on the pellet prices which is one of the highest in Europe. Producers see other pellet producers as the main competitors for raw material, also heat and CHP-plants and board industry are using the same raw materials (Höglund 2008a). Numerous new raw materials are being researched but many of them are not suitable for small scale producers or even on a medium scale since the drying costs are high and not enough pellets can be produced to be economically efficient (Thek & Obernberger 2004). For example, as a raw material bark is suitable for pelletizing, however, it can only be used in the larger boilers due to the high ash content (Kallio & Kallio 2004, Näslund 2007).

6.1.2 Bottlenecks related to pellet supply and transportation

A large share of the pellet imports come from Canada which means long transportation distances and higher delivery costs; therefore it is more profitable to buy large volumes. The cost of sea transportation from Canada to Europe can be up to 60 €/t of pellets (Sikkema 2008). The majority of pellets exported to Sweden are coming from the interior of Canada, which requires trains to

deliver them to the harbours on the east coast where pellets are shipped to Europe (Urbanowski 2005). In addition, imports done by ship means extra loading and unloading of the pellets, this causes more fines, in addition to the fact that pellets are easily exposed to moisture depending on the loading process and facilities. Imported pellets are mainly used by large scale users, heat and power plants, where pellets are crushed before combustion. However, for small scale users of imported pellets the fines need to be separated. The main logistical problem is the storage needs at both ends; since shipping is done in large amounts (typically from 7000 t up to 30 000 t) therefore large storage space is needed at the harbour facilities (New Ways 2008).

An additional bottleneck is the lack of standardization among small scale pellet producers; many of them do not follow any standards, though some are following the Swedish standard. Small producers are selling pellets to households where mainly small scale boilers (under 25kW) are used, which require good quality pellets to work efficiently and fluently (Höglund 2008a). When the EU standard is applied it is possible some small scale producers would be required to improve their production to meet the standards. On the other hand, the small scale producers are mainly using good quality raw material, cutter chips, in their production, in which case following the standard should not be a problem.

6.2 Finland

6.2.1 Bottlenecks related to pellet raw materials

In the future a "lack" of raw materials, especially cutter chips and dry sawdust, can increase the pellets prices. There are insufficient good quality raw materials for increasing production. For example, currently (winter 2008–2009) there is a lack of raw materials for pellet production due to the decreased output from sawmills this is expected to increase the pellet prices (Kauppalehti 2008). Additionally, particleboard and fibreboard industries are competing with pellet plants for raw materials. Bark would be one possible raw material for pellets but it is usually combusted at the debarking place, typically in pulp mills, or used for landscaping or gardening purposes (Hetemäki et al. 2006). New raw materials are needed which would be compatible with existing pellet production structures and users' equipment (storages and boilers). In Finland, the distances are long and transporting costs of raw materials can become very high in some areas, to have cost-efficient raw material supply, transportation distances cannot be too long. Russian wood tariffs on timber exports is reducing the amount of round wood coming to sawmills, which impacts on the availability of raw material for pellets (Heinimö & Alakangas 2006, Lappalainen et al. 2007). At the end of 2008 the economical situation had reduced the output from sawmills throughout Finland which will likely affect pellet production.

There are many potential new raw materials for pellets but currently their suitability for pelletizing is being researched (for example in the PELLETime project). Forest residues have a large potential, however, the handling and drying needs to be optimal in order to decrease the corrosive agents which can cause problems in small scale boilers (Kallio & Kallio 2004).

6.2.2 Bottlenecks related to pellet supply and transportation

In Finland, the distances are long and transporting costs of pellets can be very high in some areas, the profitable pellet delivery radius is about 300km for small/medium scale producers. If the

number of pellet users is growing the pellet supply needs to be directed to the domestic markets instead of the export market. There are sufficient pellets produced which could be used on the local market instead of being transported abroad. The pellet production for 2008 could be used for heating around 75 000 detached houses but at the moment there are only 15 000 houses heated with pellets (Maaseudun tulevaisuus 2008). Increasing the number of users in the domestic market requires the development of a transportation network and associated equipment, mainly pneumatic trucks for bulk deliveries, for good, fast and cost effective pellet delivery. Currently typical pellet delivery is two weeks from the ordering time and the delivery equipment varies for pellet design pneumatic truck to existing animal feed delivery trucks. The main complaint from the users is the amount of the fines that pellets delivered in bulk sometimes contain. Pellets disintegrate during long distance transport, loading and unloading which can increase the amount of fines and reduce the pellets' quality (Tuomi 2007). For the domestic market, a large share (71%) of the pellet deliveries are done in bulk which, compared to sacks deliveries, is causing more crumbling. The main reason is probably the use of old trucks not designed for pellet deliveries and how the unloading is done by the driver. However, bulk deliveries are more economic, efficient and cheaper than deliveries of small sacks. In Finland, there are no standards for pellet deliveries and not all transport workers are trained to handle pellets. A large amount of research has been done regarding the handling of pellets and machinery used to minimize pellet crumbling during pneumatic deliveries with some recommendations being made (e.g. Kallio & Kirjalainen 2004, Tuomi 2007).

7 SWOT analysis of the pellet raw material and pellet supply systems

Table 1. SWOT analysis of existing raw material and pellet supply systems in Finland and Sweden.

Strengths		Weaknesses	
Finland	Sweden	Finland	Sweden
- Enough domestic production to increase the number of pellet users - Domestic raw materials	- Developed pellet production - Many small scale producers - Well developed delivery network - Most of the pellets produced according to pellet standard - Favourable taxation	- Lack of good quality raw materials - No pellet standard - Amount of fines formed in bulk deliveries - Taxation	- Lack of raw materials - Many small producers do not follow standards - Quality of imported pellets (amount of fines)
Opportunities		**Threats**	
Finland	Sweden	Finland	Sweden
- Development of pellet handling and transportation - Make pellet market local instead of global - Increase the domestic pellet consumption - New raw materials	- New raw materials - Improving the harbour facilities for handling imported pellets	- Decreasing sawmill production effect on raw material availability - Rise in the pellet price - Uncertainty of raw material supply can delay forthcoming plants	- Competition for raw materials with other industries - Rise in the raw material price - Reduction in pellet importation

8 Conclusions

The pellet market and supply chains are well developed in the Northern Periphery region, apart from Iceland where is no wood pellet production and Scotland where the production plants and market have been recently established. Sweden represents the most developed pellet market which covers both small scale households and large scale power plant usages. When in Finland the pellet consumption is still small but growing steadily. The pellet supply systems are quite well established both in Finland and Sweden but the major threat is the lack of raw materials, as well as its increasing price, which can reduce the pellet production and delay forthcoming plants.

In Finland the pellet market is dominated by medium and large producers, only a few small scale producers exist. Raw materials are typically transported from several sources, also some plants are working integrated into the raw material source. The pellet supply system is quite well established and is working well; many plants are delivering bulk pellets straight to the customer thereby reducing the decrease in quality and increasing the efficiency. Furthermore, pellet sacks can be bought from many places. Nevertheless in the future the increasing number of pellet users requires an organized delivery network and good equipment for pellet deliveries.

Sweden has a high number of pellet producers, of which about half are small scale. The by-products of the small wood industries are well utilized for pelletizing by small pellet producers at the raw material site, with only the largest pellet producers having to transport raw material over longer distances. The country has well established pellet distribution networks, pellets can be ordered directly from the plants in sacks or in bulk, large retailer networks cover the whole country and small scale users have access to pellets even in remote areas. Small and medium scale producers are packing a large share or all of their production into sacks, which makes storage easier at the production site and transportation can be done with normal trucks, also the pellets keep their quality well in the sacks. The pellet supply chain is working well, however, an issue is the raw material supply at the beginning of the chain which is threatening to reduce the production.

In Sweden, the small scale consumers' pellet market is based on small sack deliveries, while in Finland the pellet markets are more based on bulk deliveries as also is the case in the Central European markets: Austria and Germany. The pellet quality remains better and storing is more flexible in small sack than in bulk deliveries, although bulk pellets are more economical than packed pellets, they are usually coming straight from the pellet plant and have no packing materials, while small sacks are packed on a pallet and wrapped with plastic, and sold via retailers. The continuous research of pellets also includes quality control in storing and pneumatic loading/unloading, only one country, Austria, has a quality standard for pellet handling and transportation.

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