Institutionen för skogens produkter

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Summary

The production and demand for wood-based fuel pellets has increased considerably both in Sweden and internationally the recent years. Today Sweden is one of the leading nations when it comes to production and use of fuel pellets.

Despite the favorable development great challenges wait. The all time high production of saw mill by-products is not enough to satisfy the growing demand for by-products, resulting in increasing raw material prices and competition. Seen in a historic context, the pellet industry has been characterized by fluctuations in supply and demand and uncertainty about how changes in governmental subsidies and the development of competitive substitutes will affect the situation.

This study presents a broad overview of the Swedish pellet industry. The study had three purposes; to analyze the business situation for the producers, to examine to what extent product standards and environmental certification instruments were used within the industry, and to make an estimate on future potentials and possibilities for the pellet industry.

The study was conducted in the form of a questionnaire survey to the manufacturers of fuel pellets in Sweden and the results are based on answers from 55 % of the producers, accounting for 86 % of the total production capacity.

The results indicate a rapidly expanding production capacity and at the same time a strained raw material situation. The production increased with as much as 260 % from 2001 to 2007, and the planned capacity expansion totals 708 000 annual tonnes, or over 40 % of the capacity for 2007. During the same period, the competition for raw materials was getting more intense; one third of the producers experience the raw material situation as the largest threat to the production and the majority of firms have evaluated alternative raw materials in response to the increased competition. Among the alternatives examined are for example roundwood and pulp wood.

The majority (47 %) of the production go to small-scale consumers. The greatest part (74 %) of all pellets manufactured are produced according to the Swedish Standard, but among the small-scale producers the use of standardization is low. More than one fifth of the production is certified according to FSC and PEFC (scarcely 300 000 tonnes). The low degree of certification depends in a first instance on the fact that 53 % of the producers do not use environmentally certified raw materials but ultimately on the low demand for environmental certified pellets.

Today the pellet industry is very dependent on the demand and supply balance for other forest industry products, a dependence that in a future perspective should be abandoned in favor of alternative and forest industry independent raw materials. To avoid the risks associated with overbuilding capacity, a greater share of the Swedish production should go to the expanding international market.

Keywords: bioenergy strategy, biofuels standardization, pellets, energy market, heat sector

Sammanfattning

Produktionen av och efterfrågan på träbaserad bränslepellets har ökat mycket kraftigt både i Sverige och internationellt de senaste åren. Sverige är idag en av de ledande nationerna när det gäller produktion och användning av bränslepellets.

Trots den gynnsamma utvecklingen väntar stora utmaningar. Sågverkens rekordstora produktion av biprodukter räcker inte för att tillfredställa den ökande efterfrågan vilket har resulterat i ökade råvarukostnader och konkurrens. Historiskt sett har pelletsindustrin präglats av fluktuationer i tillgång och efterfrågan, osäkerhet beträffande statliga bidrag samt hur utvecklingen hos konkurrerande energislag kan påverka situationen.

Den här studien utgör en bred kartläggning av den svenska pelletsindustrin. Studien hade tre övergripande syften; att analysera producenternas affärssituation, att undersöka i vilken omfattning produktstandarder och miljöcertifieringar användes inom industrin samt att bedöma vilken potential och vilka möjligheter som finns för industrin i framtiden.

Studien utfördes i form av en enkätstudie till Sveriges producenter av bränslepellets och resultaten är baserade på enkätsvar från 55 % av dessa motsvarande 86 % av den totala produktionskapaciteten.

Resultaten visar på en snabbt expanderande produktionskapacitet och samtidigt en ansträngd råvarusituation. Industrins produktion ökade med hela 260 % mellan 2001 och 2007, och den totala planerade kapacitetsutbyggnaden uppgår till 708 000 årston, eller drygt 40 % av kapaciteten år 2007. Under samma period har råvarukonkurrensen hårdnat; en tredjedel av producenterna upplever råvarusituationen som det största hotet mot produktionen och majoriteten av alla företag har undersökt alternativa råvaror som svar på den ökande konkurrensen. Bland de undersökta alternativen ingår bland annat rundved och massaved.

Huvuddelen (47 %) av produktionen går till småskaliga användare. Större delen (74 %) av all pellets produceras i enighet med Svensk Standard, men bland de småskaliga producenterna är användandet av standardisering låg. Drygt en femtedel av produktionen certifieras i enighet med FSC och PEFC (knappt 300 000 ton). Den låga certifieringsgraden beror dels på att 53 % av producenterna inte använder miljöcertifierade råvaror och främst på den låga efterfrågan på miljöcertifierad pellets.

Pelletsindustrin är idag mycket beroende av utbuds- och efterfrågebalansen på andra skogsindustriprodukter, ett beroende som i ett framtidsperspektiv bör brytas till förmån för alternativa och skogsindustrioberoende råvaror. För att undvika riskerna förknippade med överkapacitet bör en större del av den svenska produktionen avsättas på den expanderande internationella marknaden.

Nyckelord: bioenergistrategi, biobränslestandardisering, pellets, energimarknad, värmesektorn

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1 Introduction

1.1 Background

Today we are using more and more biofuels to cope with the threat of oil depletion and to decrease the amount of green house gases released into the atmosphere. The Intergovernmental Panel on Climate Change recently concluded that it is very likely the global climate change is human-induced (IPCC, 2007). One of the most important and promising biofuels today is pellets produced by densification of primarily wood biomass in pellet production facilities.

In the end of 2006 there were 285 larger pellet production facilities in Europe, producing on average 20 000 tonnes of pellets per year each. At the same time many new facilities were being planned or under construction (Ljungblom, 2008). In Florida, for example, the largest pellet production facility in the world with an annual capacity of about 550 000 tonnes is currently under construction (Biomass Magazine, 2007). The development is very fast, and internationally Sweden already is at the forefront when it comes to refined wood fuels like pellets for heating purposes (STEM, 2006).

Sweden has a long-term environmental strategy of reducing the amount of green house gases released into the atmosphere by 50 % to the year 2050. Moreover, the Swedish energy policy aims at phasing out fossil-based fuels such as oil and energy demanding technologies such as direct electric heating (Swedish Government Offices, 2007). These environmental strategies are some explanations for the rapid development of the Swedish pellet industry today.

Essentially all biomass fuel used in Sweden originate from the forest, which makes the forest industry a key sector and the main raw material supplier for the pellet producers. Residues from forest industry processes such as saw dust, dry chips and planer shavings are the most important raw materials when producing pellets. Other raw material alternatives that have been studied for use in the pellet industry is agricultural by-products and energy crops (Hirsmark, 2002), but since these are not as energy rich as forest residues they are not commonly in use for pellet production today, but may be a viable alternative in the future.

The main part of the forest industry residues are recycled within the industry and used internally, which also makes the forest industry the largest user of solid biofuels (Eriksson & Nilsson, 2003). Nevertheless, biomass is also used increasingly in district heating plants, for electricity production and in the form of pellets in a growing rate in the residential sector. The demand for biofuels in general and pellets in particular has been growing constantly the last years and the pellet industry is developing its production capacity to meet the needs.

Today raw material for pellet production and ready-made pellets are shipped across the globe. Forest rich nations like Canada have a great potential to produce pellets, while other countries such as Denmark are important consumers of pellets. The Swedish Trade Council recently identified nine countries; Austria, Canada, Czech Republic, Ireland, Poland, Romania, Spain, United Kingdom and USA, all with substantial growth opportunities for the Swedish biofuel companies (Swedish Trade Council, 2007). Because of the internationalization of biofuel trade, the need for common international standards concerning solid biofuels is becoming more important. Much work on global standardization of biofuels is currently going on.

The development in the fuel pellet industry calls for up to date information in order to understand the potentials and possible challenges in this fast growing industry. This study

provides an overview of the Swedish pellet industry, the market for fuel pellets and the current use of national and international standardization frameworks. The study also looks into the future to try to make an estimate on future potentials and possibilities for the pellet industry.

1.2 Aim of the study

The main purpose of this report is to analyze the current business situation for the firms in the Swedish pellet industry.

The research questions are:

- *What is the business situation for the pellet producer?*
  (Regarding market development, raw material situation and production)
- *How is emerging standardization and environmental certification instruments affecting the business situation?*
  (Discussing their role and impact on the pellet industry)
- *What potential does the pellet industry have to succeed in the long run?*
  (Assessing the attractiveness and potential disadvantages of the industry with the use of a PEST-analysis)

Secondary research questions

The questionnaire (see Appendix B) that serves as the starting point for this study was designed to answer the research questions raised in section 1.2. Some questions are more of a follow up nature (primarily of statistical importance) whilst others aim at revealing the business situation for the firm from different perspectives. These perspectives will be further dealt with here in some detail to give the reader an introduction to the theoretical thinking of Porter´s Five Forces applied on the pellet industry.

As already noted, the forest industry is the primary supplier of raw material for the pellet industry. When the demand for pellets is increasing the relationship between producer and supplier gets even more important for the single actor. The raw materials for pellet production are getting more expensive and trade of pellet fuel is becoming international. What does this supplier-producer relationship look like; what raw materials are used, are the firms importing any raw material for use in the pellet production and what strategies do the firms have when it comes to trade with other countries?

New customer groups are emerging and what was once an insignificant market segment is now becoming more interesting to the producer, such as the medium-scale consumer segment. An important aspect of the business situation is to analyze the present producer-consumer situation. The development of substitute products such as direct electric heating and heat pumps are important parameters when assessing the producer-consumer situation.
Another significant relationship in the pellet industry is the one between the producers already in the business, and the one between producers and potential entrants. Firms in the industry are competing for limited resources, market shares and other key aspects which intensify the rivalry among existing firms. Which actor is experienced as the main competitor to the producing firms, and what is their strategy to handle the competitive situation? What barriers do new entrants encounter when trying to enter the pellet industry?
In the growing pellet market, the need for standardization, both national and international is important for reliability of the fuel exchange activities. Standards also play an important role when environmental concerns are becoming more important, and when customers demand an even product quality. Both demand and supply side actors are interested in a uniform market

for pellets and raw material to secure facilitated trade and exchange of the products. The questions on standards and certifications will focus on the use and implementation of the new European biofuel standard compared to the one at the national level, and if the producers are using environmental certification systems in their output and input markets.

1.3 Outline of the thesis

Chapter 1 introduces the background, the aim with the study and presents the outline of the report.

Chapter 2 focuses on the fuel pellet sector, previous research and the market for fuel pellets, including production and consumption.

Chapter 3 presents the theoretical background of Porters Five Forces applied on the pellet industry.

Chapter 4 describes the methodology of the study; case-study design, target population and data processing.

Chapter 5 summarizes the results from the questionnaire survey.

Chapter 6 discusses and analyzes the results.

2 The pellet sector: development, market and standardization

2.1 Development and previous research

During the period of 1982 – 1985 there was a first boom in the pellet industry in Sweden. In the aftermath of the oil-embargo the Swedish government supported alternative energy sources, and a state of the art pellet plant was built in Mora in 1982. A few years later, in 1986, the use of pellets in Sweden began to decline rapidly due to state-supported electricity from nuclear plants. This turn of the tide left only the new Mora plant on the fuel pellet market. Following these problems, the pellet industry began its long journey and growth to where it stands today (Ljungblom, 2007).

Vinterbäck investigated the situation of the small-scale use of pellets in Sweden in 2000, assessing the growth potential on the residential market. The results indicated that wood pellets showed a considerable potential for increased use in the residential sector in the future, since the availability of pellets clearly exceeded demand. Factors promoting this development were the developing distribution networks for pellets, the improvement of small-scale pellet burning technology and the increased use and trade of solid biofuels across Europe. Other aspects such as the environmental friendliness of pellets and its favourable price compared to other energy carriers further improved its potential. (Vinterbäck, 2000)

The significance of pellet standardization was one bottleneck in the development of the fuel pellet market, but a prerequisite for increased and facilitated biofuel trade and exchange. Another conclusion from the study was that the Swedish residential market for fuel pellets was fully established by the year 2000, and that the price is comparable to those of the closest substitutes. Vinterbäck also noted that, since there are several energy substitutes available for detached home owners, pellets will always be price sensitive compared to other similar products and dependent on the price of these substitutes. (Vinterbäck, 2000)

The Swedish wood fuel market development was studied by Bohlin & Roos, aiming at the switching from fossil fuels to biofuels in the district heating sector that took place during 1980-1999. In 1980 oil was the dominant fuel in the district heating network accounting for 112 PJ, compared to the 1.1 PJ use of biofuels. The situation was the reverse in 1999 when oil accounted for only 18 PJ and wood fuels for 57 PJ in the district heating sector. In other words, the growth of the Swedish biofuel market during this period was mainly driven by increased demand from the district heating sector. District heating networks are well distributed in Sweden and was one factor that promoted the use of biofuels. The use of pellets instead of for example wood chips also made transportation less expensive. (Bohlin & Roos, 2001)

The reason for converting from oil combustion to the combustion of biofuels in large scale facilities can foremost be explained by the tax on carbon dioxide in 1991 that made fossil fuels more expensive. The conversion to pellets increased the demand, and several new production plants for pellets were built (Mahapatra, 2007). The number of pellet producers increased from two in 1990 (JTI, 2004) to 30 in 2003, and the annual production increased from 10 000 tonnes in 1990 to one million tonnes in 2004 (PiR, 2004).

The consumer market for pellets is divided into three segments depending on installed power according to the Swedish Association of Pellet Producers, PiR (See Figure 1, 2 and 3).

Figure 1, 2 and 3. Small-, medium- and large-scale combustion installations (Figure 1, 2 and 3, respectively). The left picture show a small-scale pellet stove (less than 50 kW), the middle picture a medium-scale pellet heat central supported by solar panels (50 kW – 2 MW) and the right picture a district heating plant (2 MW and larger).

Zakrisson made a comparison of international pellet production costs concerning investment costs and the pellet production processes in Sweden, Austria, North America and the Baltic States. The largest single part of the production costs in Sweden and Austria was raw material costs and the costs associated with the drying of the raw material. In Sweden the investment costs for a pellet production plant constituted about one fifth of the production costs. Moreover, Zakrisson stated that the investment costs for a pellet plant of any given size was about the same between country and region, but that the costs associated with labour, raw material and electricity etc. could vary considerably. Production plants with high production capacities could achieve economies of scale, resulting in lower production costs/tonne. The author also studied the competitive situation for the pellet producer. During the period the study was carried out, the favourable prices of electricity was one that made pellet manufacturing in Sweden more competitive relative to other countries. (Zakrisson, 2002)

Traditionally biofuels have been used in the region from where it originates, but this situation changed with the rebuild of district heating plants from combustion of oil to the combustion of biofuels during the 1990s. As a result of this the Swedish import of biofuels increased. Ericsson & Nilsson studied the Swedish biofuel import and concluded that the Swedish import was the result of several forces. For example, in the 1990s the Swedish energy policy made biofuels the most competitive energy carrier, resulting in increasing import flows to Sweden not intended by the Swedish policy makers. A common market then gradually emerged around the Baltic Sea with the greatest flows directed towards Sweden. The Swedish import accounted for approximately 18 PJ of total energy use for 2000. However, the international biofuel market was in an early and dynamic stage in the early 2000 and the trade was not coordinated in terms of common policies and standards. (Ericsson & Nilsson, 2003)

In 2002, about 50 % of the 1.6 million detached home owners used electric- or oil-based systems for space heating (STEM, 2003). However, the annual installations and sales of pellet burners in the small-scale market segment have been booming during the period 1994 to 2006. In 1994 about 300 pellet burners and stoves were installed annually in Sweden, in 2006 the annual installations were about 11 500 units within the residential market (SBBA, 2007).

It must be commented though, that this 38-fold increase in annual installations is not very impressive in absolute numbers compared to substitute products. For example, the cumulative installation of 104 700 pellet burners and boilers from 1994 to the end of 2006 (Davidsson, 2007) must be compared to the annual installation of 40 000 brine/water-based heat pumps in one single year 2004 (Mahapatra, 2007).

In 2004 pellets were imported from Canada, Poland, Finland and the Baltic Countries. The majority of the Swedish export was shipped to Denmark and to the United Kingdom (Mahapatra, 2007). The total amount of pellets imported, exported and delivered to the Swedish market during the period 1997-2006 is shown in Figure 4.

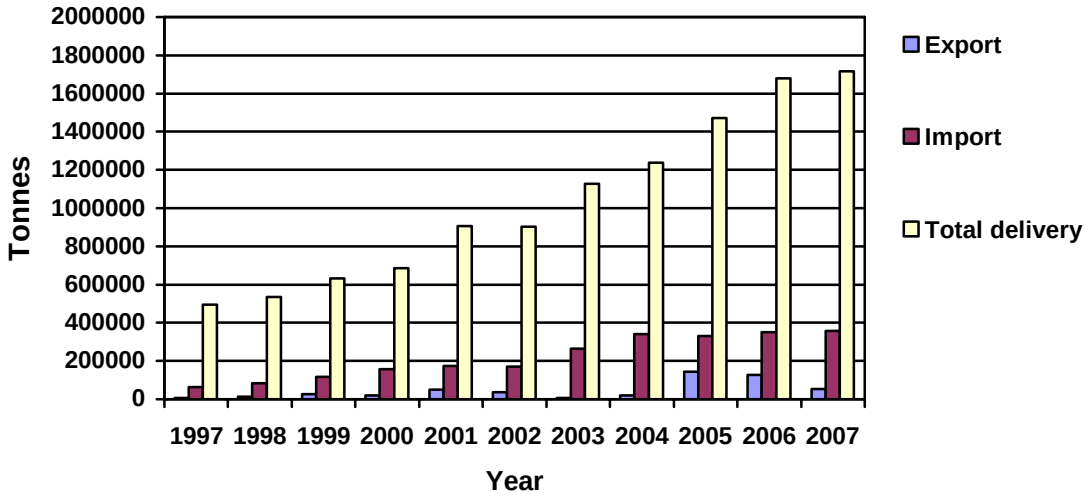


Figure 4. Export, import and total delivery of pellets to the Swedish market 1997 – 2007 (tonnes). Statistics from PiR (2008).

As seen from Figure 4, 54 455 tonnes of pellets was exported, 358 435 tonnes imported and in total 1 715 000 tonnes was delivered to the Swedish market in 2007 according to PiR (PiR, 2008).

In the beginning of the 21th century, the market and production for fuel pellets in Sweden was growing rapidly. To get an overview of the pellet business, Hirsmark (2002) mapped the Swedish industry for densified biofuels, including pellets and briquettes. In his report he identified three factors that explain the rapid development of the biofuel industry until 2002: the favourable availability of raw material, the taxing system that discriminated the use of fossil fuels and the widely extended district heating system.

To facilitate communication and trade on the biofuel market, as many researchers have noted, standardization of pellet is necessary. In the year 2000 the European Committee for Standardization (CEN) started a technical committee called *CEN/TC 335 Solid Biofuels* to develop common standards internationally for solid biofuels (see Appendix A). The standards will in time be upgraded to EN – European Norms. How two of the new standards included in CEN/TS 335 Solid Biofuels fit the need of its users and have penetrated the Swedish market has been studied recently by Belbo. Results indicated that a majority of the Swedish biofuel producers, suppliers and customers knew about the existence of at least one of the standards mentioned, but that only a few used any of them. However, the study did not evaluate the experienced performance of the new European standard by the biofuel actors and the matter of

environmental certifications was not discussed (Belbo, 2006). Especially in the small-scale segment guidelines for good practice and standardized quality of the logistic chain are essential to guarantee the quality for the end-consumer (Hahn, 2004).

To provide common understanding and facilitate contact and exchange between pellet producers and customers, national and international standards have been developed concerning quality, terminology and other vital aspects of the fuel. One problem of a functioning pellet market is that the quality differences between different pellet producers can vary considerably. Customers are usually reluctant to buy fuels that cannot be quality guaranteed (Belbo, 2006).

There are a number of national standards concerning solid biofuels already in use by pellet producers across Europe today. Sweden, Austria, Germany and Italy have developed national standards (for example ÖNORM in Austria and DIN in Germany). Large customers that need a uniform market for their fuel also tend to set their own standards beside or independent of the national standards. However, when the biofuel trade is expanding and the exchange between customers increase internationally, there is little use of standards developed for a specific country if it does not agree with the standards of trade partners (Hahn, 2004).

A number of certification systems have been developed in response to public concerns about forest management and origin and to promote sustainable use of natural resources. With the use of certification, a third independent party (called the certifier) evaluates quality factors to a set of predetermined parameters (the standard). If the quality factors are met, the producer receives a written assurance from the certifier that the factors conform to the requirements in the standard (Lewandowski, 2004). Some examples of certifiers concerning the biofuel market are FSC (Forest Stewardship Council) and PEFC (Programme for the Endorsement of Forest Certification schemes).

2.2 The market for pellets and pellet raw materials

Raw material supply

The pellet industry is, not surprisingly, closely connected to and also dependent of the Swedish forest industry. Several of the small-scale pellet production plants are started by planeries, furniture manufacturers and saw mills that use residues from their main business as input for the production of pellets. In other words, a great part of the pellet industry is organized by and integrated in the forest industry (Wetterlund, 2007). With more and more new producers and a growing international biofuel trade one can expect that the competition for raw material will increase in the future. Several pellet producers are currently testing new types of raw material (e g peat, energy crops) to try to find alternatives to the raw materials commonly used for production. Nevertheless, the forest will probably be a much greater supplier of raw material for bioenergy production than agriculture. The total agricultural biomass production in Sweden today is only about 35 % of the total biomass production from the forest. Of the total agricultural biomass production only a marginal share is used for energy generation today (Johansson *et. al.*, 2007), but the potential for increased use of agricultural-based raw materials is high.

The majority of the forest based bioenergy that is used today in Sweden comes directly from the forest industry in the form of branches and tree tops. Out of the total Swedish forest cutting in 2003, about 45 % was used for energy purposes (Johansson *et. al.*, 2007).

The forest industry is, besides being the most important supplier of raw material for pellet production, also the largest user of bioenergy in the form of forest residues. The total of 112 TWh biofuels that were used in Sweden 2006 (STEM, 2007), the forest industry used 46 % internally (Johansson *et. al.*, 2007).

The Swedish forest industry

The importance of the Swedish forest industry to the prosperity in Sweden as well as to the pellet sector is substantial. The problem is that even today when the forest industry is booming, the competition for its by-products is increasing. Despite of the high annual forest growth (more than 100 million m^3sk[I]/year) and an annual cutting of about 92.4 million m^3sk/year (Swedish Forest Agency, 2007), the forest resource cannot meet the demand for forest products. Some researchers argue that Sweden must revalue the forest resource and take advantage of its true potential by changing the forest politics and the way the forests are managed. This, they argue, can be done by using other techniques such as fertilizers and foreign tree species to increase production (Johansson *et. al.*, 2007), methods that may be perceived as rather controversial in Sweden.

Sweden has two major goals for the Swedish forest resource according to the Forestry Act stated by the government in 1993; one environmental goal and one production goal. The protection of biological diversity, social- and cultural values as well as the preservation of threatened species and nature types is included in the environmental goal. In the production goal on the other hand, the effective and responsible use of the forest resource is pointed out (Swedish Forestry Act, 2003)
Besides this, Sweden has other political strategies concerning the use and protection of the forest resource. This includes protection of areas including old-growth forests, mountain forests and other nature types. Environmental issues is one side of the coin, production another. The forest industry must balance the two goals of environmental consideration and production efficiency, and the two goals sometimes collide.

Production and consumption of pellet raw materials

Figure 5 shows a schematic overview of how the use of the annual cutting in Sweden is distributed in terms of energy content. Only a marginal share of 6 TWh, or 2.6 %, ends up as refined biofuels (including pellets).

[I] m^3_{sk} = Cubic metre standing volume (the tree volume above the root including top and bark).

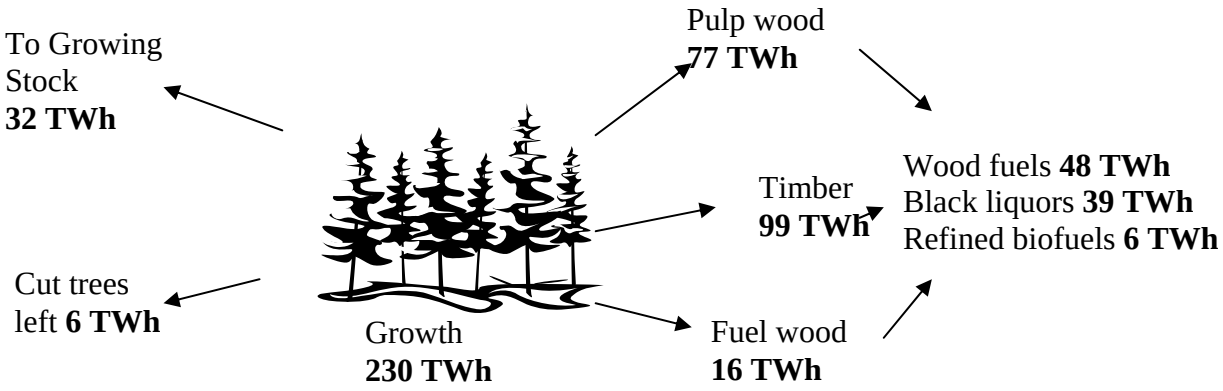


Figure 5. The use of the annual growth of 230 TWh (corresponding to about 100 million m^3_{sk}/year) with respect to energy content. Modified from Wetterlund (2007).

In short there are three big industrial users of forest industry by-products today; the saw mill industry, the pulp- and paper industry and the energy sector.

Saw dust, wood chips and shavings are the main raw materials for the production of pellets and therefore the supply of these by-products are determined by the demand for forest products (i e paper, pulp, wood etc.). The pellet industry as a buyer of raw material therefore has only minor possibilities to affect the supply just by market forces. This situation is also true for cutting residues because the supply is dependent on the demand for timber and pulp wood. (Wetterlund, 2007)

When processed in a saw mill, more than half of the initial timber volume is lost in the form of saw dust and wood chips. The main part of the wood chips goes to the pulp and paper industry and the rest to the board industry and the energy sector. Buyers of saw dust are the pulp and board industry and the bioenergy industry (see Table 1). About one-fourth of the raw material used as an input for the production of pulp is in the form of wood chips from the saw mill industry. For the pulp- and paper industry, the raw material from wood fibres accounts for almost half of the total working costs, making the access to it a crucial competitive factor in this industry. (Wetterlund, 2007)

Table 1. Use of the total production of saw dust, planer shavings and wood chips from the Swedish saw- milling industry during the period 2002 - 2006 (1 000 m^3s)[a]. Statistics from SDC (2007) converted from m^3f to m^3s (except from 2002 and 2003)

Year	Assortment	Sold (e g to the pellet industry)	Internal use (at saw mill)	To pulp and board ind.	Other use	Sum
2006	Saw dust	9 444	1 700	2 212	174	13 529
	Planer shavings	3 540	180	550	325	4 595
	Wood chips	2 597	789	30 219	22	33 628
2005	Saw dust	7 941	1 806	3 024	141	12 618
	Planer shavings	2 965	2 570	560	455	4 260
	Wood chips	3 258	833	29 431	6	33 528
2004	Saw dust	8 674	1 400	1 997	162	12 232
	Planer shavings	2 970	460	610	400	4 440
	Wood chips	3 236	653	29 958	39	33 886
2003	Saw dust & planer shavings	3 150[b]	469[b]	835[b]	136[b]	4 590[b]
	Wood chips	3 286	628	29 714	14	33 642
2002	Saw dust & planer shavings	2 610[b]	442[b]	840[b]	172[b]	4 065[b]
	Wood chips	3 944	789	27 378	100	32 211

[a] *The statistics was converted from m^3f to m^3s with the following conversion units: saw dust x(1/0.34), planer shavings x(1/0.20), wood chips x(1/0.36) (Lehtikangas, 1999)*
[b] *Unit 1 000 m^3f (the two assortments are not separated in the original statistics and therefore not converted).*

Raw material prices

The board industry has been more or less the one and only user of saw dust until the emerging bioenergy sector began competing for the same resource. For example, in 1990 about half of the saw dust available went to the board industry whereas in 2001 this share had decreased to about one fifth. During the same period the energy sector increased its use of saw dust from one-fifth to about half of the available volume. Especially after 2000 the price of saw dust has increased, mainly because heat plants are able to pay a higher price for the saw dust but also due to the expansion of the pellet industry. (Wetterlund, 2007)

Because of increased raw material competition, the pellet industry is trying to find other potential raw materials beside the forest by-products, for example energy wood. To the traditional pulp and paper industry and to the board industry the energy sector must be considered as the largest threat today, but with some constraints. If the pellet producer (or other users of forest by-products) will consider using pulp wood as an input, the producer must be willing to pay more than the price that the forest industries are willing to pay. At the same time the paying ability for forest by-products in the energy sector is approaching the pulp wood prices (see Figure 6). (Wetterlund, 2007).

Due to increased demand for forest by-products in the last years (predominantly by the energy sector) the prices have increased. The differences between pulp wood and the energy raw materials such as saw dust are getting smaller and smaller as seen from Figure 6 (see section 2.3 for more detailed information on pellets price development).

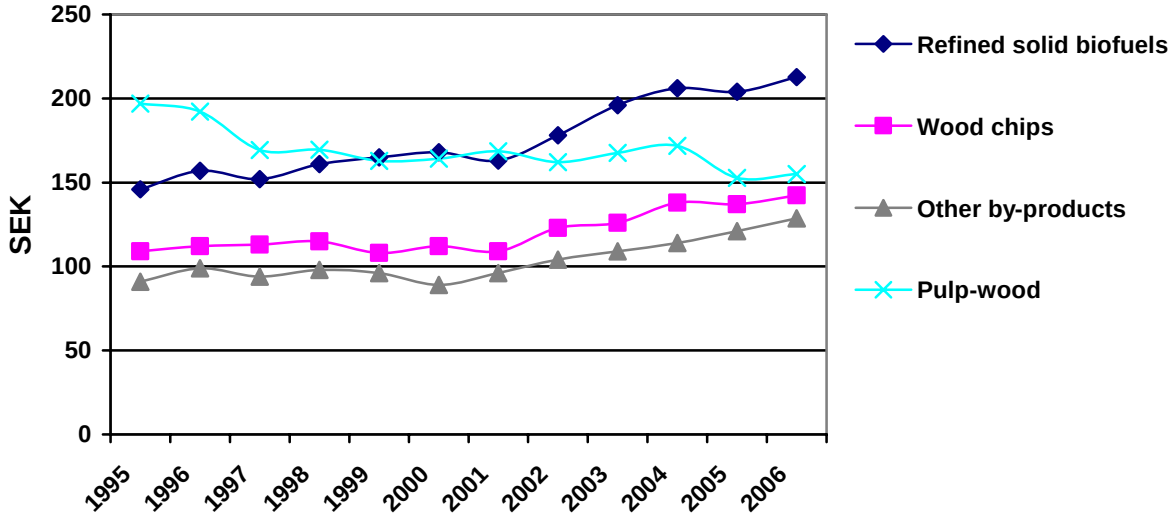


Figure 6. Price development of refined solid biofuels (e g pellets, briquettes etc.), wood chips, other by-products (e g saw dust etc.) and pulp wood. An administrative cost of 80 SEK/m3fub[II] and a cost of 40 SEK/m3fub for the pre-treatment processes of the by-products are added to the pulp wood prices. Statistics from the Swedish Forest Agency (2007), modified from Wetterlund (2007).

Supply and use of energy in Sweden

In 2006, the total energy use in Sweden accounted for 630 TWh, out of which nuclear-, water-, wind power and heat pumps stands for the greatest share. Still, crude oil and oil products accounts for 197 TWh (see Figure 7). The 112 TWh of biofuels is presented in more detail in Figure 8.

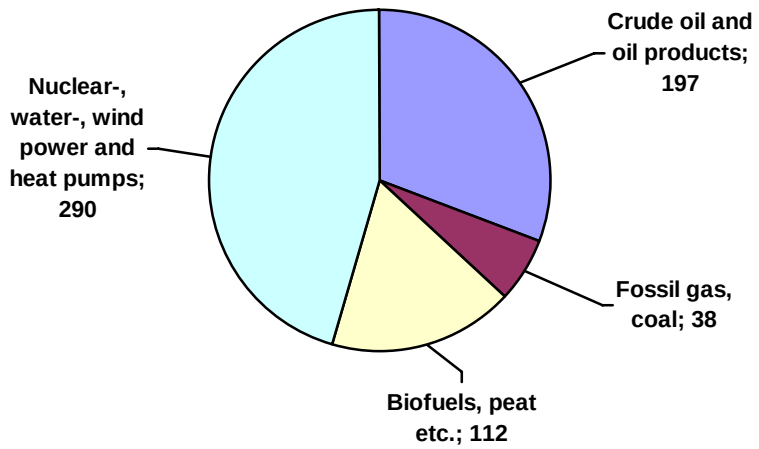


Figure 7. Total energy supplied in Sweden 2005 (TWh), 630 TWh in total (incl. import-export electricity; -8 TWh). Statistics from SCB (2006).

[II] m^3fub = Cubic metre solid volume excl. bark.

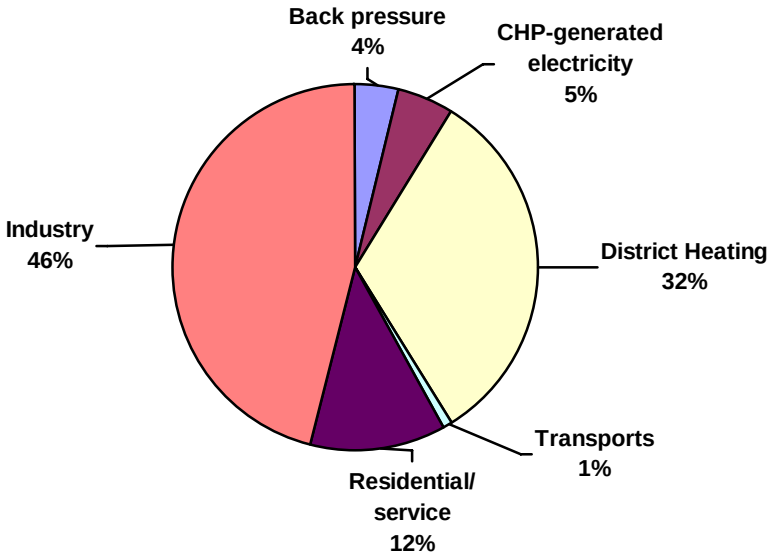


Figure 8. Total final use of 112 TWh biofuels in Sweden 2005 per sector. Note that the term "biofuels" in this sense includes not only refined fuel as pellets or briquettes, but also unrefined products as wood chips, clear-cutting residues, waste etc. (STEM, 2007).

2.3 Fuel pellet production and consumption

Biofuel characteristics in general

The markets for wood-based solid biofuels can be subdivided into three categories depending on the refinement of the fuel. Unprocessed harvesting residues (e g tops and branches), for example, can be used directly in large-scale facilities for heat generation (see Figure 11). Usually this type of fuel is combusted close to its origin since the low density and high bulkiness make distant transports too costly. Harvesting residues also have high variations of fuel properties making it unsuitable for combustion in small-scale appliances (Kaltschmitt & Weber, 2006).

Wood chips are medium refined solid biofuels (see Figure 10). Wood chips are produced from tops and branches or as an excess product in saw milling industries, or as a stage in the production of pellets. Wood chips are less costly to transport compared with harvesting residues. (Kaltschmitt & Weber, 2006)

Solid biofuels such as pellets (see Figure 9) with clearly defined and uniform fuel properties are upgraded from other biofuels (such as saw dust). In the case of pellets the wood chips are densified according to requirements usually defined in product standards. The high density and energy of pellets as well as the fact that it is easier to handle, allows it to be transported longer distances than other solid biofuels without high costs. (Kaltschmitt & Weber, 2006)

The 3 categories are presented in Figure 9, 10 and 11.

Low variations of fuel properties (e g pellets)
High density and energy content
Low transportation expenditure
Low moisture content
Figure 9

Medium variations of fuel properties (e g wood chips)

Figure 10

High variations of fuel properties (e g harvesting residues)
Low energy density
High transportation expenditure
High moisture content
Figure 11

Figure 9, 10 and 11. The different markets for solid biofuels can be divided into three categories depending on the variation of fuel properties and hence which market the fuel is best suited for. Modified from Kaltschmitt & Weber (2006).

Fuel pellets in short

Fuel pellets is a densified homogeneous fuel. The raw material is densified under high pressure with or without the use of organic additives to form pellets typically about 6-12 mm in diameter and 25-50 mm in length (Hirsmark, 2002). In this condition they are homogeneous, easily transported and stored and can be used in both large-, medium- and small-scale combustion facilities with low pollutant emission levels. The energy content, about 3.3 MWh/m^3 (Ringman, 1996), is relatively high compared to unrefined wood fuels (see Table 2).

Table 2. Approximated heating values of different fuels (Ringman, 1996)

Unit	Type of fuel	Energy contents, MWh
1 m^3	Pellets	3.3
1 m^3	Heating oil (E04)	10.6
1000 m^3	Fossil gas	9.5
1 m^3f	Wood, solid volume, 30 % moisture content	2.1
1 m^3s	Chips, loose volume, 30 % moisture content	0.9
1 tonne	Household waste	2.9

Production

The actual production of pellets takes place in pellet production machines which constitute the “heart” of a pellet production facility. The most commonly used machines today are ring die

pelletisers where the raw material is pressed from the inside and out through the die by rollers (Hirsmark, 2002). Besides the pellet machines, there are a range of other machinery and equipment used in the production process from for example fresh saw dust to dry pellets. In the following section the production processes for a large-scale production facility (Figure 12) and a small-scale production facility (Figure 13) will be presented briefly.

Large-scale process overview

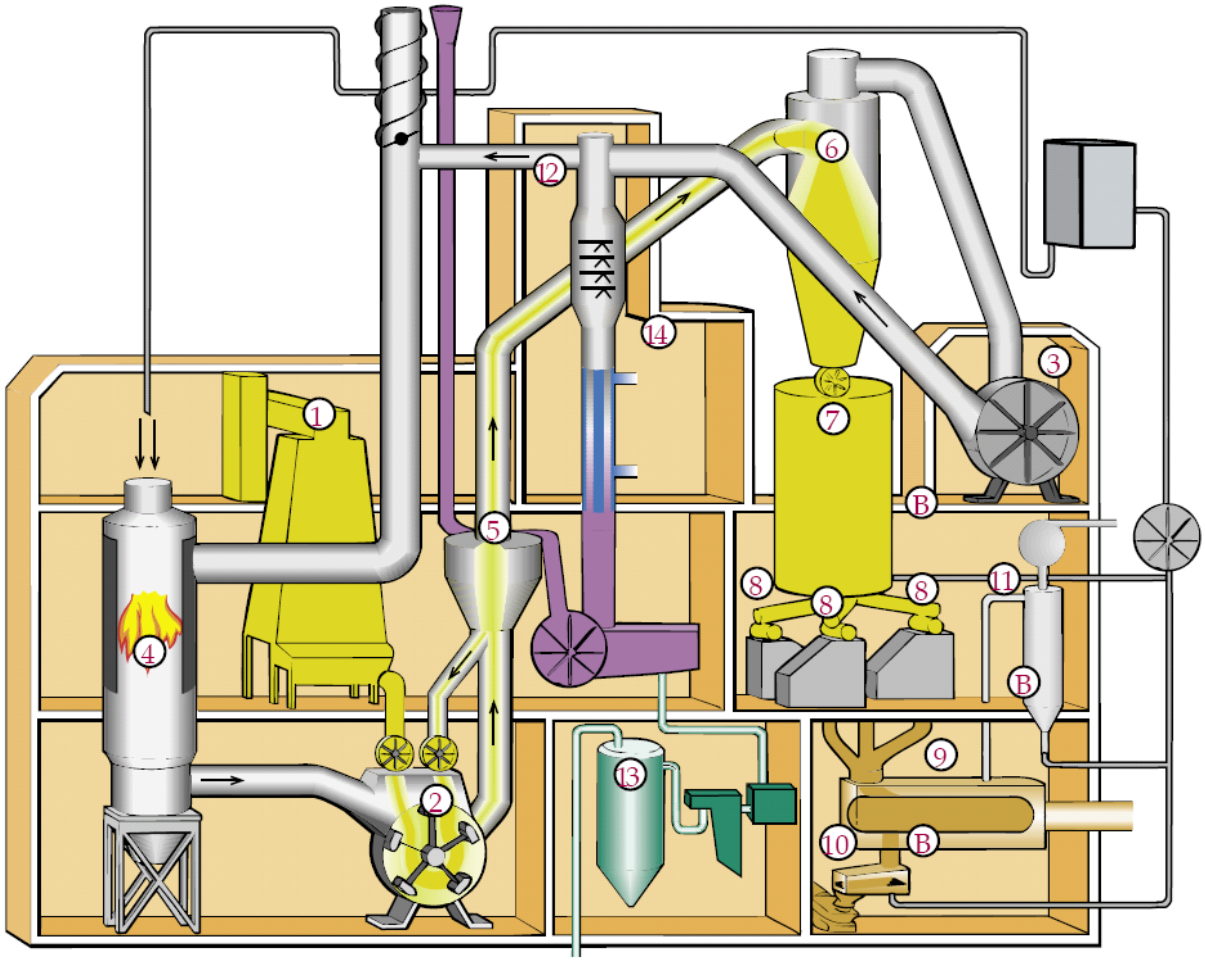


Figure 12. Schematic overview of a large-scale pellet production plant (SCA BioNorr AB, 2007). (1) Loading & buffer bin, (2) milling device, (3) fan, (4) hot-gas generator, (5) screening device, (6) cyclone separator, (7) buffer silo, (8) pellet mills, (9) air-cooler, (10) vibration separator, (11) recycled particles from screening, (12 & 13) smoke-scrubbers, (14) heat exchanger, (B) particles recycled as fuel.

The unprocessed raw material is loaded into the loading and buffer bin (1) and then conveyed into the milling device (2). Depending on the raw material, different types of milling equipment may be used. Rough material such as forest residues from clear cuttings need to be crushed or chipped before the following drying. Homogeneous raw material such as sawdust is usually ground before the next process step. Impurities in the raw material such as sand or stones can be a problem in this preparation step (Näslund, 2003). In the mill the material is ground into a fine powder and dried by flue-gases from the hot-gas generator (4).
(SCA BioNorr AB, 2007)

In this illustration the milling and drying is combined, but directly heated rotary drum driers are more common. Different fuels are used for drying heat generation, for example wood

powder, bark residues or industrial surplus heat (Hirsmark, 2002). A fan (3) then blows the dry powder to a screening device (5) where oversized particles are separated and re-circulated to the mill. This step is made easier if the material has low moisture content from the drying process. The finer the material is when leaving the grinding device, the better the durability of the pellets made from it. Occasional large particles may cause breaks in the pellet which reduces its durability and quality, and can also result in insufficient drying.
(SCA BioNorr AB, 2007)

The ground powder is transported to a cyclone separator (6) where the material is separated from hot gases and water vapour. The gases are then returned to the hot-gas generator for re-heating. Small amounts of these gases are cleaned in smoke-scrubbers (12 &13) and condensed in a heat exchanger (14). The resulting heat can then be transferred to the municipal district heating network. After the drying process the powder is ready for densification and stored in a buffer silo (7) connected to the pellet mills (8). In the following pelletising process the powder is compressed to pellets. In the densification process the material is heated up by friction in the pellet press machines causing the natural wood binding agent, lignin, to melt and bind the material together. Normally no additives are used in the compression process due to the lignin-content. (SCA BioNorr AB, 2007)

When the pellet is leaving the pellet machine its temperature is high, normally about 90° C (194° F) and therefore needs to be cooled in an air-cooler (9) until it reaches a temperature suitable for storing. The cooling also hardens the lignin making the pellets retain their shape (Alakangas & Paju, 2002). Before the pellet can be stored, fine particles have to be removed in a vibration separator (10) to avoid problems with dust. The screening is important, since it reduces fines and thereby prevents problems in conveyors or combusting equipment later on. The fine particles removed by the vibration separator and by air-cooling (11) are recycled as fuel (B) and returned to the hot-gas generator for combustion. (SCA BioNorr AB, 2007)

The pellets is now ready for bagging, storing and/or bulk delivery to customers.

Small-scale process overview

Small-scale pellet production is currently experiencing a rapid increase. In January 2007 there were 48 small-scale producers of fuel pellets in Sweden with a production capacity ranging from a few hundred tonnes a year up to several thousand tonnes a year (Tidningen Bioenergi, 2007). Small-scale production plants are often associated with carpentry factories or saw-mills using mainly dry raw material from their own production. Normally small-scale facilities have no drying equipment installed for by-products, why the raw material for pelletising has to be dry.

The production capacities in small-scale plants are not able to carry the costs associated with full-time employees, but such disadvantages are compensated for by the low need of maintenance and process steering. Moreover, the staffing requirement is usually covered by the existing personnel resources (Näslund, 2003).

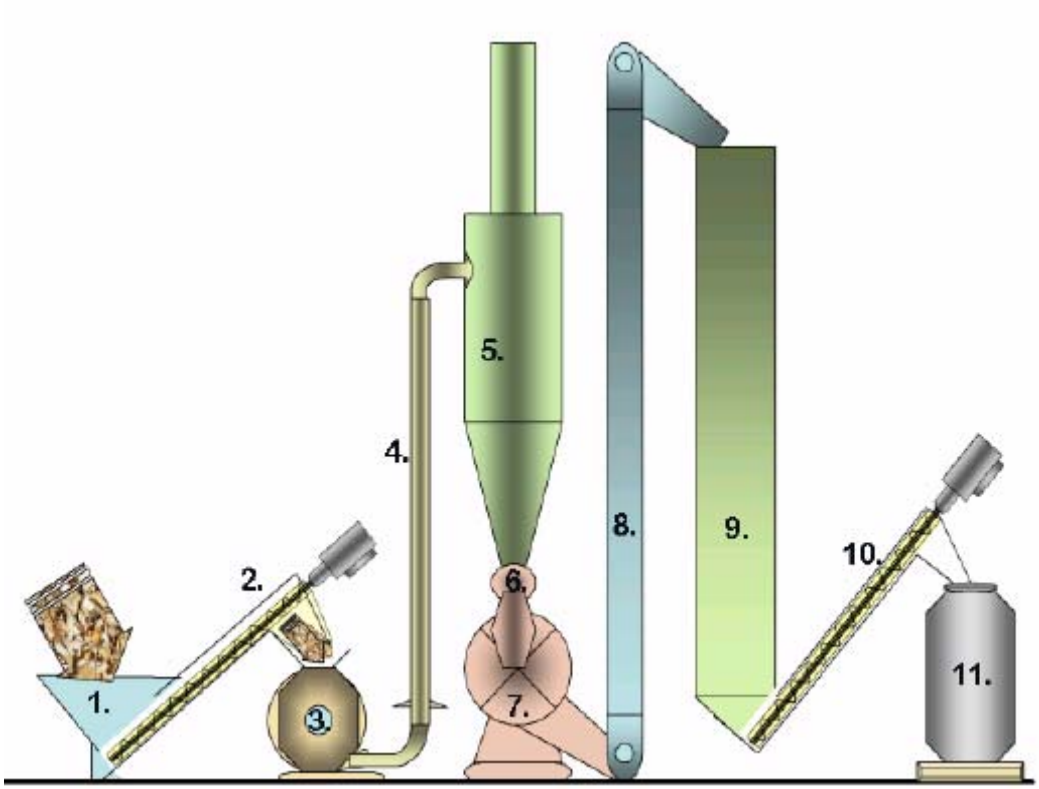


Figure 13 (Granö, 2007). Schematic overview of a small-scale pellet production plant. (1) loading and buffer bin, (2) screw conveyor, (3) hammer mill, (4) fan conveyor, (5) cyclone separator, (6) screw conveyor with steam-appliance, (7) pellet mill, (8) elevator, (9) drying equipment, (10) pellet conveyor, (11) bagging equipment. (SPC, 2008)

A schematic overview of a small-scale pellet production installation is shown in Figure 13. The principle is much the same as for large-scale facilities. Depending on the need of drying, raw material crushing etc., the system can be simplified in terms of fewer process steps or extended with more components.

Consumption

A more detailed look into the three consumer segments for pellets is presented in this section.

The large-scale segment includes large facilities such as CHP-plants (combined heat and power plants) or district heating plants that convey energy by water based pipe networks and has a capacity of over 2 MW[III]. In the medium-scale segment are boilers with a power ranging from 50 kW to 2 MW and are mainly used in multi family houses, schools, industries or public buildings. The small-scale segment consists of boilers with a capacity less than 50 kW used in detached houses and other small buildings (Hirsmark, 2002).
The three market segments and their development will be further described next.

Large-scale

The large-scale use of pellets in district heating plants still represents the main part of the Swedish pellet market (PiR, 2007) and accounted for 55 % of the total Swedish consumption of pellets in 2004; about 1.2 million tonnes (Mahapatra, 2007). The considerable large-scale pellet use has several historical explanations. District heating plants have gradually reduced

[III] Power ranges defined by PiR in their delivering statistics (PiR, 2007).

their consumption of fossil-fuels from 14.3 TWh in 1970 to 3.6 TWh in 1990 due to energy taxes on fossil fuels. Many district heating plants switched from combustion of oil to coal, and after the tax on CO_2 emissions was imposed by the government in 1991, they are now switching from coal to biofuels, such as pellets (Mahapatra, 2007). Another important factor to this development is the introduction of the electricity certificate system in 2003 in order to make the use of renewable energy more competitive. The system has made production of electricity from renewable energy sources more profitable in the large-scale segment where the majority of plants uses biomass as fuel (Olsson, 2006).

Figure 14 presents the historical use of wood fuels, including refined wood fuels (pellets, briquettes etc.) and unrefined wood fuels (wood chips, tree tops and branches etc.) in district heating plants.

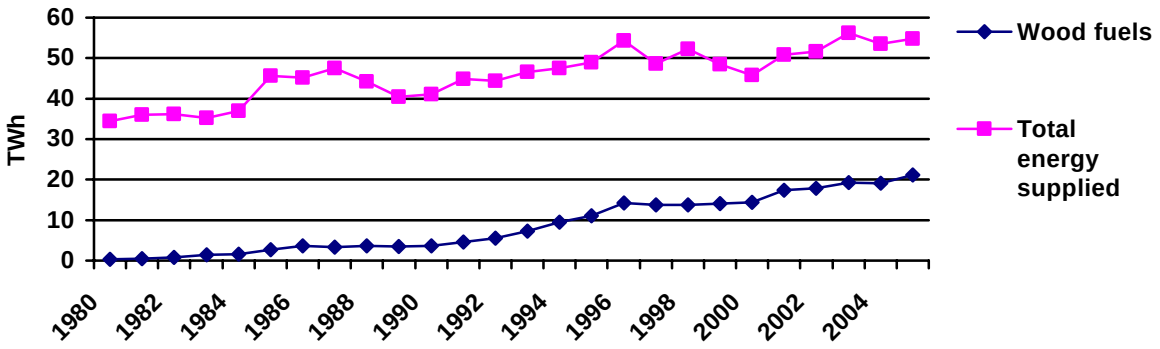


Figure 14. Use of wood fuels in district heating plants during the period 1980-2005 (STEM, "Energy in Sweden: Facts and figures 2006").

Most district heating plants uses converted boilers originally designed for coal powder combustion. With rather simple modifications they are converted for combustion of wood powder. Large-scale facilities are often located in densely populated areas the pellets are normally used in co-combustion with other fuels (Kaltschmitt & Weber, 2006).

Medium-scale

In the medium-scale segment industries contribute to the greatest part. The Swedish industry sector used about 51 TWh biofuels in 2005 for heat and electricity generation. 7 TWh was used in pulp- and paper industry and 5 TWh in sawmills and other industries producing refined forest products. Both pulp and paper as well as the saw milling industry use by-products as bark and saw dust as fuels. The energy from combustion of black liquors within the chemical pulp industry contributed in 2005 to about 38 TWh, excluding electricity production. (Johansson *et. al.*, 2007)

Other sectors used slightly less than 1 TWh biofuels. The total use of pellets in medium-scale systems increased by 25 % in 2006 (Stenegard, 2007).

Small-scale

The small-scale segment is the fastest growing market segment for pellets today, why this sector will be given a more detailed look in the following section.

For use in fully automatic appliances like pellet stoves and burners for detached houses, biofuels with low variation in fuel properties are needed. As transportation costs decrease with higher density and energy content, pellets can also be transported to reasonable costs and delivered in bags or in bulk to the customer. The disadvantages with the small-scale market are the costs associated with the high quality needs and the need for longer transportations (Kaltschmitt & Weber, 2006). The total use of pellets in small-scale systems increased by 33 % in 2006 (Stenegard, 2007).

During the 1970s most newly built houses and other buildings in Sweden were designed for heating with electric radiators. The system is relatively easy to install and do not need any water based heat distribution system or pumps for its function (The Swedish Consumer Agency, 2007). However, since this alternative is strongly dependent on the electricity price which has increased substantially, it has become less popular as a heating solution in recent years (Mårtensson, 2005).

Another alternative for space-heating in detached houses are different types of heat pumps. A heat pump collects energy from a low temperature and emits energy at a higher temperature with the help from a compressor (Mårtensson, 2005). During peak-loads when the heat pump system can not cover the heating need of the house, an electric device can step in to cover this need (Energirådgivningen, 2007).

During several decades the use of oil for space heating in detached houses has been a rather inexpensive alternative compared to other systems. However, due to political decisions, international climate agreements and the climate change discussion as well as increasing oil prices, the use of oil for heating purposes is steadily declining (Mårtensson, 2005).
An existing oil boiler can act as a complement to heat pumps and rather easily be converted for combustion of pellets (Energirådgivningen, 2007).

Buildings close to a district heating plant have the possibility to connect to the municipal district heating network. The heat produced by the district heating facility is distributed in a network of underground hot-water pipes to the internal system in the building (Mårtensson, 2007). The energy source used in the district heating facilities varies from excess heat to combustion of biofuels and municipal waste etc.; mainly fuels unsuitable for combustion in ordinary small-scale appliances. The district heating solution for small-scale consumers has the advantage of being space- and maintenance effective, but may also involve high costs for connection to the district heating network (Energirådgivningen, 2007).

The historical use of oil, biofuels, electricity, heat pumps and combinations of these as fuel sources in detached houses from 1987 – 2005 is shown in Figure 15.

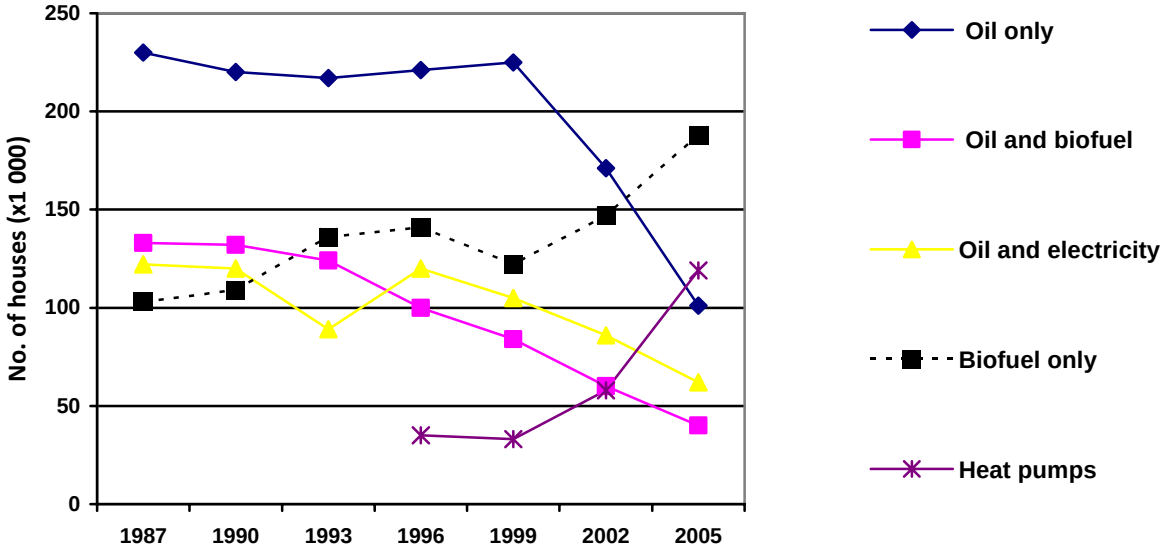


Figure 15. The historical use of oil, biofuel, electricity, heat pumps and different combinations of those in detached houses in Sweden 1987 – 2005 (SCB, 2007).

The costs of different heating systems in the small-scale segment are dependent on the location and municipality in Sweden, and the subsidies that can be obtained from a specific system. Figure 16 shows the average annual price for different residential heating systems including investment-, operating- and maintenance costs (STEM, 2007)

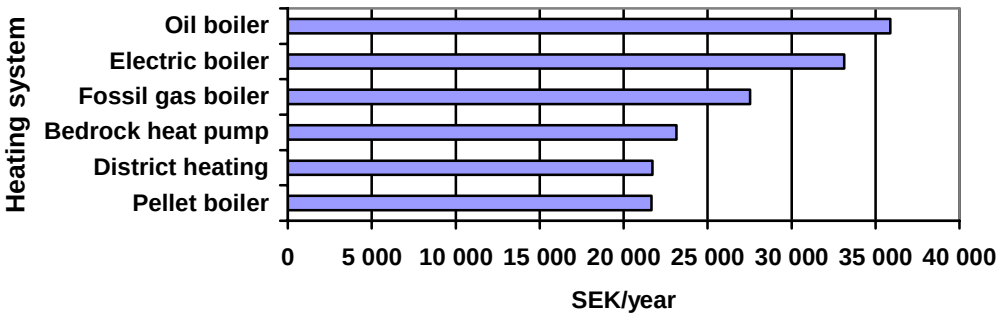


Figure 16. Average heating cost per year depending on heating system in detached houses. The figures includes investment-, operating- and maintenance costs (STEM, 2007). Calculations are based on a house with 5 rooms, a total heated area of 120 m^2 and an energy demand of 30 000 kWh/year.

As seen from Figure 16, the differences in average heating cost between pellets, district heating and bedrock heat pump are almost insignificant. The slight difference between the three systems will therefore be a critical factor in deciding what system will be the least expensive alternative.

District heating shows the greatest price differences of the 6 systems over the country which means that district heating will be the least expensive alternative in communities with low district heating prices. The prices for connection to the district heating network can vary as much as 72 000 SEK depending on geographic region in Sweden (Villaägarnas Riksförbund, 2007). On the other hand, in municipalities with high district heating cost, pellet heating systems and bedrock heat pumps would be a more cost-effective alternative. However, on

average a pellet heating system is the least expensive (21 658 SEK/year) and the most expensive are oil boilers (35 874 SEK/year) followed by electric boilers (33 138 SEK/year). Based on a study performed by the Swedish District Heating Association in 2006, heating with pellets is less expensive compared to district heating in 97 of the 178 municipals in Sweden (STEM, 2007).

Pellets substitutes

The heating market can be further divided into four competing segments; electricity, district heating, pellets and heat pumps.

The district heating market is a natural monopoly since the availability of a hot water distribution grid is necessary. One district heating facility can provide energy to the whole of a local market, a condition that is difficult to meet from other energy providers. To enter the district heating market, acquisitions or heavy investments in infrastructure is necessary. Lock-in effects are common in this market since customers in the small and medium-scale segments normally cannot choose between other forms of heating sources without costly installations. As monopolists, district heating companies (community-owned as well as private) can set the price on the basis of competing substitutes instead on the basis of costs. There is currently an intensive debate in Sweden concerning the monopoly status of district heating plants on the energy market, but at present there are no political means of control on this issue. The heat pump market on the other hand, consists of a large number of actors and the competitive situation has contributed to declining prices in this segment, making it more competitive relative to pellet-based heating systems. (STEM, 2007)

Price development

The energy prices have increased more than prices for other consumer goods during the last 10 year period and the greatest increase has been for oil and fossil gas (113 % and 126 % respectively). In general, space-heating with pellets is the cheapest alternative in the small- and medium scale sector compared to the other alternatives (see Figure 17).

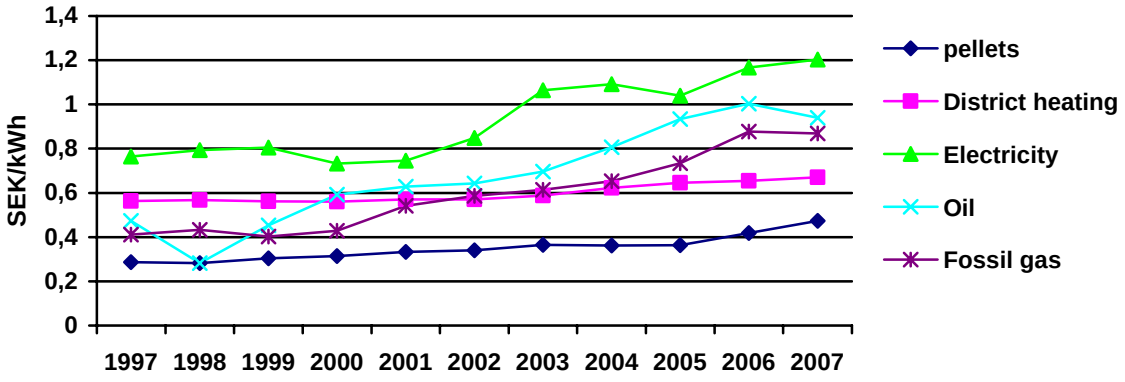


Figure 17. Price development of 5 different energy sources from 1997-2007 (SEK/kWh) incl. taxes and duties (STEM, 2007). The price includes only running energy prices; investment- and maintenance costs for heating systems are not taken into consideration. The prices for 2007 are 6 month prices.

Figure 18 shows the price index development for pellets in Sweden during August 2006 and December 2007 (PiR, 2008). The price index is based on a 3 tonne bulk delivery to homeowners (costs for delivery are included in the price index). Between 2005 and the end of

2006 the price of pellets increased by 30 %. In total the pellet price has increased by 65 % since 1997. (STEM, 2007)

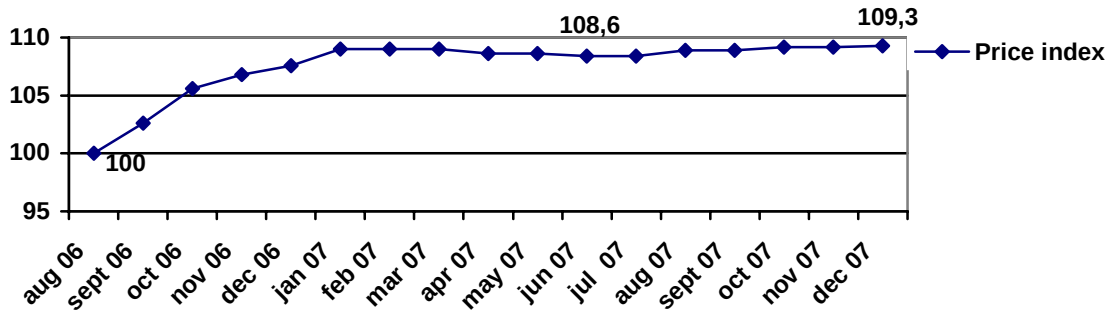


Figure 18. Pellets price index from August 2006 to December 2007. The index is based on a 3 tonne bulk delivery to homeowners and includes costs for delivery (PiR, 2008).

2.4 Small- and medium-scale pellet combustion technology

Sweden has, compared to many other countries, a greater need for space-heating due to its relatively cold climate. Many local entrepreneurs as well as larger companies have developed pellet combustion equipment for many years which makes Sweden one of the leading nations also when it comes to pellet heating technology. The Swedish market for pellet stoves comprises a wide range of high-technology pellet combustion equipment, with over 50 different models to choose from (Bioenergi Villa, 2007a). Some of the new models can be run by remote-control or by sms sent from mobile phones

The pellet heating systems of today are reliable, maintenance-, cost- and energy effective and work perfectly well for small- and medium-scale heating needs. Figure 19 shows the market development for pellet burners in Sweden during the period 1994-2007.

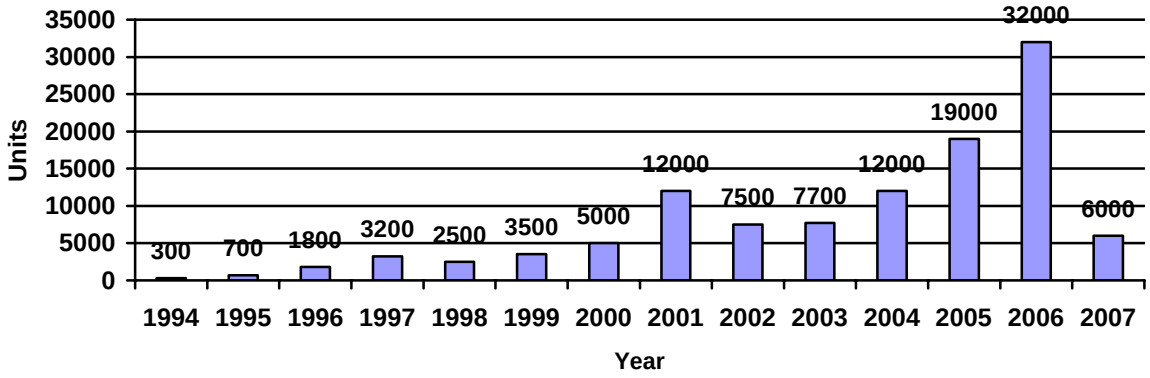


Figure 19. Number of sold pellet burners <25 kW in Sweden 1994-2007 (Davidsson, 2008).

New system solutions with pellet heating and solar heat combined offer even more advantages. By combining the two technologies, solar heating can for Swedish conditions be used during the spring, summer and autumn months while pellet heating gradually takes over during the cold months. The solar heat technology works especially well in combination with pellet systems, and is now technically well developed and ready for the market (Bioenergi Villa, 2007b). Although this combination is extremely good from an environmental point of

view, the relatively high investment cost for the combination still makes the overall economy better for a pellet-only heating system.

A new imported pellet stove, *Effecta Komplett*, generates a very high efficiency of about 90 %, resulting in low overall energy consumption. With a large ash container relative to other stoves, Effecta Komplett only need minor maintenance with ash removal twice a year for a normal house. Moreover, the stove is equipped with automatic soot cleaning. (Börjesson, 2008)

A German pellet conveying invention (inventor: Dr. Helmut Schellinger) has been further developed by Swedish manufacturers. The device, *Mullvaden ("the Mole")*, enables the fuel to be transported longer distances from the pellet store to the combustion unit by vacuum technology (up to 25 meters). The device is placed directly on top of the pellet fuel in the store after it has been filled and the device then "digs" itself downwards, continually conveying pellets to the combustion unit. Mullvaden also manages to completely empty a pellet store with a flat bottom, thereby making the store less space-demanding. Usually, pellet stores need a funnel-shaped bottom to be drained properly by traditional screw technology (Börjesson, 2008).

Thanks to a new patented technology, *Janfire NH*, one of the new pellet burners is among the market leaders when it comes to low maintenance need among pellet burners. This multi fuel burner, produced by Janfire AB, manages to clean itself at regular intervals and removes impurities in the combustion chamber between every burning cycle. This technology ensures an even combustion that minimizes emissions and smoke particles (Ingvarsson, 2008).

Another Swedish-based company, Ariterm AB, has developed a pellet heating system without the need of a traditional chimney. This solution allows any of two compatible pellet stoves (*KMP Mysinge* or *KMP Solberga*) to be connected to a new device called *KMP Drag* (patent no 0600366-9). By lowering the flue gas temperature, KMP Drag allows the exhaust gases to be diverted from the house through a horizontal hole in a side wall instead of going through a vertical chimney. The new unit is attached to an outside house wall and mixes the flue gases from the pellet combustion with outdoor air by means of a fan. The technology is claimed to be cost and space effective by making the installation of a chimney unnecessary (Gullaksen, 2008)

In Sweden, the relative importance of pellets stoves has until now been small compared to pellet boiler systems. Many pellet systems are imported to Sweden, but there are a significant number of Swedish manufacturers of pellet appliances, as presented in Table 3.

Table 3. Swedish manufacturers of pellet burners, stoves, boilers and heat-centrals (Svebio, 2008)

Company name	URL	Burners	Stoves	Boilers	Heat centrals
Ariterm AB	http://www.ariterm.se	x	x	x	
Baxi AB	http://www.baxi.se		x	x	
Ecotec Värmesystem AB	http://www.ecotec.net	x	x	x	x
Ekosystem AB	http://www.ekosystem.se	x		x	
Energilösningar	http://www.energilosningar.nu	x		x	x
HOTAB	http://www.hotab.se			x	

Janfire AB	http://www.janfire.com	x			x
Järnforsens ES AB	http://www.jf-energi.se			x	x
JÖAB		x		x	
KMW Energi i Norrtälje AB	http://www.kmwenergi.se			x	x
Kvänum Energi AB	http://www.kvanumenergi.se				x
Metro Therm AB	http://www.metrotherm.se	x		x	
Nibe AB/Nibe Brasvärme	http://www.nibe.se/ produkter/Pellets		x		
Pannprojekt Lars-Åke Nyberg AB	http://www.pannprojekt.se				x
Petro ETT AB					x
Petrokraft AB	http://www.petrokraft.se	x	x	x	
Swede-Tech AB	http://www.swede-tech.se	x		x	
Fagerströms Maskin AB	http://www.traenergi.se	x	x		
TPS AB	http://www.tps.se	x		x	x
Turbec R ´n D	http://www.turbec.com	x			

There are approximately 120 000 pellet boiler systems in Swedish single houses while there might be about 20 000 pellet stoves (Davidsson, 2008). There is, however, an enormous potential to improve the pellet stove sales as there are close to 300 000 homes that are heated with direct electricity that need to be converted in the coming years and an additional 270 000 homes that are heated with water-distributed electricity (SCB, 2007).

Figure 20 summarizes the number of sold medium-scale combustion units during the period 1996-2007.

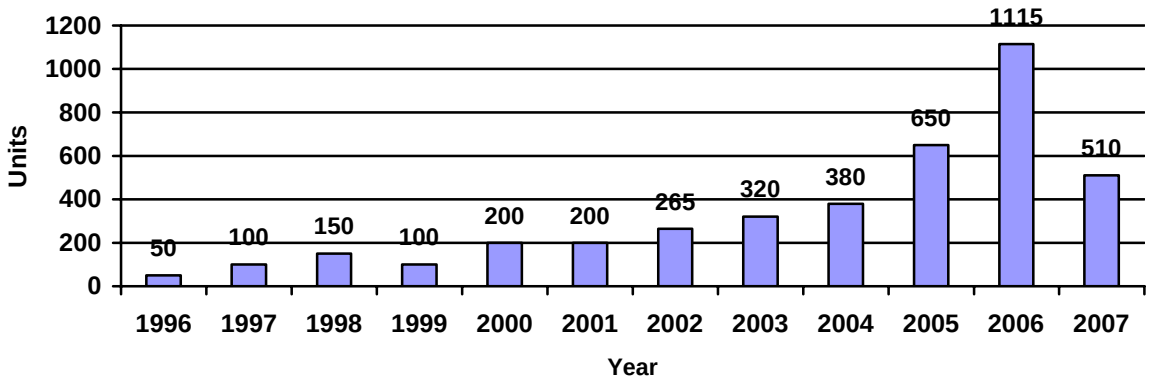


Figure 20. Number of sold pellet burners 26-500 kW in Sweden 1996-2007 (Davidsson, 2008).

Until the end of 2006, the royal castle Drottningholm, built during the 1600s century in Stockholm, was heated with oil and lake heat pumps. However, as the system needed to be replaced and converted to a renewable and cost effective system, H.M. King Carl XVI Gustaf of Sweden decided that the existing system should be replaced by a 900 kW pellet heat central. The new system is flexible, and can be supplied with other bio fuels as well (Ekonominyheterna, 2008).

2.5 Pellet standardization and environmental certifications

National pellet standardization

As mentioned in chapter 2.1, there are currently several national standards in use among pellet producers in Europe. In Sweden the so called Swedish Standard (abbreviated SS) is already well established (see Table 4). The Swedish standard SS 18 71 20 refers to pellets and classifies the fuel into three groups. The first (Group 1) is designed to fit the high quality needs of the small-scale segment for use in one or two family houses. Group 2 and 3 are designed to fit the needs of large-scale industrial users that do not need the highest quality (Sjöberg, 2007).

Table 4. The Swedish Standard SS 18 71 20 – Classification of Fuel Pellets (SS 18 71 20, 2008)

Property	Test Method	Unit	Group 1	Group 2	Group 3
Dimensions: diameter and length in producer's store	By measuring at least 10 randomly selected fuel pellets	mm	To be stated as max 4 times Ø	To be stated as max 5 times Ø	To be stated as max 5 times Ø
Bulk density	SS 18 71 78	kg/m^3	≥ 600	≥ 500	≥ 500
Durability in producer's store	SS 18 71 80	Weight of fines < 3 mm, %	≤ 0.8	≤ 1.5	> 1.5
Net calorific value (as delivered)	SS-ISO 1928	MJ/kg	≥ 16.9	≥ 16.9	≥ 15.1
		kWh/kg	≥ 4.7	≥ 4.7	≥ 4.2
Ash content	SS 18 71 71	% w/w of DM	≤ 0.7	≤ 1.5	> 1.5
Total moisture content (as delivered)	SS 18 71 70	% w/w	≤ 10	≤ 10	≤ 12
Total sulphur content	SS 18 71 77	% w/w of DM	≤ 0.08	≤ 0.08	To be stated.
Content of additives		% w/w of DM	Content and type to be stated.		
Chlorides	SS 18 71 85	% w/w of DM	≤ 0.03	≤ 0.03	To be stated.
Ash dissolution	SS 18 71 65 / ISO 540	^0C	Initial temperature (IT) to be stated.		

International pellet standardization

The White Paper released by the European Commission in 1997 aimed at increasing the share of renewable energy in the EU from 6 % in 1997 to 12 % in 2010 and thereby set a sustainable strategy for the future (European Commission, 2007).

One important way of reaching this goal is to write new standards that facilitate and increase the use of carbon dioxide neutral fuels like pellets. Along with the increasing internationalization of fuel pellet trade the market is getting wider and more difficult to overlook (Bioenergy International, 2007) for pellet producers as well as for pellet consumers. Common standards are therefore needed.

The work to establish common European standards on solid biofuels was started in 1998 when the Swedish Standards Institute (SIS) was questioned by the European Commission (EC) for

definitions on solid biofuels. Together with EC and the Committee for European Normalization (CEN) SIS started a Technical Committee called CEN/TC 335 Solid Biofuels in order to elaborate and be in charge of the standardization work for solid biofuels. The aim was to produce 30 new standards for solid biofuels, of which 27 are published so far (December 2007). (Bioenergy International, 2007)

In Sweden the Technical Committee 335 concerning solid biofuels (such as pellets) is a secretariat operating under SIS (Alakangas *et. al.*, 2006). The work within CEN/TC 335 has, from the start of the standardization process in 2000, been undertaken in five working groups in order to cover all issues under the mandate from the European Commission. The five working groups are working with:

WG 1	Terminology, Definitions and description
WG 2	Fuel Specifications, classes and quality assurance
WG 3	Sampling and sample reduction
WG 4	Physical and Mechanical Test Methods
WG 5	Chemical Test Methods

(Belbo, 2006)

An example of the work programme for working group 2 is given in Table 5 (the complete schedule of the work of CEN/TC 335 Solid Biofuels can be seen in Appendix A).

Table 5. Extract from the work schedule of CEN/TC 335 (SIS, 2007)

Number	Title	PrCEN/TS
335 002	Solid Biofuels - Fuel specifications and classes	14961
335 003	Solid Biofuels - Fuel quality assurance	15234
335 033	Solid Biofuels - Guide for a Quality Assurance System	15569

The overall purpose of the CEN/TC 335 Solid Biofuels committee is to elaborate standards, technical specifications and technical reports on solid biofuels for use throughout Europe. For example, the aim of the technical specification CEN/TS 14961 Solid Biofuels – Fuel specifications and classes (see Table 5) is to provide a clear and common classification principle for solid biofuels and enable efficient trading and understanding between seller and buyer. (Belbo, 2006)

The process of elaborating new standards often is very time consuming. Experts from different European countries are asked for their opinion and the manuscript then has to be circulated for comments. The manuscript is then, after revision, presented to the Technical Committee that give their comments, and is then re-circulated to the working group. Finally, the manuscript is sent out for formal vote to the CEN members. Eventually it is then approved and published by CEN. This process is the formal way for new standards to be approved. (Sjöberg, 2007)

Up to today the 30 new standards concerning solid biofuels has the “simple” form of Technical Standards (TS), but the intention is to upgrade them to European Norms (i e “real” standards). The upgrading process started in autumn 2006 and will continue until 2010. In preparation for the upgrading process it is important to get the standards out on the biofuel market. The users can then leave their comments on the standards to improve them. (Sjöberg, 2007)

The interest for biofuel standardization is not limited to Europe. In other parts of the world; China, Canada, Brazil etc. there is a growing interest for biofuel standardization that raises the standardization work to a global level. Recently ISO approved Sweden to start a Technical Committee and lead the work with the elaboration of global standards, a project hopefully finished within two or three years. Already eleven countries (France, Canada, China, Korea, Malaysia, Spain, England, Sweden, South Africa, Thailand and Germany) are participating in the project from start. Holland and Finland are also interested in the project and hopefully, USA and Brazil can participate in the future as well. (Ny Teknik, 2007)

Certification

Forest Stewardship Council (FSC)

FSC is an international non-profit organization that promotes environmentally appropriate, socially beneficial and economically viable management of the forests in the world (FSC Sweden, 2007). FSC issues forest-related standards worldwide by accredited certification bodies. There are two types of certifications available:

- Forest Management Certificate
  Involves inspections of the forest management by an independent certification body to check that the forest is managed according to the FSC Principles of Responsible Forest management.
- Chain of Custody Certificate
  Provides a guarantee that a certain product is produced according to FSC standards and includes the path taken by raw material throughout the production chain from the forest to the customer.
  (FSC International, 2007)

Over 90 million hectares in more than 70 countries have been certified according to FSC standards, and several thousands products carry the FSC trademark (FSC International, 2007). The total area of forest land in Sweden is about 23 million hectares (Swedish Forest Agency, 2007), out of which over 11 million hectares are certified according to FSC (FSC Sweden, 2007).

Programme for the Endorsement of Forest Certification schemes (PEFC)

PEFC is a global, independent, non-governmental organization that promotes sustainable forest management, market access, economic benefit and rural development through an independent third party certification (PEFC International, 2007). In Sweden, over 6.6 million hectares are certified according to PEFC (PEFC Sweden, 2007).

3 Theoretical framework

3.1 The pellet industry as an emerging industry

Porter (1980) classifies industries into three stages with respect to their development; emerging industries, mature industries and declining industries.

According to Porter, emerging industries are *"… newly formed or re-formed industries that have been created by technological innovations, shifts in relative cost relationships, emergence of new customer needs, or other economic and sociological changes that elevate a new product or service to the level of a potentially viable business opportunity."* (Porter, 1980)

Today pellets are used widely in Sweden and in other parts of the world, but this situation is rather new. The pellet industry has been developing for a long time, before governmental means, public opinion, economic incentives and other aspects made it increase in popularity. Compared to the industries producing the main substitute products to pellets (e g direct electricity, oil, coal etc.), the pellet industry must be regarded as relatively new. For example, the use of pellets in the residential sector was not established until the year 2000 (Vinterbäck, 2000), and it is assumed that the demand for pellets will continue to grow in the near future. Fossil based fuels have been around for about a century, and together with direct electric heating (since the 1070s), the main energy carrier for several decades. From this standpoint, the pellet industry must be viewed as a rather emerging industry in this context that has not reached its full potential.

There are a number of important industry characteristics that define an emerging industry. For example, it is difficult to evaluate which product quality or what production process will dominate the industry in the future, resulting in technology uncertainty. Another example of such characteristics is the presence of first-time buyers; it is of primary importance for the emerging industry to convince new or potentially new customers to buy the new product instead of something else. Moreover, the emerging phase is usually followed by the greatest proportion of newly established firms that the industry will ever have, as more firms rush into the market when the product has proved itself successful. The many new firms in the emerging phase also increased the risk to over-establish capacity in the industry.

In the emerging state of development, there initially is *a rapid increase of raw material prices* that the industry needs for its production. When demand is increasing fast, the industry needs large amounts of raw material to satisfy the need for their product, resulting in a rapid increase in raw material prices. Today the district heating and CHP sector, the board industry and the pulp and paper industry are competing for the same limited resources.

Erratic product quality. With a number of newly established firms, the absence of standardization and technological uncertainty, the product quality is likely to be erratic. The problem may be caused by only a few firms, but may it impact the image and credibility of the entire industry.

3.2 Porter´s Five Forces of Competition Framework

Michael E. Porter (1980) developed an extensive model for analysing the competitive situation for business firms within an industry[IV]. The model is represented by five forces that affect the competitive state and the collective strength of those forces determines the profit potential in the industry (see Figure 21).

The five competing forces are:

- The potential threat of entry of new actors to the industry
- Pressure from substitute products from within the industry or from other industries
- The power of buyers who purchase the product or service
- The power of suppliers of raw material
- The rivalry of competing firms within the industry

According to Porter, competition in an industry continually drives down the rate of return on invested capital towards a competitive floor rate of return. The companies that cannot generate profit above this minimum rate of return will eventually go out of business. The strength of the five competitive forces in an industry determines the intensity of the competition and thereby the profitability for the single firm (Porter, 1980). Besides competition there are many short-term factors that can affect profitability and competition, such as fluctuations in economic condition, material shortages and temporary spurts in demand. Presumably the pellet industry in Sweden may be affected by such short-run factors, like the present favourable economic conditions and the following spurt in demand.

However, the Porter Five Forces model will not assess the short-term situation, even if it may have tactical significance. Instead the model presented here will focus on the underlying industry potentials and factors that, in the long run, affect the business environment where the pellet producers are operating.

[IV] Porter (1980) define an industry as *"… the group of firms producing products that are close substitutes for each other."*

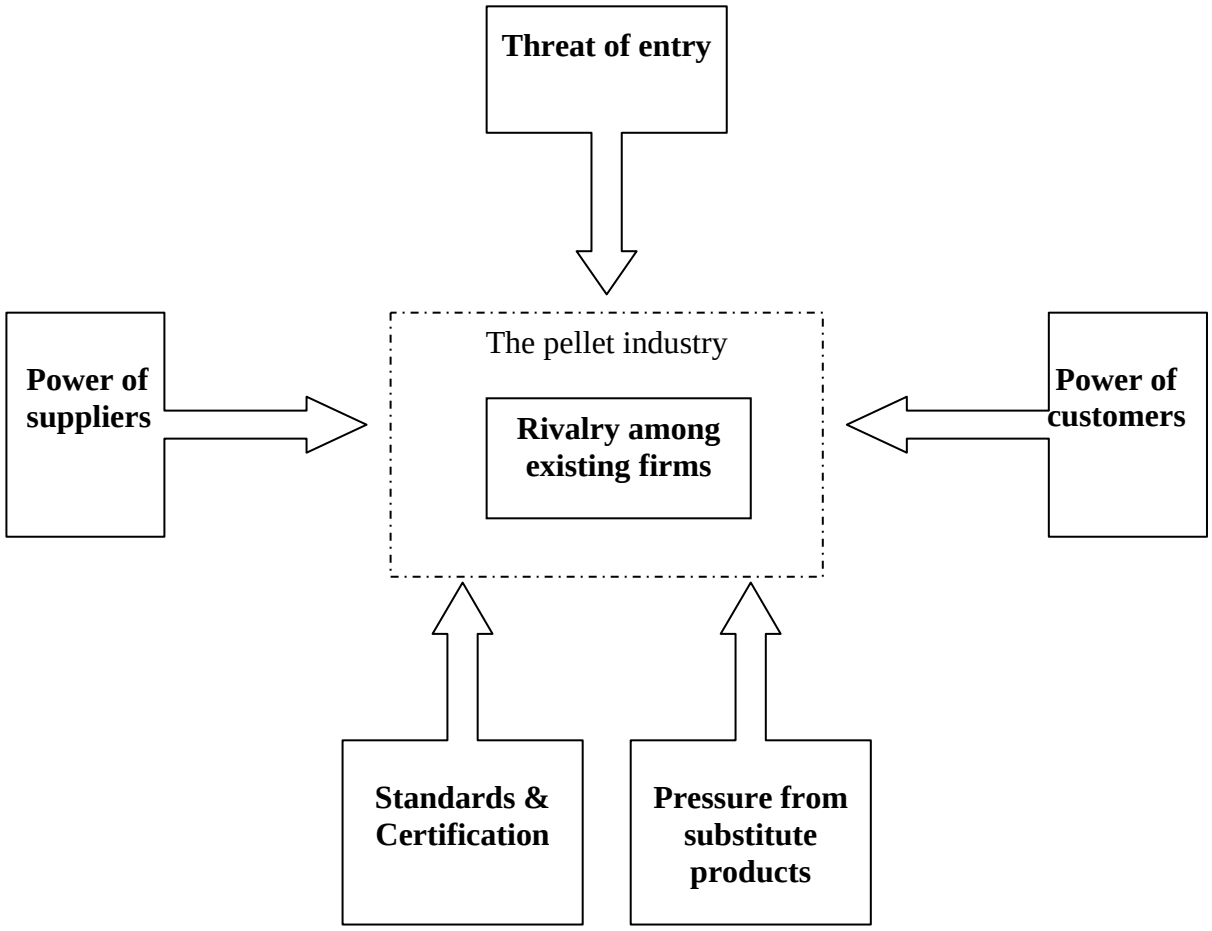


Figure 21. Forces driving industry competition (modified from Porter, 1980). "Standards & Certification" is not included in the original model of Porters Five Forces.

Power of suppliers

An industry that produces goods is dependent on the availability of raw material, which leads to a supplier-producer relationship on the input market. By threatening to raise prices or lowering the quality of purchased products the supplier are in a better bargaining position, and the power of the supplier group increases. With these competitive tools powerful suppliers may, in some cases, severely reduce the profits in industries that cannot cover the increased costs by raising prices.

The supplier group is powerful under the following circumstances:

The supplier group is dominated by a few firms and is more concentrated than the purchasing industry. Suppliers that are selling their goods to many customers can more easily influence prices, quality and terms.

The suppliers´ products are an important input for the producer´ business. The product is important as an input to the producers´ production process, and ultimately determines the success of the producers´ business. In this sense the pellet industry is very dependent on the forest industry and their production of raw material (e g industrial by-products). (Porter, 1980)

Power of customers

There are two types of markets in which firms within an industry operate: the market for inputs and the market for outputs. At the input market the pellet producers buy personnel resources, raw material, components and services. At the output market the firms sell their products to customers such as retailers or district heating facilities. (Grant, 2005)

In the output market customers are competing with the industry in such a way that they ultimately, by bargaining and by playing producers against each other, force down prices and hence the industry profitability. There are several factors that determine where the power lies between the producers and customers. The power of the customer group is high if the following aspects are present:

The customers are concentrated, or they purchase large volumes with respect to producer sales. If a significant share of the producers´ output is purchased by one or a few large customers, this increases the importance of the customer for the producers´ results.

The products that the customers purchase from the industry are standardized or undifferentiated. Buyers that are sure that they always can find alternative producers are more eager to play producers against each other. Pellets are a somewhat uniform product with only minor quality differences between different manufacturers. The new standardization work may also contribute to even greater uniformity between different brands and manufacturers of pellets. If there are several producers to buy from most customers can be expected to play these firms against each other. (Porter, 1980)

Threat of entry

New entrants in the industry are often experienced as a threat to firms already in the business. Entrants bring new capacity, the risk of gaining market shares and competing with existing firms about limited resources. As a result, competition may increase causing prices to go down and costs to escalate and in the end reducing profitability in the industry. The threat of entry depends on the barriers of entry, key aspects that affect the firms trying to get into the industry. Three important barriers of entry will be dealt with in more detail; economies of scale, product differentiation and capital requirements.

Economies of scale emerge from the decline in unit cost of a product as the produced volume per period increases. The phenomena deters entry to the industry by forcing the entrant to risk capital losses in order to start the business at a large scale, or to start at a small scale and risk cost disadvantages relative to larger firms.

Product differentiation refers to the fact that established firms usually have advantages from customer loyalties that stem from advertising, product differentiation or other activities in the past. Firms that have been in the industry for a long period may also have an advantage to new entrants simply by being first in the business.

Capital requirements are usually a prerequisite for starting up a business; whether it is the need to invest resources in production facilities, inventories or to cover start-up losses. This aspect limits the pool of potential entrants and acts as a barrier to entry. Cost disadvantages independent of scale are factors that deter new entrants independent of economies of scale advantages attained by established firms. One such factor is favourable access to raw material; firms already in the business may have locked up sources of raw material so that the overall resource pool available for the entrants is limited. (Porter, 1980)

Pressure from substitute products

A substitute product is a product that can perform the same function as the product of the industry, and all the firms in an industry are competing with firms producing substitutes. Products that can act as substitutes to pellets are, for example, oil and heat pump technology. (Porter, 1980)

The price that customers are willing to pay for a specific product depends on the availability of substitute products. For example, if close substitutes for a particular product are absent the customers are comparatively insensitive to price. If close substitutes are present, customers tend to switch to substitutes in response to price increases for the product. (Grant, 2005)

Substitute products limit the potential profits in the industry by setting a ceiling on the prices that the firms can charge. If the firms in the industry are setting prices above this ceiling, the risk is high that customers will switch to the cheaper substitute product. In other words, if the pressure from substitute product is high, the profit potential for the industry is low. Substitutes that desire most attention are those that show trends to become cheaper or have the potential to be associated with higher performance by end-users. (Porter, 1980)

Today the traditional energy sources such as oil and electricity are becoming more expensive, why more customers tend to switch to substitutes like pellets that provide an inexpensive and reliable alternative.

Rivalry among existing firms

Every firm seek strategies to maintain a competitive advantage over their rivals and a more favourable position in the industry. Some competitive moves, such as price competition, may result in lower industry profitability. On the other hand, measures such as advertising battles between firms might increase sales and revenues in favour of all firms in the business. (Porter, 1980)

Competition among existing firms depends on the number of firms and the product offered. Customers are more willing to switch to substitutes if the products among rival firms are very similar, which encourage firms to cut prices to increase sales. The price tends to be the primary competitive tool in businesses where the product is a commodity and the result if often price battles and low profits. In industries with highly differentiated products, price competition tends to be weak. (Grant, 2005)

Standardization and certification

Standards as well as certification systems play an essential role in the modern world to translate and co-ordinate procedures and behaviour inside organizations and between actors on the market. This sixth force is not originally included in Porters model but since it is of major importance to the pellet industry it is added to the model (see Figure 21).

On the demand-side of standards are the adopters and the potential adopters that accept and implement standards. For example, producers of pellets can choose to produce their products in accordance with the Swedish Standard or, recently, according to European standards. Private sector organizations, international non-governmental organizations and a number of less organized actors that prepare and offer standards represent the supply side of standards (e g SIS, CEN, ISO etc.). (Brunsson, 2000)

A standard is a set of rules and/or advice about what those who adopt them should do. Standards are voluntary and based on the hope that some organizations will adopt them, or at least consider adopting them. Standardisers therefore have to convince other people and organizations that it is in their interest to accept and implement the standards offered. Today the words ´standardized´ and ´uniform´ are often used as synonyms; standardization normally creates some uniformity between adopters when the standards are implemented. The uniformity may be the result of product requirements in the standard, such as the specifications of ash content in the Swedish Standard for pellets. (Brunsson, 2000)

International standard organizations try to reduce the number of competing standards with international standards designed to replace those at the national level. The new European standardization work on solid biofuels has a great potential to streamline terminology, quality and other aspects that is vital for a functioning European pellet market.

3.3 PEST analysis

PEST is an acronym for Political, Economic, Social and Technological factors and used as a strategic tool for analyzing the environment in which the firm operate. The political factors include legislation, home market and environmental related issues. Examples of economic factors are economy trends and taxation, both national and international. Social factors include demography, consumer attitudes and company image. The development of competing technologies, technology dependency and technology innovation potential are included among the technological factors. Together, the PEST factors reveal the overall market attractiveness and business potential for the firms within a particular industry. (Kotler & Keller, 2005)

4 Methodology

4.1 Survey design

Since the main objective of this thesis was to monitor and evaluate the current situation for the Swedish pellet producers from a wide range of issues, a quantitative approach were used. With a quantitative method the collected information can be transformed into numbers that make it possible to conduct statistical analyses on the material. By using a traditional questionnaire survey, the desired information can be collected in a relatively standardized and systematic way from the target population (Edwards *et. al.*, 1996). Another important advantage with using a questionnaire is that the respondents will not be affected by the interviewer as would be the case with interviews. (Ejlertsson, 2005)

The questionnaire consists of 42 questions divided into 4 parts; Market situation, Raw material supply, Production & customer and Standardization & certification (see Appendix B). The reason for the division into these four sections were to provide some structure to the questions and to present the questions in a logic sequence. The questions included in the questionnaire were prepared from the three research questions and the theoretical framework, based on the chapter *"How to Conduct an Industry Analysis"* by Porter (1980).

In general, survey questions fall into two categories; close ended and open ended (Edwards, 1996). Close-ended questions are usually experienced as easy and fast to answer, and are relatively easy to code and process when analyzing the material. However, some issues are difficult to categorize in close-ended questions, and therefore also open-ended questions were used in the questionnaire to allow the respondents to use their own frame of reference without the influence from prespecified alternatives.

The questionnaire has been commented and reviewed several times by scientists within the bioenergy field at the department for Forest Products at the Swedish University of Agricultural Sciences (SLU), and developed in cooperation with the Swedish Bioenergy Association (Svebio). This procedure ensured that the questionnaire was well prepared and well suited for the study before the pilot survey was sent out.

4.2 The population

The aim with the questionnaire survey was to reach in principle all commercial producers of wood pellets in Sweden and thereby get an overview of the whole population. The majority of respondents were identified using already available producer statistics from Svebio, but as the number of producers was growing continuously the statistics was probably not fully complete. In order to find more producers or potential producers, three major manufacturers of pellet production equipment were contacted by email and telephone. This procedure resulted in 7 more potential producers that had recently purchased pellet production equipment from the contacted manufacturers and had started their production. The survey was then conducted as a total survey of the whole population of 66 individual pellet producing firms (for population and survey data, see Table 6).

Pilot survey

A pilot study is a preparatory survey conducted in much the same way as the major survey, but in smaller scale with only a few respondents from the target population. The purpose with the pilot survey is to test and evaluate the questions and eventually replace or change them prior to the major survey. (Edwards, 1996)

The pilot questionnaire was sent out to three pellet producers in paper form. When the questionnaires were returned from the respondents, the survey was followed up by telephone contact and the respondents were asked about how they perceived the questionnaire and if any question could be experienced as ambiguous. The telephone contacts provided valuable comments on the questionnaire, and after evaluating each question and updating the questionnaire based on the pilot survey it was ready for the major survey.

The time of response was set to two weeks from the date the questionnaires were sent out. 20 questionnaires were returned within this period. After two weeks a short reminder were sent out in paper form to the respondents that had not returned the questionnaire so far. This resulted in 4 more returned questionnaires.

To get a higher response rate the producers that had not returned the questionnaire within one week after the reminder (i e three weeks after the major survey were sent out) were contacted by telephone. The telephone contacts resulted in 12 more returned questionnaires (see Table 6).

Table 6. Survey data concerning the total population and the number and percentage of returned questionnaires

Initial number of producing firms and facilities	86	Including both individual firms and facilities within concerns.
Facilities clustered or removed	- 20	Concerns with several production plants counted as a single firm, firms without pellet production removed.
Total population	**66**	
Number of questionnaires sent out	86	Capacity covered
Number of questionnaires returned before reminder	20	30 %
Number of questionnaires returned after reminder	4	6 %
Number of questionnaires returned after telephone contact	12	17 %
Total number of returned questionnaires	**36**	**55 %**

4.3 Response frequency

A deadline was set to november 21st 2007. One questionnaire from a small-scale producer was returned after the deadline and was not included in the data. Up to november 21st, 36 producers had answered and returned the questionnaire accounting for about 55 % of the total population, or roughly 86 % of the total production capacity in Sweden[V]. The response frequencies for each question in the questionnaire are presented in Appendix C.

4.4 Non-response analysis

Several non-respondents, primarily among the new small-scale producers, claimed that they were too busy to participate in the survey. Others answered that they never answered any questionnaires; they did not feel that they got something in return. 15 producers could not be reached or did not answer the questionnaire despite of repeated attempts.

4.5 Data analysis and presentation

When the questionnaires were returned by the respondents, the raw data was coded into numerical scores suitable for statistical analysis. To make sure that the questionnaires did not include any obvious errors they were first of all gone through and edited to ensure completeness, reliability and consistency of the data. The data were then put into an Excel[VI] spreadsheet. The open-ended questions were put into a few general categories that could be assigned numerical values. All data analyzes were done using Microsoft Excel.

Some of the 36 respondents include major companies with several production facilities in Sweden and abroad while others include small newly-established firms. The data for the largest companies has been obtained from the company head-offices and thereby includes more than one production facility.

[V] The estimation is based on the production capacity figures for 2006 (Bioenergi no. 1, 2007) which equals 2 005 000 tonnes. This information is compared to the production capacity figures from this study (1 726 770/ 2 005 000 = 86 %).
[VI] Microsoft Office Excel 2007, Microsoft Corporation.

5 Results

This chapter is divided into 5 sections; Market situation, Raw material situation, Production & Establishments, Standardization & Certification and Future Prospects.

Throughout the chapter the results have been compared and analyzed on the basis of the maximum production capacity of the producers. The production capacity is a characteristic that must be considered since the total capacity of the industry is heavily concentrated to a few large producers. The respondents were divided into three capacity categories; small-, medium- and large-scale producers (see Table 7).

The small-scale category represents respondents with an annual maximum pellet production capacity of less than 5 000 tonnes. In the medium-scale category are producers with a capacity that ranges between 5 000 and 40 000 tonnes, and the large-scale category includes respondents with a capacity over 40 000 tonnes per year. Note that the categories represent maximum production capacity and not actual production.

Table 7. Producer capacity scale. The respondents included in the survey are divided into three categories based on their stated maximum annual production capacity. "Number of respondents" represents the number of respondents in each category

Category	Capacity range (tonnes/year)	Number of respondents
Small	< 5 000	14
Medium	5 000 - 40 000	12
Large	> 40 000	10
Sum		36

5.1 Market situation

Coordination with other activities

According to survey results, it is obvious that primarily the small-scale production is run in association with other activities, such as saw mills or planeries. Among the small-scale producers 11 out of 14 companies have other activities beside pellet production whereas in the large-scale segment only 4 out of 10 are doing other activities than pellet production.

Market segments

The respondents were asked to state the percentage of total pellet sales into the three segments of the consumer market[VII]. In Figure 22 the total pellet production of all respondents was distributed into each consumer segment based on the planned production figures for 2007 (1 391 420 tonnes in total).

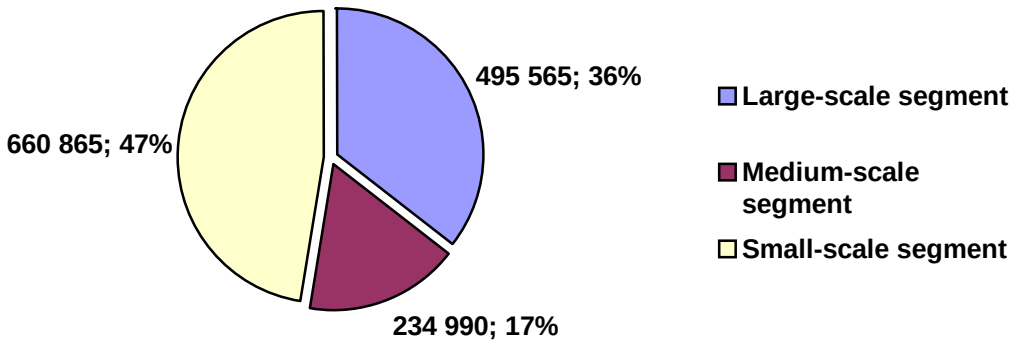


Figure 22. Total pellet sales of all respondents distributed per consumer segment. The figure was based on the planned production figures for 2007. As seen in the figure, most pellets produced in 2007 go to the small-scale segment (that is 47 % of the total pellet production, accounting for 660 865 tonnes).

Apart from the findings presented in Figure 22, the results also show that producers with capacities of less than 5 000 tonnes (small-scale producers) with few exceptions turn solely to the small-scale market. Also the medium-scale producers primarily sell their pellets only to the small-scale consumers. Large-scale producers show a much more widely distributed market segmentation where not one single producer turns solely to one or two consumer segments.

Increase in demand since 2000

Not surprisingly the absolute majority of the respondents (over 87 %) stated that the small-scale consumer segment contributed to the greatest increase in demand the last 7 years. The reasons for this development can, according to the answers, be summarized into two categories; the price development of substitutes (primarily oil and electricity) and the current public and political opinion concerning environmental issues.

[VII] The consumer market for pellets is divided into three segments depending on installed power according to the Swedish Association of Pellet Producers (PiR).

Competition for raw material

A central question in this study is which competitive situation the producers are facing and what actor is experienced as the main competitor.

The answers to the question “Which of the following actors or markets is your main competitor for raw material for pellet production?” are summarized in Figure 23.

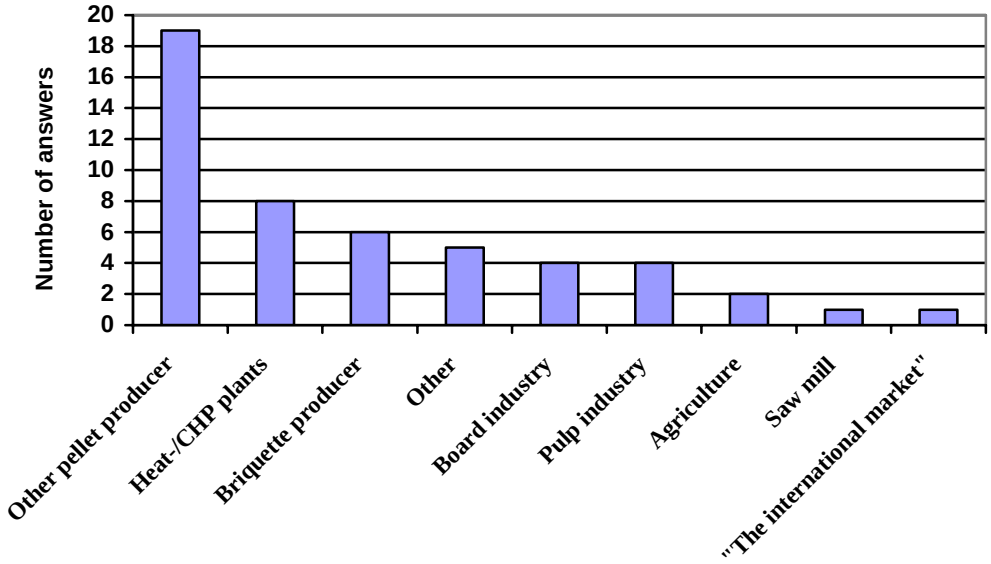


Figure 23. Main competitor for raw material according to survey results. Some respondents chose more than one competitor, why the total number of answers exceeds the number of respondents.

A number of respondents that answered the question on raw material competitors chose more than one alternative. However, it seems clear from Figure 23 that other pellet producers are identified as the main competitor for raw material. Heat-/CHP-plants are identified as the second hardest competitor for raw material. Among the producers that stated “other pellet producers” as their main competitor, the majority indicated the need for similar raw material as the foremost reason. Two respondents stated “too many actors”, referring to a large number of pellet producers within a small raw material uptake area.

Among the respondents indicating heat-/CHP-plants as their main raw material competitor, one medium-scale and one large-scale respondent explained this with the higher payment ability of heat-/CHP-plants compared to pellet production plants. According to the large-scale respondent the reason behind the differences in payment ability for raw material between pellet producers and heat-/CHP-plants is the electricity certificate system, which increases the attractiveness of biofuels for electricity generation.

International expansion plans

As already noted earlier in this report, the pellet industry is expanding in Europe. This development will probably contribute to increased international trade and eventually plans among the Swedish pellet producers to reach new markets abroad by expanding internationally. The results for such expansion strategies are summarized in Figure 24.

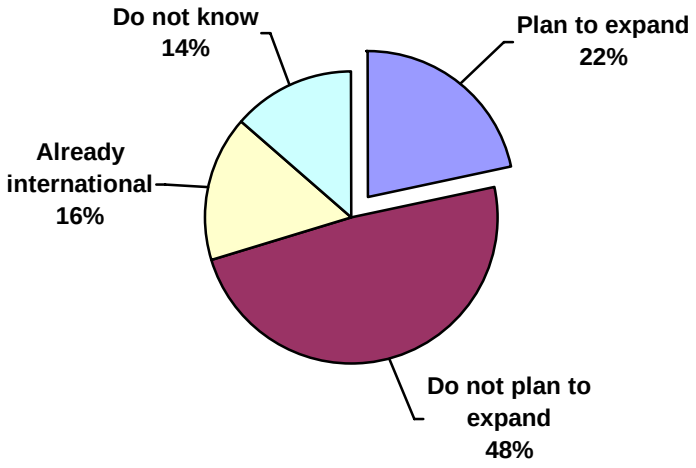


Figure 24. International expansion plans stated by the respondents. The figure was based on the question "Have you got plans to expand your production- or sales activities with pellets internationally?".

The firms that plan to expand internationally also include firms that are already international. Put in another way, the 22 % that plan to expand includes both firms that are currently not international but plan to become and firms that plan to expand their already existing international activities.

5.2 Raw material situation

Raw material used

The largest producers in Sweden use fresh saw dust as input for pellet production; this is the reason why the absolute majority of the total amount of pellets produced is made from fresh saw dust. However, when the number of firms is taken into consideration, the raw material used for pellet production is predominantly planer shavings followed by fresh and dry saw dust. Figure 25 shows the percentage of firms using each raw material.

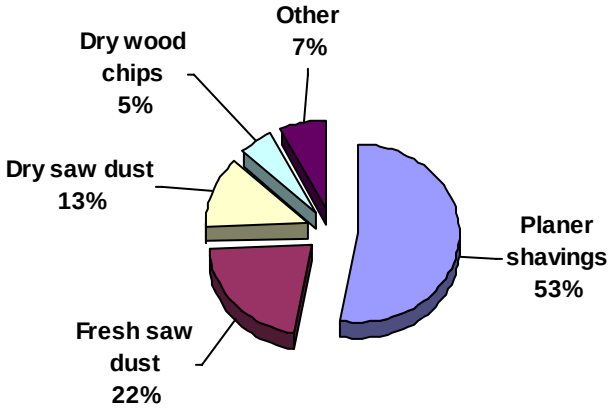


Figure 25. Percentage of respondents (e g number of firms) with respect to used raw material for pellet production. "Other" refers to 4 respondents using bark, grain residues, recycled wood and energy wood refuse respectively.

Figure 23 is based solely on the number of firms using each raw material, it does not take into account the amount used. Among the small-scale producers, no one uses fresh raw material.

Raw material origin

Most producers use either by-products from their own production or purchased raw material, only six producers use both. The results also indicate that 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. The results on raw material origin are summarized in Table 8.

Table 8. Raw material origin stated by the respondents. For example, 17 % of the total production planned in 2007 stems from by-products from other activities within the companies, accounting for 230 500 tonnes in total

	Tonnes	**Percentage**
Raw material from own production 2007	230 500	17
Purchased raw material 2007	1 160 920	83
Total (planned) production 2007	1 391 420	100

As is clear from Table 8, 83 % of the total production of pellets originates from purchased raw material corresponding to 1 160 920 tonnes of the planned production in 2007. 230 500 tonnes of pellets is made from own raw material.

Now, a closer look will be given to the firms that purchase their raw material to any extent. 23 respondents stated that they buy raw material for pellet production out of which 17, or 74 %, purchase all of their raw material (the remaining 6 respondents both uses own raw material and purchased raw material). Respondents that purchase raw material to any extent are presented in Table 9 depending on from where the raw material is bought.

Table 9. Firms that purchase raw material depending on origin of purchase

The raw material is bought from…	**No. of respondents**	**Share**
Other units within the same company/concern (internal)	1	4 %
Other companies without connection to own business (external)	18	78 %
Both internal and external	4	18 %

Alternative raw material

The growing pellet industry needs large amounts of raw material, primarily saw dust and planer shavings. When competition increases many firms try alternatives to the traditional input products for pellet production to avoid raw material shortage or the increasing competition. According to survey results 13 producers, or 36 % of the respondents, stated that they had investigated the possibility of using other types of raw material as a response to increasing raw material competition. The alternatives included peat, tree tops and branches, energy crops, salix, roundwood, rejected adjusted wood, wood chips, rape, pulp wood and straw.

Among the alternatives evaluated by the respondents that are worth a closer look are the 3 producers that stated roundwood and the 2 producers that answered pulp wood. The processing of roundwood into raw material suitable for pellet production requires bark drums and comminution equipment; two prerequisites that usually cannot be met by small-scale

producers. Moreover, large amounts of energy have to be put into the production chain when converting roundwood into pellets.

Payment ability for raw material

The majority of respondents answered that they would have difficulties in coping with increased raw material prices. Out of the 31 respondents that answered the question *"Do you consider that you have a good purchase marginal to cope with increased prices of raw material for pellet production"* 25 stated "No" (81 %). There seem to be no obvious differences between producer scale among the answers.

Raw material imports

Only 3 producers stated that they import raw material for pellets production, all imports came from Finland.

Raw material shortage

11 of the respondents stated that they had difficulties in getting raw material for their production of pellets. The arguments for these difficulties varied. 4 producers, of which two are some of the largest producers in Sweden, gave high raw material prices and intense competition as the main explanation behind the raw material situation.

5.3 Production and etablishment

Maximum production capacity

The actual production did not reach the maximum production capacity of most producers. According to the results only 5 respondents stated that they plan to produce 100 % of their maximum production capacity in 2007, the actual production is otherwise considerably lower. The maximum production capacity of all respondents taken together equals 1 726 770 tonnes (see Table 10) and the planned production in 2007 equals 1 391 420 tonnes (see Table 11). In other words, the industry is currently producing at about 80 % of its maximum production capacity. However, the capacity in use varies somewhat among producer scale. As shown in Table 11, large-scale producers produce at about 86 % of their capacity, while the medium-scale respondents use only about half of their capacity. One explanation behind the low capacity use among the medium-scale producers may be rapid capacity expansions, resulting in a relatively high capacity compared to actual production.

The majority of pellet producers in Sweden are constituted by a large number of small firms producing from a few tonnes up to a few thousand tonnes of pellets per year. The largest capacities are found in the large-scale producer segment, where a few dominant players represent the largest capacities and production in the industry.

Table 10. The total production capacities distributed according to producer scale and mean individual capacities in each catgory. For example, small-scale producers have a total capacity of 28 770 tonnes (2 % of overall capacity) and a mean capacity of 2 055 tonnes

Producer scale	Total capacity per category	Share	Mean of individual capacities
Large > 40 000 t	1 470 000	85 %	147 000
Medium 5 000 – 40 000 t	228 000	13 %	19 000
Small < 5 000 t	28 770	2 %	2 055
Total sum	1 726 770	100 %	

Table 11. The actual planned production in 2007 distributed according to producer scale and the capacity in use in each category. For example, medium-scale producers plan to produce 121 800 tonnes in total (9 % of overall production) and produces at about 53 % of the medium-scale capacity

Producer scale	Actual planned production 2007	Share	Capacity in use
Large > 40 000 t	1 257 000	90 %	86 %
Medium 5 000 – 40 000 t	121 800	9 %	53 %
Small < 5 000 t	12 620	1 %	67 %
Total sum	1 391 420	100 %	

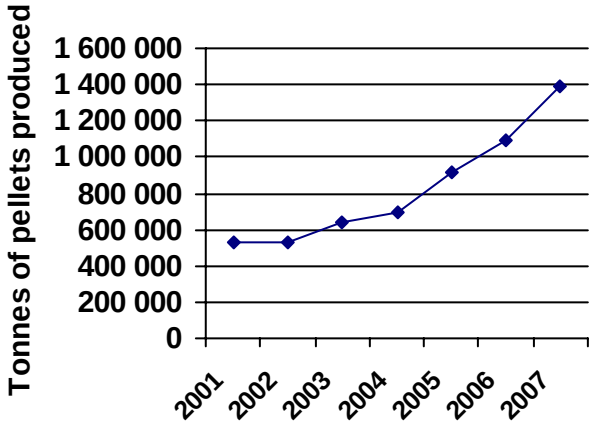
As a comparison to Table 10 and 11 it can be mentioned that the three largest producers alone included in this survey represent about 55 % of the total capacity of all respondents.

Annual actual production 2000 – 2007

With a few exceptions all producers are increasing their production each year. Table 12 summarizes the total production each year, the average production per year, and producer. The many new producers that started producing pellets within this period contribute to the decreasing average production from 2001 to 2004, especially the great number of new producers in 2003.

Table 12. Total pellet production each year during the period 2001 – 2007. For each year the number of respondents, total production and average production is shown. The decrease in average production from 2001 to 2004 can be explained by the large numbers of new small-scale producers the last 7 years

Year	No. of respondents	Total annual production	Average production per company
2001	10	527 000	52 700
2002	11	531 900	48 355
2003	16	641 475	40 092
2004	20	696 770	34 839
2005	25	915 790	36 632
2006	28	1 092 796	39 028
2007 (planned)	33	1 391 453	42 165



To get an overview of the increase in production during the period 2001 – 2007, the total annual production is presented in Figure 26 to the left. As shown in the figure there has been a more or less linear increase in production from 2004 to 2007.

Figure 26. Total annual production during the period 2001 -2007.

To get an overview of all respondents with respect to the annual production all production data is presented in Figure 27.

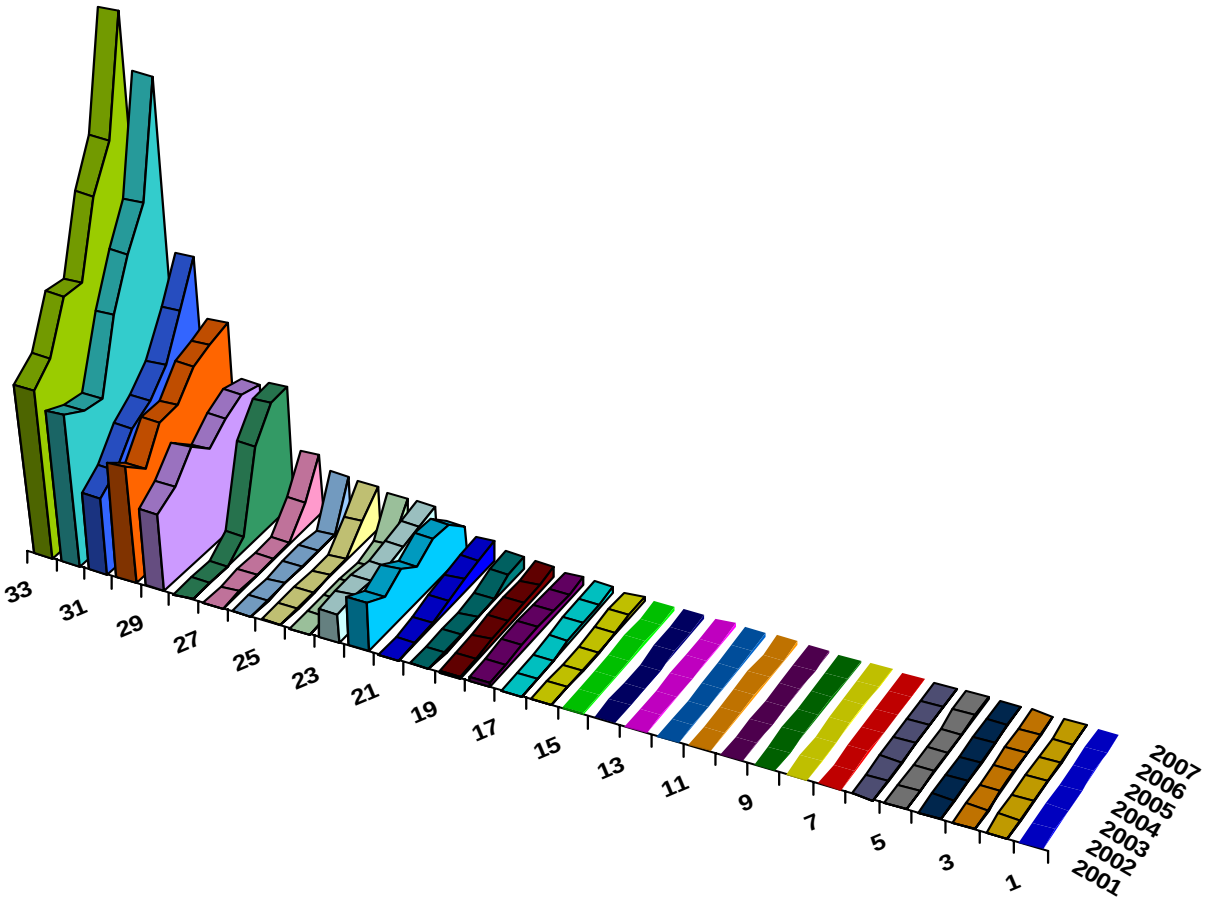


Figure 27. Annual production of 33 respondents (3 non-reply respondents are excluded). Each figure on the X-axis represent one producer and the figures to the right represents a time-line from 2001 to 2007 so that the production development can be seen for every respondent. No production figures are presented to avoid identification; the figure shows the relationship between producers with respect to annual production.

All references to producer number in the rest of this section refer to Figure 27.
Producer 1 to 17 has an annual production of less than 5 000 tonnes. Most of these are newly established firms with low annual production. Except from 3 producers (number 1, 22 and 29) that will in fact decrease production in 2007, all respondents plan to produce more or equal in 2007 compared to 2006.

As seen in this figure, the six largest producers represented by number 28 - 33 have a production that is several times higher than the production of most other producers. Some of these leading producers have several pellet production facilities in Sweden.

Planned capacity expansions

In general, the producers plan to produce more in 2007 than the year before. Some producers are currently producing according to their capacity, while the majority produces less than maximum capacity. Nevertheless and regardless of production capacity, slightly less than half of the respondents (about 47 %) stated that they plan to expand their maximum pellet production capacity. All of the respondents answered the question *"Have you got plans to expand the production capacity for pellets?"*. If capacity expansions were planned, the respondents were asked to state the additional annual capacity planned. The results are summarized in Table 13.

Table 13. Planned capacity expansions according to survey results. 47 % of the respondents plan to expand their pellet production capacity with 708 000 tonnes in total

Plan to expand capacity	Number of respondents	Share of respondents	Planned additional annual capacity (total of all respondents)
Yes	17	47 %	708 000 tonnes
No	14	39 %	
Do not know	5	14 %	

New entrants

Out of the 36 respondents, 28 firms have started the production of fuel pellets within the last 7 years (see Figure 28). Most of these new firms commerce their production from a low starting point and their annual production capacity is just about 26 % of the total capacity of 1 726 770 tonnes per year of all respondents.

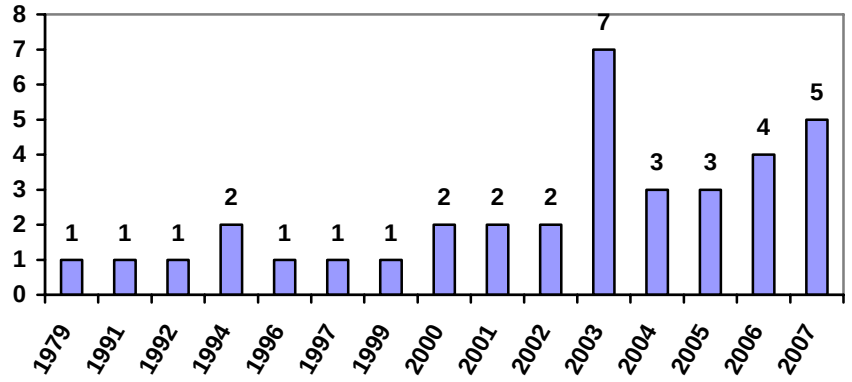


Figure 28. Number of firms that started their pellet production per year according to survey results. The majority of firms have started their production in the last 7 years.

Reason for production start

Respondents that had started their production within the last 7 years were asked about the reasons behind production start. The results taken together show that the expectations for an increased demand and profitability were the main reasons. As noted earlier, the greatest increase in demand the last 7 years has been in the small-scale consumer segments and producers with production start since 2000 also turn more or less solely to the small-scale segment.

Only one respondent stated that the main reason for starting pellet production was to reach a new market.

Establishment obstacles

The establishment of new production facilities or machinery installations for pellet production can be associated with start-up difficulties. Heavy investments in new plants at corporate level in the leading pellet producing firms differ a lot from the situation of the small-scale pellet entrants.

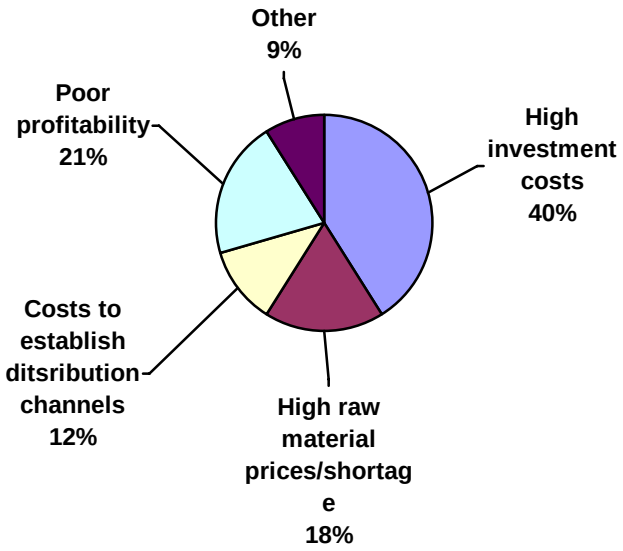


Figure 29. Establishment obstacles on the pellet market for new producers that started their pellet production within the last 7 years. The majority mentioned high investment costs for the production facility as the major obstacle to get into the market.

According to Figure 29 the majority of new producers experience high investment costs with the production facility as the foremost obstacle to enter the pellet market. High raw material prices and difficulties in getting raw material for pellet production was the main obstacle for 18 % of the producers.

Production problems

As with most industrial production processes there are some problems associated with the production of pellets (for example start-up problems, bad raw material quality etc.) The

respondents were asked to state the main production problems associated with their pellet production. The results are presented in Figure 30.

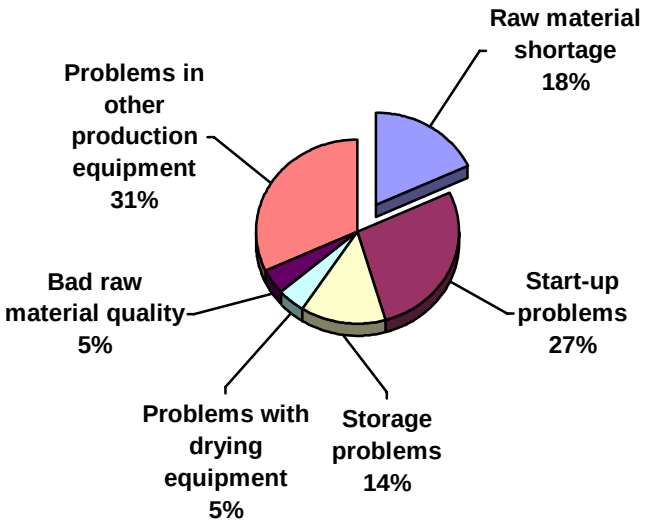


Figure 30. Main problems associated with pellet production according to survey results.

As seen from Figure 30, the slice representing raw material shortage is lifted out to point out that it is one of the major problems today, accounting for almost one-fifth of the responses. Start-up problems (e g problems in the production chain, supply of raw material etc.) are perceived as the main problem primarily among newly established firms. Also a number of producers contacted by telephone during the questionnaire survey indicated that they needed to put much time and effort in order to get the production process in the start-up phase to function properly.

Storage

Pellets is a fuel that is produced all year around but which is primarily used during the cold seasons for heating purposes. In order to keep an even production and to satisfy increase in demand during the cold season much pellets need to be stored during the year.

The total storage capacity of all respondents is 490 645 tonnes which corresponds to an average storage capacity of 14 018 tonnes per producer (see Table 14). Moreover, the industry has a storage capacity of about 28 % of the production capacity. In terms of actual planned production in 2007 the storage capacity is 35 % of total production.

Table 14. Storage capacity and comparisons with actual and maximum production

Total storage capacity of all respondents	**490 645 tonnes**
Average storage capacity per respondent	14 018 tonnes
Storage capacity of all respondents in relation to production capacity	28 %
Storage capacity of all respondents in relation to actual planned production 2007	35 %

Since more pellets is usually produced during the warm seasons the amount of pellets in stock varies from month to month. Table 15 presents the amount of pellets in stock on a half year basis.

Table 15. Pellets in stock december 31th 2006 and June 30th 2007

Date	In stock (tonnes)	Average per respondent (tonnes)
December 31th 2006	99 070	3 096
June 30th 2007	136 285	4 259
Difference	37 215	1 163

Pellet exports

Sixteen firms, mainly large-scale producers, export pellets to other countries, accounting for 44 % of all respondents. Every producer with a capacity over 50 000 tonnes exports pellets to other countries compared to only three small-scale exporters; one to Norway and two to Denmark. The number of countries exported to by a single producer varies from 1 to 8 countries.

The countries exported to by the Swedish pellet industry are summarized in Table 16.

Table 16. Countries exported to by the Swedish pellet industry and the number of firms exporting to each country

Country/region	Number of firms
Denmark	8
Norway	6
Germany	3
Finland	2
England	2
The Netherlands	1
Greece	1
Italy	1
Scotland	1
Belgium	1
Holland	1

Connection to railroad and/or sea transport

The availability of railroad or sea transport is a strategically important aspect when pellets is distributed to customers in Sweden as well as in trade activities with other countries.

7 producers have connection to railroad (19 % of the respondents) and 8 producers to sea transport (22 % of the respondents). Not surprisingly, most multiple-country exporters have access to both railroad and sea transport.

5.4 Standards and certification

Standardization

In order to measure the implementation of standards among the Swedish fuel pellet producers the respondents were asked whether they produced pellets according to any standard. The respondents could choose between Swedish Standard (SS 18 71 20) or CEN 14961 (the new European biofuel standard) but could also state "other" or "No standard".

The results show that the majority of respondents produce their pellets according to the Swedish Standard. Only two respondents, one medium-scale and one large-scale producer, used the new European standard CEN 14961.

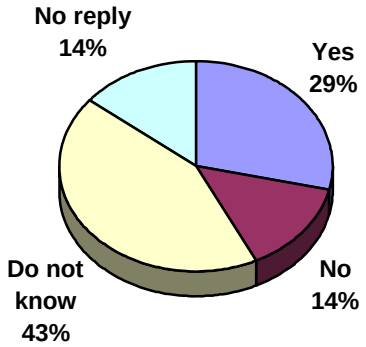
Among the small- and medium scale producers 12 respondents use no standard at all. Except for one, these are all found in the production capacity range from 10 000 tonnes and less per year. With respect to the total planned production in 2007 for all respondents, 74 % is produced according to SS 18 71 20 (that is 1 025 600 tonnes). Only 22 % of the production in 2007 is produced with the requirements specified in CEN 14961. Among producers with a capacity over 10 000 tonnes 100 % uses a standard; all of those except two use the Swedish Standard.

The use of standardization for pellet production is summarized in Table 17.

Table 17. Pellet production according to standard among respondents. There is a considerable difference between large- and small-scale producers concerning the implementation of pellet standards

Standard	No. of respondents	Share of respondents	Tonnes 2007	Share of production	Comment
SS 18 71 20	19	54 %	1 025 600	74 %	Primarily in use in the large- and medium-scale producer segment
CEN 14961	2	6 %	310 000	22 %	One medium- and one large-scale producer
Other	2	6 %	*	*	Uses own standard and industry classification, respectively
No standard	12	34 %	49 520	4 %	All except one with a capacity less than 10 000 tonnes

** The two respondents using other standards also use CEN 14961.*



The respondents were asked if they planned to use the new European standard in the future. The results are presented in Figure 31.

Figure 31. Plans among the respondents to use the new European standardization in the future. The answers are based on the question "If you are not using the European standard today, do you plan to use it in the future?".

29 % stated that they plan to implement the new standard, while the majority stated “Do not know”. It may be the case that the respondents that do not know have not heard about the new standard (it is relatively new and published recently). Respondents that plan to use the new European standard are mainly large-scale producers.

Environmental certification

Here follows a presentation of the use of environmental certification systems among the actors in the Swedish fuel pellets industry. Table 18 represents the supply-side of the production process assessing the demand for environmentally certified raw material from the suppliers. About half of the respondents do not demand that the raw material used for input for pellet production is environmentally certified.

Table 18. Demand for environmentally certified raw material. The answers are based on the question “Do you demand environmentally certified raw material for pellet production from your suppliers?”

Do you demand environmentally certified raw material for pellet production from your suppliers?	**No. of respondents**	**Share**
Yes	11	30 %
No	19	53 %
No reply	6	17 %
Sum	36	100 %

Table 19 shows what certification systems the producers use for ready-made pellets. Three types of ISO standards are used by five respondents. The forest management systems (FSC and PEFC) are used by 5 respondents. However, the majority of producers do not have an environmental certificate for finished goods.

Table 19. Environmental certification system for ready-made pellets used by the respondents. The three types of ISO standards indicated by the respondents are included as well

Certification system for ready-made pellets	No. of respondents	Share of respondents	Tonnes 2007	Share of production
ISO[VIII]	5 Type: ISO 9000: 1; ISO 14000: 1; ISO 14001: 3	15 %	750 000	54 %
The Swan label	0	0 %	0	0 %
FSC	4	12 %	279 000	20 %
PEFC	1	3 %	20 000	1 %
Other	4	12 %	37 320	3 %
No certificate	18	53 %	305 100	22 %
No reply	2	5 %	-	-

To evaluate the demand from customers for environmentally certified pellets, the producers were asked if and how often they encountered this demand. The absolute majority indicated that customers never demand such a certification, and only one respondent mentioned that this was often the case. Altogether 97 % stated that customers never or seldom demand certified pellets (see Table 20).

Table 20. Summary of the answers to the question "Does it occur that your customers demand environmentally certified pellets from you?"

Does it occur that your customers demand environmentally certified pellets from you?	No. of respondents	Share
Yes, often	1	3 %
Yes, seldom	9	25 %
No	26	72 %
No reply	0	0 %
Sum	36	100 %

[VIII] ISO 9 000 = Quality management systems, ISO 14 000 = Environmental Management systems (ISO, 2008). ISO-systems are more to be regarded as standards rather than certifications.

5.5 Future prospects

Threats and opportunities

The opportunities stated by the respondents can be distributed into 5 separate categories presented in Table 21. Most producers rely on the growing market for fuel pellets, both the domestic and international markets. Also environmental issues and the price increase of the main substitutes to pellets are experienced as important opportunities. A number of respondents mentioned the use of new raw materials for pellet production and the use of raw material from own production.

Table 21. Opportunities presented per category. The "share" column represents the share of answers in each category and the right column presents the answers included in each category. The compilation is based on an open-ended question

Opportunities	Share	The category includes answers such as
Market	35 %	Market growth, increased demand (nationally and internationally), increased export, the favourable saw mill boom.
Environmental issues	20 %	Public environmental discussion and concern, political climate decisions (both nationally and on the European level).
Development of substitutes	20 %	Increased energy prices (primarily those of oil and electricity).
Quality, service & logistics	15 %	High quality, local thinking, qualified personnel, effective production, logistic advantages due to geographic location, short distances to be driven (for delivering, raw material transports etc.).
Raw material situation	10 %	The use of own raw material, alternative raw materials, closeness to raw material, favourable access to raw material.
Sum	100 %	

Threats experienced by the respondents are presented in Table 22. The raw material situation; bad access and high prices of raw material are considered as the greatest threats to the producers. Other respondents highlighted various kinds of energy taxes and regulations as threats to their production.

Table 22. Threats presented per category. The share column represents the share of answers in each category and the right column presents the answers included in each category. The compilation is based on an open-ended question

Threats	Share	The category includes answers such as
Raw material situation	37 %	Bad access to raw material, high raw material prices and price development, raw material shortage, too many actors with similar raw material needs.
Taxes and regulations	20 %	Political tax decisions, taxes on biofuels and taxes generally, regulations.
Development of substitutes	17 %	Increased use of nuclear power, increased use of heat from combined heat and power plants, decreased oil- and electricity prices.
Overproduction and competition	15 %	Too many pellet producers, large actors lock access to raw material, overproduction of pellets.
Pellet import	11 %	Inexpensive pellet imports (compared to pellets produced in Sweden).
Sum	100 %	

Expected increase in demand

Even if over 90 % of the respondents stated that the greatest increase in demand has taken place in the small-scale segment does not mean the future is expected to be the same. When asked about what market segment is predicted to show the greatest increase in demand in the future, 35 % of the respondents think that the medium-scale segment (including schools, industries and local heat centrals) will show the greatest increase. However, the majority, or 47 %, thinks that the small-scale segment will increase the most. Only two producers state the large-scale segment. 4 respondents (about 12 %) think that both the medium- and small-scale segment will increase the most. The answers are summarized in Figure 32.

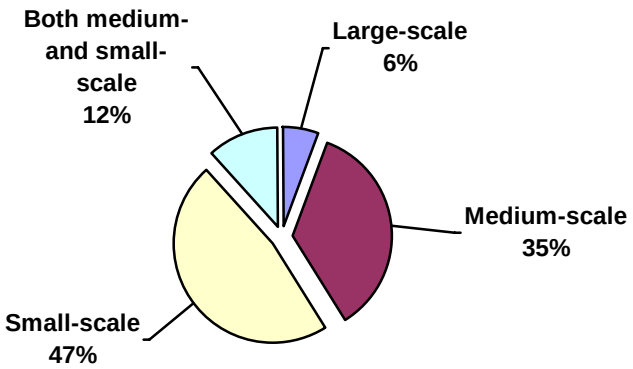


Figure 32. Expected future increase in demand among producers with respect to consumer market.

Strategies to reach growing markets

As presented in the previous section, slightly less than half of the respondents expect the small-scale segment to show the greatest increase in demand in the coming years. Figure 33 presents the strategies to reach this market according to the respondents. The majority will expand the production to meet this demand, but a number of firms will also produce new products or services to satisfy the need for pellets (e g installation service etc.).

Two major producers of pellets answered that their main strategy to reach growing market segments is to develop or produce new products or services.

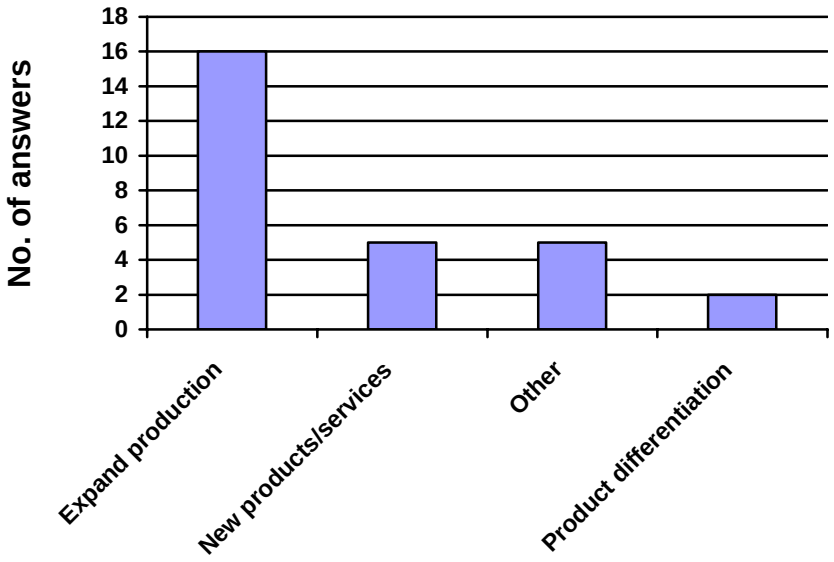


Figure 33. Strategy to reach growing market segments.

Price expectations

Some general conclusions can be drawn from the comparison between the expected price development and producer characteristics. All producers with production capacities over 10 000 tonnes expect the price to increase within the range from 5 % to 25 %.

Out of all respondents, only two expect the price do decrease with 10 % and 20 %, respectively. Altogether, the average expectation on price development within the two years to come is an increase with 9.5 %.

6 Concluding discussion

The purpose of this study was; to analyze the business situation for the producers, to examine the use and influence of product standardization and environmental certification systems and to make an estimate on industry potential and future success.

6.1 The business situation

The business situation includes factors such as market situation, raw material situation, production & establishment etc. and will be analyzed with the theoretical framework of Porters Five Forces.

Power of suppliers

According to the results there are a number of signs that indicate a problematic raw material situation:

- 37 % of the respondents experience the raw material situation to be the greatest threat to their production.
- 36 % of the respondents had investigated alternative raw materials as a reaction to increased raw material competition.
- 81 % of the firms did not experience that they had a good purchase marginal to deal with increased raw material prices.
- 31 % of the respondents had difficulties in getting raw material.
- One of the major obstacles for starting pellet production is considered to be high raw material prices or shortage (18 % of the respondents).

Earlier reports on densified biofuels in Sweden (Hirsmark, 2002), assumed that the price of alternative raw materials would increase, and that alternative raw materials would be profitable enough for pellet production. The growing competitive intensity and the following increased raw material prices during the last seven years have clearly made alternative raw material more interesting. The use of roundwood and pulp wood (energy wood) for pellet production is very interesting from a competitive point of view, since these raw materials usually go to the saw-mill and pulp industry, respectively.

Conclusion

The supplier group, mainly constituted by the forest industry, remains powerful. The use of alternative raw materials and the expanding international raw material trade will hopefully reduce the dependence on the forest industry.

Power of customers

The pellet industry in general sells their products to a number of customers much depending on the scale of the producers. Large-scale pellet manufacturers often turn to all three customer segments; large, medium and small, and each segment has different needs in terms of customer service, fuel quality and so on. Moreover, it is much easier for a large producer to select customers (by effective logistical systems) relative to small producers that usually sell their fuel on a local market. On the other hand, large producers tend to have a few dominating customers that consume a great part of their production (in other words, large consumers purchase large volumes with respect to producer sales).

Demography and the quantities of purchase is two other important factors when determining where the power lies between customers and producers. Producers that turn to large

consumers can usually rely on long-term purchase contracts that secure their sales over a long time period and so on. There are also costs of serving customers, a parameter that also varies between customer segments. For example order size and delivering/selling costs are dependent on customer segment (i e district heating plant or household). Large pellet producers usually have more services to offer their customers, as for example delivering, sales of technical pellet equipment, installation service etc. With more producers comes more alternatives for the customers, and since pellets is a rather undifferentiated product with great uniformity between different manufacturers, customers can be expected to play producers against each other.

Producers in the southern part of Sweden have the advantage of being able to reach a large number of customers and potential customers due to its geographical position thereby lowering the costs of delivering. However, the competitive condition also gets worse in the southern parts of the country where there are more producers in a relatively limited geographical area. Such a condition also makes it more difficult to get enough raw materials to reasonable prices. The geographic position also partly determines the possibility to export pellets and thereby reaching the expanding international market; 22 % of the respondents have connection to sea transports.

The growth rate of the primary market segments also influences the business situation of the pellet producers; growth rates in the small and medium-scale segments are high and are expected to be highest in the small-scale segment according to this survey, while the growth in the large-scale segment seems to have slowed down. The slowdown among large consumers can be explained by the increasing pellet prices.

Conclusion
With more producers to choose from, brand differentiation and increased competition between producers, the customer group can be expected to more eagerly play producers against each other.

Threat of entry
Numerous new firms are starting pellet production each year, but the contribution of the small-scale segment to the total production in Sweden is almost insignificant (about 1 %). Likewise the total capacity of the small-scale producers (less than 5 000 tonnes/year) equals no more than 2 % of the total capacity of the industry. Apart from the occasional entrants that enter the industry at a large- or medium-scale size, a number of aspects indicate a low threat of entry among small-scale entrants:

- Small firms primarily produce pellets from their own by-products. In this sense they do not compete with other producers for raw material on the open market.
- Compared to the total capacity of the industry the planned capacity expansions by small-scale producers are almost insignificant.
- Small-scale producers turn more or less solely to the small-scale consumer segment compared to large-scale producers that show a more widely distributed market segmentation.

The pellet industry is dominated by a few large producers with favourable access to raw material and well established customer relationships. Large producers also have more resources and ability to cope with increases in raw material prices and raw material shortage just from the fact that they are dominant consumers of by-products. Moreover, with high raw material consumption and few suppliers they also have great bargaining power towards their

suppliers relative to smaller producers. Nevertheless, inability to obtain enough raw material is not a major problem facing the small-scale producers today since they mainly use raw material from their own production. If the pellet market continues to grow in the near future, as can be expected, there will be a situation where small producers expand capacity and production and ultimately need to purchase input material on the open market, thereby threatening the favourable position of large producers. How the competitive situation will develop when small-scale producers enter the raw material market, however, will be dependent of the current economic condition of the saw mill industry and its production of by-products.

The capital requirements during the start-up phase are experienced as one of the main obstacles to get into the market. Except from the costs for the pellet machines other equipment is needed such as cyclone separators and bagging devices (Zakrisson, 2002). Moreover, there probably are great costs associated with the start-up problems experienced by many entrants. The capital requirements seem to be the most important factor that deters entry to the pellet industry.

Governmental subsidies are an indirect factor that has promoted the establishment of new pellet producers. Through tax incentives (taxes on carbon dioxide emissions) and conversion subsidies to buyers (a tax deduction that could be obtained for the conversion from oil or electricity to biofuels as well as other renewable alternatives) the government have indirectly supported pellet production by increasing the demand. This is probably one important factor why so many new producers turn solely to small household consumers. There is still a 30 % tax deduction for public buildings that change from fossil fuels to, e g pellets, valid until the end of 2008 (STEM, 2007).

Conclusion

Despite of the high establishment rate among small-scale producers, the threat of entry to already established producers is low. The further adding of capacity among entrants (as well as among existing producers) poses a potential future threat to already established industrial actors.

Pressure from substitute products

During the recent years many consumers of energy (industries, district-heating facilities and homeowners etc.) have switched from one fuel to another. There are many alternatives, and homeowners can choose between heat-pump technology, district heating connection or fuel pellets for space heating, all favourable in price compared to electricity. Oil is no longer an alternative, at least not among small-scale users, as the oil price reached all-time high in January 2008. However, the many alternatives might be confusing to potential customers.

In the small-scale segment connection to the municipal district-heating network is the alternative that from an economical aspect is the closest substitute to pellets, provided that this alternative is possible (there must be a network in the vicinity and a number of households in the nearby area that must be interested in district heating connection as well). Connection to the district heating network might also include lock-in effects considering the monopoly position of many district-heating facilities. Moreover, the price for connection to the heating network also varies considerably depending on the geographical position in Sweden (up to 72 000 SEK[IX]). Compared to heat pumps, pellet technology has the advantage of being more or less independent of fluctuations in electricity prices.

[IX] 100 SEK = 0.11 € (Januari 2008)

The high presence of first-time buyers of pellet heating technology is one factor that must be handled with care by producers and retailers of pellets and pellet combustion equipment. New customers must be informed about pellet technology and convinced that it can perform its functions properly. Homeowners must be aware that the cost savings of pellet technology is real, that it is both environmentally and ecologically sustainable and that they do not need to wait for further tax incentives to commit to pellet heating. The pellet sector must be proactive and contribute to a favourable development in this emerging industry phase.

The small-scale market is the largest consumer of pellets today according to this survey. This segment has increased partly due to the governmental subsidies available when home-owners have changed heating technology from oil to pellet boilers. What is especially important in this segment is that a demand for pellets now is established, a demand that probably will continue to increase in the years to come.

Conclusion
The pressure from substitute products is high, resulting in a relatively low profit potential for the pellet industry. On the other hand, the input products used for pellet production never compete with those of the closest substitutes (heat pumps), why a viable pellet industry should be possible more or less irrespective of the development of substitutes.

Rivalry among existing firms
Pellets is solely used for space heating and must, at least among homeowners, be regarded as a commodity. As long as the fuel functions properly together with the combustion unit and emits enough energy, the question is not whether company A or B is the manufacturer. Moreover, according to research (e g Mahapatra, 2007), consumer purchase decisions tend to first and foremost be dependent on the price; not on the type of heating technology or brand. Consequently, the price is the primary competitive tool in the pellet industry, a price that must be comparable to the closest substitutes.

Competing pellet producers are experienced as the main competitors for raw material among the respondents. Today, the rapid growth of the industry together with an escalating demand for pellets somewhat mitigates the intensity in the rivalry. As the industry mature and the growth rate decline, the rivalry will probably intensify resulting in decreasing profits.

Conclusion
The growing number of pellet producers and the following increasing rivalry among existing firms can be expected to tempt producers to cut prices to increase sales, a measure resulting in low industry profitability. At present, the moderate rivalry among existing producers seem to mainly derive from the intense raw material competition.

6.2 Standardization & Certification

Standardization
The majority of respondents produce their pellets in accordance with a standard, most of them according to the Swedish Standard.

- 19 respondents produce their pellets according to SS 18 71 20, accounting for 74 % of the total production in 2007.
- 2 respondents produce their pellets according to the new European standard, accounting for 22 % of the total production in 2007.
- 12 respondents claim they do not use any standard.

The credibility of the pellet industry is dependent on the performance experienced by the customers. When the majority of the small-scale producers do not use any standard there is a risk that small-scale consumers of pellets get an erratic product quality since small pellet producers mainly target the small-scale consumer segment. It is regrettable that small producers cannot guarantee the quality by producing their pellets in accordance with a standard. On the other hand, small-scale production is usually run beside another main business and it may be difficult to meet the needs of a standard with the scarce resources of a small firm. Nevertheless, even if only 4 % of the total production is manufactured by small firms, it is important that the high quality needs of small consumers are met, especially since the small producers probably will continue to grow in the future.

International trade of solid biofuels is expanding rapidly and is expected to grow further. As evident from the results presented in this report much pellets is exported to other countries primarily by the leading pellet producers. Today when most pellets is produced according to the Swedish Standard it can be difficulties when the import countries use their own sets of standards with other criteria concerning the fuel. This is probably the reason why two of the companies in this survey produce according to the European standard (CEN 14961).

According to the results, most large-scale producers plan to implement the new European standard in the future; these are also the firms that export pellets to other countries and need international standardization. Sweden is one of the leading countries in the world when it comes to production and consumption of bioenergy in general and pellets in particular. Therefore, it is important that the Swedish industry is at the forefront also when it comes to the implementation and knowledge of pellet standardization.

Certification

In other forest-based industries, the use of environmental certification systems is widely used and implemented through the production chain from the growing tree to ready-made products on the market. The use of environmental certification is important in order to increase customer awareness, and to put forward the environmental image of the company.

Today, pellets is extensively used among small-scale consumers but the use of environmental certification systems is not as implemented compared to other forest-based industries. Only 21 % of the production in 2007 is certified with the most common certificate systems in Sweden for sustainable use of the forest resource; FSC and PEFC. However, the demand for certified pellets from customers is very low, only one respondent stated that customers demand certified pellets often. If there is no demand, the incentive to implement environmental certification systems will of course be low. As stressed in earlier chapters one of the main drivers behind the favourable development in the pellet industry is the public climate discussion. It is therefore important to convince new potential customers that pellets is produced in a sustainable way since its environmental friendliness is one important parameter in many customers purchase decisions (Mahapatra, 2007).

The development in other energy sectors that produce substitutes to pellets also use environmental certificates to some extent. One example is the possibility for customers of electricity to buy what is called “green electricity”; energy produced from renewable energy sources without pollution. In other words, the pellet industry has much to gain from using environmental certification systems for their fuel in terms of goodwill, customer loyalty and credibility.

More than half of the respondents do not demand environmental certified raw material from their suppliers. Nevertheless, a great proportion of the forest properties in Sweden is already certified according to FSC and PEFC (11 million and 6.6 million hectares, respectively), why it should not be any major problem with the use of environmental certification for pellets.

Taken together the Swedish pellet industry should consider the use of environmental certificate systems throughout the whole production chain from the management of the forest resource to ready-made pellets (such as the PFC Chain of Custody Certificate). In Sweden this would be eased by the fact that Swedish pellet producers do not use fossil fuels for raw material drying. The pellet industry is not only responsible to deliver a high quality fuel to end customers – it is also responsible for a sustainable use of the raw material resource.

Conclusion
The use of standardization is high, but could be higher especially among the small-scale producers targeting mainly the small-scale consumer segment. The role and impact of standardization to the pellet industry will be even more important with increasing trade. The degree of environmental pellet certification is low and could rather easily be significantly higher in resemblance with other forest industry related products.

6.3 Potential and possibilities

One of the major findings from this study is the planned capacity expansion. In total, the planned expansion is 708 000 tonnes which corresponds to an increase of the current capacity by 41 % in a few years. When assessing the need and potential for expansion, the firms must consider future demand as well as the future behaviour of its competitors. Obviously, the pellet producers see a great future potential in their business.

When too many actors add capacity, there is a risk to overbuild capacity. Moreover, the pellet industry is characterized by cyclic changes in demand depending on weather condition and the need for space heating, a condition that may increase overcapacity in downturns. There also seems to be some inflated expectations in terms of increased demand and growing markets. There is a mainstreamed discourse in media and politics in Sweden today concerning the need for a way out of the energy crisis. When pellet producers evaluate the public discussion there is a risk that the expectations of the future get over-inflated when everyone try to increase capacity and production to gain market shares. If a 40 % adding of capacity are to be possible without adverse consequences for the Swedish pellet industry, more pellets must get out on the international markets. On the other hand, there is a great domestic potential for increased pellet use. More than 400 000 detached houses in Sweden still are heated with direct electricity according to Statistics Sweden's statistics for 2005 (SCB, 2007). Left to see is how much of this potential that will be converted to pellet-based heating systems.

PEST analysis

To summarize the findings from this study and to apply them onto the industry as a whole, a PEST analysis will be conducted putting forward the major issues affecting the pellet industry.

Political factors

Governmental policies regarding environmental issues, increasing international trade as well as a growing home market all promote increased consumption of fuel pellets. Never before, the international political consensus on renewable energy has been as strong as it is today. 2007 was the year when the climate change issue came on top on the political agenda worldwide, and international agreements on renewable energy has partly secured a future beneficial business climate for the pellet industry. From this standpoint, the future for the pellet industry looks bright, especially if the Swedish industry manages to benefit from the growing demand abroad.

Economic factors

The overall economic situation is favourable today in Sweden, at the peak of the economic upswing. Since the pellet industry is affected by fluctuations in demand, however, the situation may change rapidly due to a possible recession together with a potential overbuilding of capacity. The expected adding of capacity will put further pressure on the already limited traditional raw material base (saw dust and dry wood chips). Moreover, the pellet industry has the disadvantage of being dependent on the demand and supply balance of the forest industry, and therefore raw materials such as short rotation coppice, energy crops, peat etc. must be evaluated and tested in full-scale to find alternatives other than the traditional ones. Tax decisions on fossil fuels will further promote the use of pellets, but the viability of the pellet industry remains dependent on the cost development for substitutes, in particular heat pumps. Most likely, the widespread and growing use of pellets in the small- and medium-scale segment will secure a stable future domestic demand despite of changing prices.

Social factors

The pellet industry clearly benefits from the current public opinion on climate issues and the following changes in consumer lifestyle, trends and attitudes. Further on, more and more people tend to move from countryside to towns, a global trend that also may be beneficial to the pellet industry since low pollutant emissions is to prefer in densely populated areas. The ongoing standardization work on biofuels as well as increased certification is important also as a social aspect. Thereby, the pellet industry can put forward and anchor the environmental benefits of pellet heating among consumers and guarantee an environmental reliable production process.

Technological factors

The development of competing heating technologies (heat pumps etc.) is rapid. Nevertheless, the competitive potential for pellet heating solutions is high if other raw material sources are exploited, both in Sweden and in other countries. The relatively slow biomass growth in the northern hemisphere though, limits the possibilities to cultivate biomass just for pellet production. On the other hand, Sweden has a biomass resource incomparable in size to many other countries. The development of cutting-edge pellet heating technologies and state of the art production technology and facilities will further improve the Swedish pellet industry potential.

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Appendices

Appendix A: CEN/TC 335 – Solid Biofuels SIS/TK 412 N073

Work Programme for field of WG 1 *Terminology, definitions and description*.

Number	Title	PrCEN/TS	Stage 32	Stage 49	CEN/TS	Comments
335 001	Solid Biofuels - Terminology, definitions and descriptions	14588	2001-11	2002-08	2003-05	Published 2003-12-17

Work Programme for field of WG 2 *Fuel specifications, classes and quality assurance*.

Number	Title	PrCEN/TS	Stage 32	Stage 49	CEN/TS	Comments
335 002	Solid Biofuels - Fuel specifications and classes	14961	2002-06	2004-03	2004-12	Published 2005-04-11
335 003	Solid Biofuels - Fuel quality assurance	15234	2004-03	2004-10	2005-07	Published 2006-03-15
335 033	Solid Biofuels - Guide for a Quality Assurance System	15569	2006-01			Stage 32 06-01-11--02-28

Work Programme for field of WG 3 *Sampling and sample reduction*.

Number	Title	PrCEN/TS	Stage 32	Stage 49	CEN/TS	Comments
335 004	Solid Biofuels - Sampling - Part 1: Methods of sampling	14778-1	2003-06	2004-06	2005-01	Published 2005-11
335 005	Solid Biofuels - Sampling - Part 2: Methods for sampling particulate material transported in lorries	14778-2	2003-06	2004-06	2005-01	Published 2005-11
335 006	Solid Biofuels - Sampling - Methods for preparing sampling plans and sampling certificates	14779	2003-06	2004-06	2005-01	Published 2005-11
335 007	Solid Biofuels - Methods for sample preparation	14780	2003-06	2004-06	2005-01	Published 2005-11

Work Programme for field of WG 4 *Physical and mechanical test methods*.

Number	Title	PrCEN/TS	Stage 32	Stage 49	CEN/TS	Comments
335 008	Solid Biofuels - Method for the determination of calorific value	14918	2002-12	2003-08	2004-09	Published 2005-05
335 009	Solid Biofuels - Methods for the determination of bulk density	15103	2003-05	2004-07	2005-04	Published 05-11-30
335 010	Solid Biofuels - Methods for the determination of moisture content – Oven dry method – Part 1: Total moisture – Reference method	14774-1	2002-01	2002-10	2004-07	Published 2004-09-01
335 011	Solid Biofuels - Methods for the determination of moisture content – Oven dry method – Part 2: Total moisture – Simplified method	14774-2	2002-01	2002-10	2004-07	Published 2004-09-01
335 012	Solid Biofuels - Methods for the determination of moisture content - Oven dry method – Part 3: Moisture in general analysis sample	14774-3	2002-01	2002-10	2004-07	Published 2004-09-01
335 013	Solid Biofuels - Method for the determination of the content of volatile matter	15148	2004-06	2004-12	2005-08	Published 2005-11-03

335 014	Solid Biofuels - Method for the determination of ash content	14775	2002-01	2002-10	2004-07	Published 2004-09-01
335 015	Solid Biofuels - Methods for the determination of ash melting behaviour	15370-1	2004-10	2005-07	2006-04	Published 2006-04
335 016	Solid Biofuels - Methods for the determination of particle size distribution. Part 1: Oscillating screen method using sieve apertures of 3,15 mm and above	15149-1	2003-06	2004-07	2005-03	Published 06-01
335 017	Solid Biofuels - Methods for the determination of particle size distribution. Part 2: Vibrating screen method using sieve apertures of 3,15 mm and below	15149-2	2003-06	2004-07	2005-03	Published 06-01
335 018	Solid Biofuels - Methods for the determination of particle size distribution. Part 3: Rotary screen method	15149-3	2003-06	2004-07	2005-03	Published 06-01
335 019	Solid Biofuels - Methods for the determination of impurities					No activity. More research is needed.
335 020	Solid Biofuels - Methods for the determination of particle density	15150	2004-02	2004-11	2005-08	Published 05-11
335 032	Solid biofuels - Method for the determination of particle size distribution of disintegrated particles		2006-03			Stage 32 2006-03-08--04-21
335 022	Solid Biofuels - Methods for the determination of mechanical durability of pellets and briquettes - Part 1: Pellets	15210-1	2004-02	2004-11	2005-08	Published 05-12
335 023	Solid Biofuels - Methods for the determination of mechanical durability of pellets and briquettes - Part 2: Briquettes	15210-2	2004-02	2004-11	2005-08	Published 05-12
335 024	Solid Biofuels - Methods for the determination of bridging properties		2004-09	2005-03	2005-12	Stage 32 15 Dec 04 - 1 Feb 05

Work Programme for field of WG 5 *Chemical test methods*.

Number	**Title**	**PrCEN/TS**	**Stage 32**	**Stage 49**	**CEN/TS**	**Comments**
335 025	Solid Biofuels - Determination of total content of carbon, hydrogen and nitrogen - Instrumental method	15104	2003-02	2004-07	2005-04	Published 05-08
335 026	Solid Biofuels - Determination of total content of sulphur and chlorine	15289	2004-07	2004-12	2005-08	Published 06-04
335 027	Solid Biofuels - Methods for determination of the water soluble content of chloride, sodium and potassium	15105	2002-12	2003-08	2004-05	Published 05-08
335 028	Solid Biofuels - Determination of major elements	15290	2004-07	2004-12	2005-08	Published 2006-04
335 029	Solid Biofuels - Determination of minor elements	15297	2004-07	2004-12	2005-08	Published 2006-04
335 030	Solid Biofuels - Calculation of analyses to different bases	15296	2004-07	2005-05	2006-02	Published 2006-04

Appendix B: The questionnaire

Note: the questionnaire is translated from Swedish, why the meaning of some words and expressions may differ from the original.

Questionnaire Nr. ……..

Questionnaire to you as pellet producer

About the company:

Company name: …….

Company postal adress: …….

Company telephone number: …….

Company email adress: …….

Company homepage: …….

Production facility age: …… Years

Sometimes we need further information, why we ask for contact information from you that filled in this questionnaire.

Your name: …….

Your position/profession: …….

Other comments:

1. What is the main business of the company?

- ❑ Pellet production
- ❑ Sawmill
- ❑ Planery
- ❑ Carpentry
- ❑ Construction store
- ❑ Pulp- and paper industry
- ❑ Recycling
- ❑ Heat- / power production
- ❑ Other; what?.....

2. Is your pellet facility included included together with other pellet production facilities in a larger company or concern?

❒ Yes, if so, what? ……
❒ No

Market situation

3. Which are your main market segment for pellets? Please specify percentage of total pellet sales.

Large-scale (2 MW and larger) …… % (Heat plants/ CHP-plants[X])

Middle-scale (50 kW – 2 MW) …… % (Heat centrals, schools and industries)

Small-scale (less than 50 kW) …… % (Detatched houses and smaller properties)

4. In which of these segments do you experience that demand has increased most since the year 2000?

- ❒ Large-scale (2 MW and larger)
- ❒ Middle-scale (50 kW – 2 MW)
- ❒ Small-scale (less than 50 kW)

5. What do you consider has been the most important contributing factor to this development?

6. Which market segment do you think will show the greatest increase in demand in the coming years?

- ❒ Large-scale (2 MW and larger)
- ❒ Middle-scale (50 kW – 2 MW)
- ❒ Small-scale (less than 50 kW)

7. What is your main strategy to reach this growing market?

- ❒ Develop/produce new pellet relates products and services
- ❒ Expand the pellet production
- ❒ Expand our product range with other bioenergy products
- ❒ Other: …….

8. Have you got plans to expand your pellet production- or sales activities with pellets internationally?

- ❒ Yes.
- ❒ No.
- ❒ We already carry out production- or sales activity with pellets internationally.
- ❒ Do not know.

[X] Combined Heat and Power plants.

9. Which of the following actors or markets is your main competitor for raw material for pellet production?

❒ Sawmills
❒ Pulp mills
❒ Board industry
❒ The international market
❒ Other pellet producer
❒ Briquette producer
❒ Heat-/CHP-plant
❒ Agriculture

❒ Other: ……

10. Why do you experience this actor/market as your main competitor?

11. What do you consider to be the two greatest possibilities for and the two greatest threats against your pellet production in the future?

Possibilities	Threats

Raw material supply

12. What are the main raw materials for your production of pellets?

❒ Fresh sawdust
❒ Planer shavings
❒ Saw mill chips[XI]
❒ Cutting residues
❒ Dry sawdust
❒ Rejected energy wood
❒ Recycled wood
❒ Peat

❒ Other: ……

13. From where do you get the raw material for the pellet production?

By-product from own production ……... %

Purchased raw material ……... %

14. If the company purchases raw material for pellet production, where do this raw material come from?

❒ The raw material is bought from other units within the same company/concern.
❒ The raw material is bought from external companies without connection to our business.
❒ The raw material is bought both from other units in the same company/concern and from other companies without connection to our own business.

[XI] Saw mill chips refer to a special assortment of wood chips sorted out from the saw mill industry (swe. "pinnflis").

15. Has the company investigated the possibility to use other kinds of raw material as a reaction for increased raw material competition?

❒ Yes. What raw materials?……..
❒ No.

16. Do you consider that you have a good purchase marginal to cope with increased prices of raw material for pellet production?

❒ Yes.
❒ No.

17. Does your company import any raw material for pellet production?

❒ Yes, from the following countries:……..
❒ No

If Yes, how large is this share in relation to the total raw material demand for pellet production of the facility?

…….. %

18. If the company has imported raw material for pellet production, is it your intention to increase or decrease imports during the coming two year period?

❒ Our intention is to <u>increase</u> the share of imported raw material
❒ Our intention is to <u>decrease</u> the share of imported raw material
❒ Our intention is neither to increase or decrease the share of imported raw material.
❒ Do not know.

19. Does the company export any pellets to other countries?

❒ Yes, which? ……
❒ No.

20. If Yes, is your intention to increase or decrease exports during the coming two year period?

❒ Our intention is to <u>increase</u> the share of exported pellets.
❒ Our intention is to <u>decrease</u> the share of exported pellets.
❒ Our intention is neither to increase or decrease the share of exported pellets.
❒ Do not know.

21. Does the facility has availability to connection to

Railroad	❒ Yes	❒ No
Sea transport	❒ Yes	❒ No

22. Is the company currently experiencing difficulties in getting raw material for pellet production?

❒ Yes.
❒ No.

If Yes, what is the main reason for this?

Production and customer

23. What year did the company started producing pellets?

Year ……

24. If the company started producing pellets after 2000, what was the main contributing factor to start the pellet production?

❒ Because the pellet production became profitable enough.
❒ Establish on new markets
❒ To get an outlet of our by-products
❒ As a reaction for increased demand for pellets.

❒ Other……

25. If the company started producing pellets after 2000, which one of the following factors was experienced as the main obstacle to get into the pellet market?

❒ High investment costs for the pellet production facility.
❒ High raw material prices/difficulties in getting raw material
❒ Costs associated with establishing distribution channels for the product
❒ Bad profitability.

❒ Other……

26. Which are the main causes to eventual problems associated with the pellet production?

❒ Raw material shortage
❒ Bad raw material quality
❒ Start-up problems
❒ Storage problems
❒ Malfunctioning drying equipment
❒ Errors in other production equipment

❒ Other …….

27. What is your maximum production capacity of pellets per year?

…… Tonnes

28. What maximum storing capacity do you have for ready-made pellets?

…… Tonnes

29. How much pellets was in your stock the following dates?

December 31, 2006 …… Tonnes
June 30, 2007 …… Tonnes

30. Have you got plans to expand the production capacity for pellets?

❒ Yes
❒ No
❒ Do not know

If Yes, please specify the additional planned production capacity per year

……..…. Tonnes

31. Is the facility producing other biofuel products than pellets?

❒ Yes. Which? …….. representing …….. % of total production.
…….. representing …….. % of total production.

❒ No.

32. If Yes, does the company plan to phase out other biofuel products in favour of expanded pellet production?

❒ Yes. Which ones? ……..
❒ No.

33. Can the company offer extra products/services to the customer in connection with the sales of pellets?

❒ Yes. What products/services?

❒ No.

34. Please specify your total pellet production during the latest years.

2001	……. Tonnes
2002	……. Tonnes
2003	……. Tonnes
2004	……. Tonnes
2005	……. Tonnes
2006	……. Tonnes
Planned production 2007	……. Tonnes

35. How do you consider that the price of pellets in Sweden will develop during the coming two year period? Please specify percentage in increase or decrease of the price compared with the price today.

+ …… %
- …… %

36. What was your total turnover of pellet sales 2006?

…… SEK

Standardization and certification

37. According to what standard is your pellets produced today?

❒ SS 18 71 20 (Swedish Standard, Biofuels and peat – Fuel pellets– Classification)
❒ CEN 14961 (European Standard, Solid biofuels – Fuel specifications and classes)
❒ Other: ……..
❒ None.

38. If you are using or know any of these standards, how do you experience that they function/would function together with your pellet business?

	SS 18 71 20	❒ Good	❒ Bad	❒ Do not know
	CEN 14961	❒ Good	❒ Bad	❒ Do not know
Other:	……	❒ Good	❒ Bad	❒ Do not know

If you experience that any of these standards is functioning badly together with your business, why/in what way?

……
……
……
……
……

39. If you are not using the European standard today, do you plan to use it in the future?

❒ Yes.
❒ No.
❒ Do not know.

If No, why?

……
……

40. Do you demand environmentally certified raw material for pellet production from your suppliers?

❒ Yes.
❒ No.

41. Is your ready-made pellet products environmentally certified according to any of the following systems?

❒ ISO. Which one? ……...
❒ The Swan
❒ FSC
❒ PEFC
❒ According to other system …….
❒ No.

If No, why not?

42. Does it occur that your customers demand environmentally certified pellets from you?

- ❒ Yes, often.
- ❒ Yes, rarely.
- ❒ No.

Other comments on this questionnaire:

THANK YOU FOR YOUR PARTICIPATION!

Appendix C: Response frequencies

Question nr: (see Appendix B)	**No. of responses**	**Response frequency**
1	36	100 %
2	36	100 %
3	36	100 %
4	33	92 %
5	28	78 %
6	33	92 %
7	30	83 %
8	36	100 %
9	31	86 %
10	21	58 %
11	29	81 %
12	36	100 %
13	36	100 %
14	23	64 %
15	34	94 %
16	31	86 %
17	35	97 %
18	8	22 %
19	36	100 %
20	21	58 %
21	36	100 %
22	35	97 %
23	36	100 %
24	29	81 %
25	27	75 %
26	32	89 %
27	36	100 %
28	35	97 %
29	32	89 %
30	36	100 %
31	36	100 %
32	20	56 %
33	34	94 %
34	35	97 %
35	34	94 %
36	23	64 %
37	34	94 %
38	23	64 %
39	31	86 %
40	30	83 %
41	34	94 %
42	36	100 %
Average	31	86 %

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Sveriges lantbruksuniversitet (SLU)

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