Swedish University of Agricultural Sciences
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The state of the Latvian wood pellet industry: A study on production conditions and international competitiveness

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Abstract

In the last decade, member states of the European Union have adopted a range of measures to decrease the dependency on fossil fuels. This has led to an increased use of biomass in heat and power production. In some countries, the lack of forest resource has led to large scale power producers importing their biomass needs. Due to high energy content and homogeneity, wood pellets have become an internationally traded commodity used for large scale power production.

The Baltic States have emerged as one of the largest wood pellet exporting regions in Europe. This study focused on the case of Latvia, the country with the largest wood pellet production in the region. The purpose was to investigate the production conditions and the competitiveness of the Latvian wood pellet industry. The study was limited to industrial wood pellets for large scale utilities. Three import countries; Belgium, the Netherlands and the UK were identified as large industrial pellet importers for further research. Coal was seen as the major competing alternative energy source on these markets.

The global wood pellet industry, the wood pellet value chain and Latvian conditions for pellet production was first researched through a literature study. Coupled with theories on competition, it formed the framework for the empiric data gathering through qualitative semi-structured interviews with actors in the Latvian wood pellet industry.

The study revealed that raw material costs were a weakness for the pellet industry. Pellets contracts were made for 1-3 years and there was no way to hedge against increases in raw material. The result further suggests that the current size of the Latvian wood pellet industry might not be sustainable, based on future raw material availability and increased raw material competition. Changes in freight rates could also affect the competitiveness of Latvian pellet producers as the currently low rates are thought to increase. However, the industry is doing well at the moment experiencing a steady demand and good FOB (free on board) prices at the ports of export.

Calculations showed that wood pellet mills under Latvian conditions had a total cost of 103-110 €/tonne FOB Riga and 117-124 €/tonne CIF ARA (cost, insurance and freight to Antwerp-Rotterdam-Amsterdam), which suggests they could compete based on the average spot price of 125 €/tonne CIF ARA. Calculations also revealed that the cost of producing and transporting Latvian pellets was competitive with the coal price under the current market situations and the existing support schemes for biomass in biomass dedicated energy producing utilities. The result further showed that Latvian pellet producers were able to compete at profit against the coal price in co-firing utilities in Belgium and the UK. However, the power plants profitability of co-firing wood pellets was proportional to the share of biomass used.

Latvian pellet producers had an advantage on Scandinavian markets, large storage abilities to handle demand fluctuations and some had the possibility to switch between residential and industrial pellets. The geographical location coupled with their storage options also resulted in a possible niche towards the large scale industrial consumers in flexibility and delivery speed. However, the energy producers on the selected markets required large volumes of wood pellets and had infrastructure capable of handling the large North American bulk shipments of 40.000 tonnes. Based on the scale of operations and price, the pellet producers in the US and Canada will probably continue to be the main suppliers for the large scale consumers on these markets.

Keywords: *bioenergy, export, biomass, renewable energy, pellet mills, the Baltic States, support schemes*

Sammanfattning

Medlemsländerna i EU arbetar för att minska sitt beroende av fossila bränslen. Detta har lett till en ökad användning av biomassa som energikälla. I brist på resurser, främst skogsråvara, har energiproducenter i flera av EU-länderna börjat importera sitt behov av biomassa. Träpellets har då vuxit fram som en internationellt handlad råvara inom storskalig energiproduktion.

I Baltikum har träpelletproduktionen ökat i takt med det växande europeiska behovet. Denna studie fokuserade på Lettland, landet med den största träpelletproduktionen i regionen. Syftet var att undersöka produktionsförhållandena och konkurrenskraften för träpelletsindustrin. Studien begränsades till industriella träpellets där Belgien, Nederländerna och Storbritannien identifierats som stora importörer och kol som den konkurrerande energikällan.

Studien inleddes med en litteraturstudie där den globala industrimiljön, pelletproduktion och Lettiska produktionsförhållanden undersökts. Tillsammans med teorier om konkurrenskraft har detta utgjort grunden för den empiriska datainsamlingen där kvalitativa semistrukturerade intervjuer utförts med aktörer i den Lettiska träpelletsindustrin.

Resultatet påvisade att råmaterialskostnaden var en svaghet för industrin. Då en del råvaran inte kunde kontrakteras och kontrakt med pelletkonsumenter skrevs på 1-3 års sikt blev industrin känslig för prisförändringar. Tillgången på råmaterial upplevdes också som ett framtida hinder. Med ökad konkurrens från andra sektorer och en minskande andel av lågkvalitativ rundved i skogen ansågs storleken på den lettiska pelletindustrin inte vara hållbar på längre sikt. Konkurrenskraften för lettiska producenter av industriella träpellets kan också påverkas av skeppningskostnaden som förväntades öka. För närvarande upplevde pelletindustrin i Lettland en hög efterfrågan och bra FOB (lastat vid hamn) priser vid de lettiska exporthamnarna.

I studien beräknades kostnader för träpelletsproduktion under lettiska förhållanden till 103-110 €/ton FOB Riga och 117-124 €/ton CIF ARA (skeppat till Antwerpen-Rotterdam-Amsterdam). Detta var under det genomsnittliga marknadspriset på 125 €/ton CIF ARA, vilket visade att lettiska pelletproducenter kunde konkurrera i pris på de utvalda marknaderna. Samtidigt var kostnaden för lettiska träpellets konkurrenskraftig mot kolpriset på de marknader som studerats under gällande stödsystem för förnyelsebar energi och prisförhållanden för bränslen. Skillnaden i den lönsamhet pelletkonsumenterna erfor mot att använda kol var störst i kraftverk som använder 100% träpellets. I Belgien och Storbritannien kunde förbränning av pellets tillsammans med kol även vara lönsammare än ren kolförbränning.

Jämfört med nordamerikanska producenter var lettiska pelletindustrin bättre diversifierad och därför troligtvis mindre riskutsatt. Lettiska producenter hade ett konkurrensövertag på de skandinaviska marknaderna, stora lagringsmöjligheter för att snabbt hantera fluktuationer i efterfrågan och några hade också möjlighet att ställa om och producera pellets för småskalig användning. Tillsammans med ett kort transportavstånd resulterade lagringsmöjligheterna även i en nisch i flexibilitet och leveranstid mot de storskaliga pelletkonsumeterna. Men konsumenter på de valda marknaderna är i konstant behov av stora volymer och har en infrastruktur för att hantera stora skeppningslaster på 45 000 ton pellets från nordamerikanska producenter. Baserat på pris och storskalighet kommer USA och Kanada troligtvis fortsatt vara huvudleverantörer till energiproducenter i Belgien, Nederländerna och Storbritannien.

Nyckelord: *bioenergi, export, biomassa, förnyelsebar energi, pelletsfabriker, Baltikum, stödsystem*

Preface

I would like to express my gratitude to Jonas Jacobson at GreenGold for giving me the idea and opportunity to do my thesis on the wood pellet industry in Latvia. I would also like to thank Folke Bohlin, my supervisor at SLU for the guidance and support. Finally I would like to thank the interview respondents who took the time to answer all of my questions.

Abbreviations

ARA = the region of Antwerp, Rotterdam and Amsterdam (used in the shipping industry)
CHP = Combined Heat and Power
CPS = the Carbon Price Support
ETS = Emissions Trading System
FIT = Feed-in Tariff
GC = Green Certificate (Belgium)
LEC = Levy Exemption Certificates (UK)
MWh = Mega Watt hours
m^3l= loose cubic meter (cubic meters measured in bulk)
m^3s = solid cubic meter
m^3ub = cubic meter under bark (cubic meter of logs excluding bark)
RES = renewable energy source
RES-E = electricity generated from renewable resources
RO =Renewable Obligation (UK)
ROC = Renewable Obligation Certificate (UK)
tCO_2e = tonne CO_2 equivalent (CO_2 equivalence of greenhouse gas emissions)
TGC = Tradable Green Certificates

Shipping incoterms:

FOB = Free on board. The seller pays for transportation to the port of exit and loading the ship. The buyer pays for freight, insurance, unloading and transportation from the port of entry to the final destination. (Schaffer et al. 2014)

CIF = Cost, insurance and freight. The seller pays for all transports and freights to the port of entry plus insurance costs. (Schaffer et al. 2014)

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1 Introduction

1.1 Renewable energy in Europe

The demand and production of renewable energy has risen substantially in Europe. An increased awareness of environmental issues coupled with supply uncertainties and high price fluctuations in the current fossil fuel based energy system has created a need for alternative energy sources. (Olsson 2012; Verhoest & Ryckmans 2012).

The European Union (EU) has been a major force in this change (Eurelectric 2011). In December 2008, the EU decided to set targets for their future energy composition and use in the 20-20-20 objectives. The objectives state that by year 2020 greenhouse gas emissions in EU should be reduced by 20%, energy from renewable sources should amount to 20% of the total energy mix and the energy efficiency should be increased with 20% (European Commission 2013).

The 20-20-20 objectives have been translated into targets for each country based on previous emission levels (Fig. 1). The member states were also required to submit National Renewable Energy Action Plans (NREAP) containing detailed roadmaps on how to reach the binding 2020 targets (European Parliament and EU Council 2009). These have been incorporated by governments through regulation, legislations and support policies, steering the economies towards production and consumption of renewable energy (Sikkema et al. 2011).

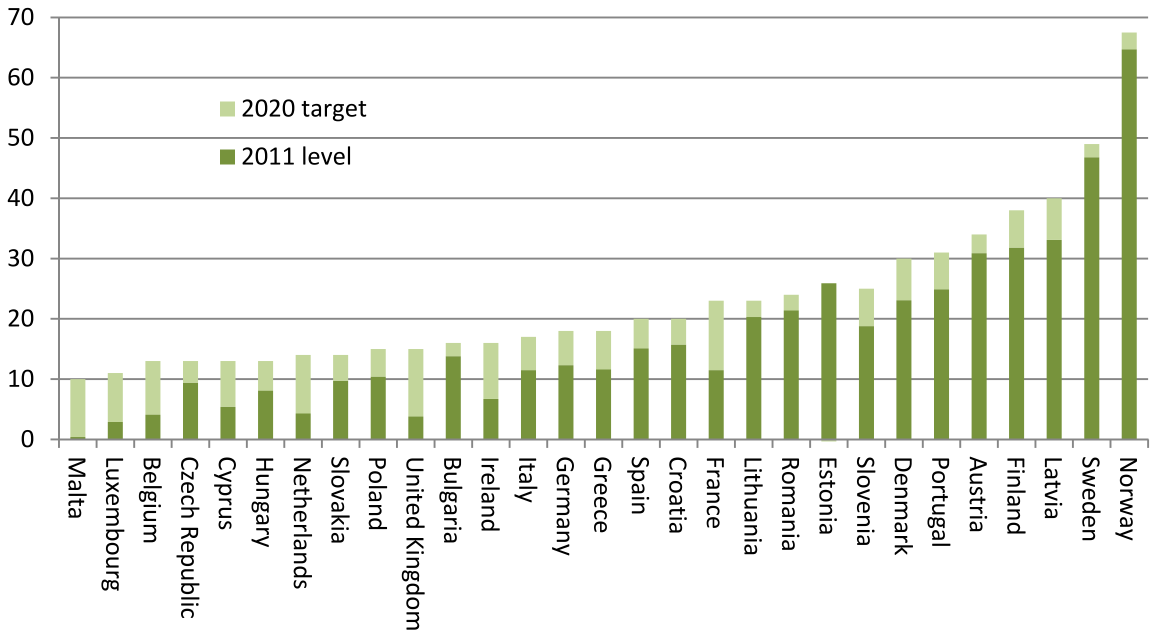

Figure 1. Share of renewable energy in 2011 in Europe and their target levels for 2020 (Eurostat 2013b).

From 2000 to 2010 the amount of renewable energy of total energy consumption within the EU increased from 6% to 10%. Energy from biomass accounts for 64% of the total energy production from renewable energy sources (RES) and is experiencing a steady growth across markets (AEBIOM 2012). A review of the NREAPs by Eurolectric (2011) suggested that the use of bioenergy within the EU must increase by 2.5 times from 2010 to 2020 in order for EU to reach the 20-20-20 targets. Biomass power generation capacity needs to almost double from 24 GW to 43 GW, for this to be possible. In another prediction made by Pöyry in 2012, the

UK, Belgium and France are expected to have the largest increase in biomass use for power production to 2020 (Carroll 2012).

The demand for RES, specifically biomass for energy production, has led to wood pellets becoming an globally traded commodity used for power production (Sikkema et al. 2011).

The global production of wood pellets has increased from below 2,000 tonnes in 2000, to above 22 million tonnes in 2012 (AEBIOM 2013). The growth can be explained by wood pellets advantages against other solid biomass fuels. The high energy density, low moisture content and homogeneity results in better storage and handling capabilities and increased long distance transportability (Sikkema et al. 2011). Main consumers of industrial wood pellets for power production in recent years are the UK, Belgium and the Netherlands, projected to reach a consumption of 7,570 million tonnes in 2013 (AEBIOM 2013). A lack of forest resource in these countries has led to large scale utilities importing their biomass needs (Cocchi et al. 2011). North America has emerged as one of the largest pellet exporting regions in the world, shipping wood pellets across the Atlantic to supply the large power plants (Goh & Junginger 2013). However, Europe continues to be the most productive region, representing about 70% of global wood pellets production. (AEBIOM 2013)

The future development of the European industrial wood pellet markets, fueling the intercontinental trade, rest on the actions of the EU member states' governments. Without financial support there is no profitability burning wood pellets to produce power. The industry is forced to rely on continued policy efforts promoting biomass as a renewable energy source. (Sikkema et al. 2011)

1.2 Motive for the study

The Baltic States have become one of the largest wood pellet exporting regions in Europe and the industry is a potential offset market for low quality wood and milling residue (AEBIOM 2013; Muiste & Habicht 2009). With a growing interest from stakeholders in the Baltic States forest industry, there is a need for further knowledge about the wood pellet industry and its global industry position. Previous studies have indicated barriers against production such as a lack of efficient supply chains, expertise and equipment and suggested that low raw material availability and domestic consumption has led to a cap on production (Muiste & Habicht 2009; Goh & Junginger 2013). Yet, the production from this region has continued to increase (AEBIOM 2012). This study aims at providing information, previously lacking for stakeholders in the Baltic States' forest industry by a case study on the wood pellet industry in Latvia, the largest wood pellet producing country in the region. The objective of the study has been developed in collaboration with an actor in the Latvian forestry sector interested in gaining knowledge about the Latvian pellet industry in a national and international context.

1.3 Objective

The aim of this study is to investigate the Latvian wood pellet industry and assess the competitiveness of exported Latvian wood pellets on the industrial markets in the UK, Belgium and the Netherlands.

Research questions:

- What are the current production and exporting conditions in Latvia for the industrial wood pellets industry? (Conditions include industry structure, raw material availability, suppliers, logistics)

- How can Latvian wood pellet producers compete with other pellet producers and other energy sources on the selected markets? (Direct cost competitiveness and assessment of factors affecting competition)

1.3.1 Scope and limitations

The scope of this study was limited to industrial wood pellets for large scale utilities. Belgium, the Netherlands and the UK were identified as large wood pellet importers with pellet consumers consisting of mostly large scale power plants and was therefore selected for further research (AEBIOM 2013; Junginger & Sikkema 2009; Sikkema & Steiner 2009). On these markets, wood pellets are considered to compete with coal because coal firing installations can be retrofitted at a relatively low cost to burn biomass (Baxter & Koppejan 2005). North American producers are considered to be the main competitors as the largest import volumes in 2012 on the selected markets came from the US and Canada (AEBIOM 2013).

2 Theoretical framework

The theoretical framework provides a background into the drivers and the sources of competitive advantages in a national and international perspective. It also presents a model for analysis which later is used in the discussion to analyze the results of the study.

2.1 Competitiveness on international markets

Classic economic theory proposes that trade will occur between two economies when a difference in production conditions are large enough to result in a profitable exchange of goods under the ruling terms of trade (Horvat 1999). Moving away from the simple case of two economies, globalization has formed large complex systems of competitive trade. Many factors influence the competitiveness of products, firms and nations. To be successful requires proper knowledge of the operations' internal and external environments (Porter 2004; Grant 2005; Porter 1990).

Grant (2004) uses the term competitive advantage when defining, assessing and creating competitiveness. There are two primary types of competitive advantage, cost advantage and differentiation advantage (Fig. 2). A differentiation advantage derives from producing goods or services that differentiate from other products on the markets which creates a higher customer value. To create a differentiation advantage companies will often have to choose a smaller market segment and focus on certain customer requirements to create a unique market position. Cost advantages occur by being able to reach the selected markets at a lower cost than competitors. The source could be a high market share (i.e. economies of scale), favorable raw material access or transportation options, advanced technology or innovation (Porter 2004). In industries with low product differentiation, such as commodity markets, cost advantage strategies are often dominating (Grant 2005).

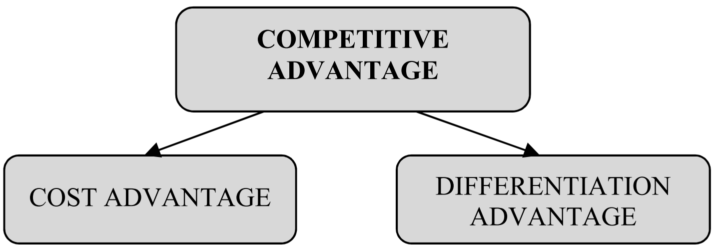

Figure 2.Primary types of competitive advantage (Grant 2005).

The resources and capabilities are important for a firm trying to achieve a competitive advantage. Resources are the firm's productive assets and what it can do, such as financial and physical assets, technological resources, reputation and human resources. However, the capabilities of the firm are not only a result of its resources, but is determined by the way the resources are organized (Grant 2005).

Competition in international industries differs from competition with domestic firms. In domestic industries, firms are bound by the same environment and the source of competitive advantage derives from firms' internal value generation. However when firms are located in different countries, their potential in reaching competitiveness also includes the national environment. The national environment creates a framework of constraints and opportunities for firms to develop in terms of available resources, domestic market conditions, government policies, exchange rates and related and supporting industries. The national environment can provide a comparative advantage against firms in other countries (Grant 2005).

For firms developing strategies, understanding the particular industry environment is important. Competitive advantage within an industry environment could stem from generating value for customers, creating relationships with suppliers and positioning the firm correctly amongst the competition (Grant 2005). The three sources of competitive advantage are further discussed in the sections below.

2.1.1 Firms' resources and capabilities

Much literature on competitive theory focuses on strategic position or market scope in the quest to achieve competitiveness. However, Grant (1991) argues that the resource position of the firm serves as base for competition and choosing the right competitive strategy. A successful cost advantage strategy requires superior process technology, scale-efficient plants and access to low cost resources. Correspondingly, the ability to establish a differentiation advantage stems from product technology, brand reputation or a superior sales and service network (Fig. 3). (Grant 1991)

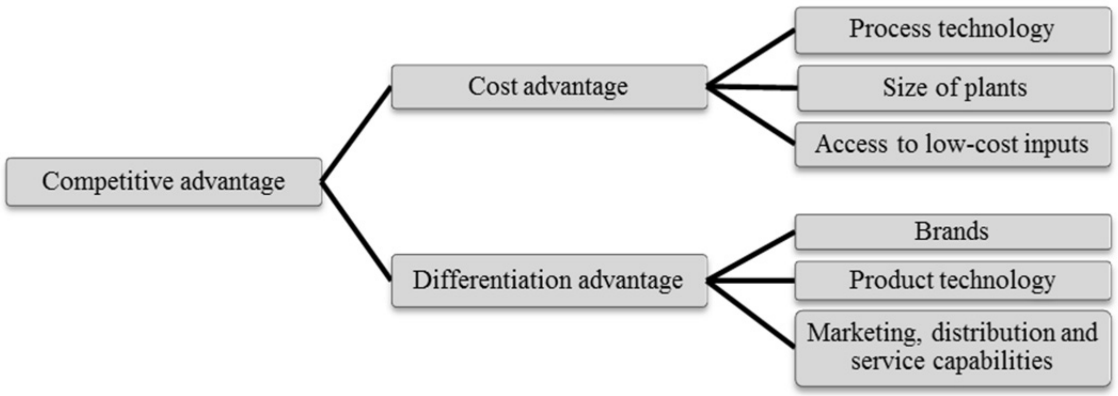

Figure 3. Resources of the firm leading to competitive advantage as suggested by Grant (1991).

A firm's resources can also be the source of other market based power as patents, experience and scale economies which could create barriers of entry that only partly or slowly can be acquired by entrants. For resources to be a source for market power they have to be exclusive and only owned or accessible by a single firm or a small group of firms, thus creating the advantage (Grant 1991).

However, Grant (2005) further states that having superior resources does not necessarily translate into superior performance. The resources need to be organized in an efficient manner to achieve the full potential capabilities of the firm, which requires learning through repetition and developing optimal routines for the organizational processes (Grant 1991). This can lead to achieving superior capabilities in relation to competitors which creates a competitive advantage (Grant 2005).

2.1.2 The national environment – Comparative advantage

The national environment provides the framework for firms to operate within and can provide advantages or disadvantages for producing certain goods or services. National resources and capabilities include availability of raw materials, national culture, human resources, transportation, communication and infrastructure. These are the external inputs available for a firm within the national environment. Competitive advantage derived from the national environment is known as comparative advantage as it is created by the relative efficiencies of producing different products *compared* to other countries. (Grant 2005)

Hunt & Morgan (1995) presented a theory stating that enhanced competitiveness for nations can arise from a comparative advantage in resources in a market based economy (Fig. 4). Their view was that low cost resources domestically available for firms could lead to an international competitive advantage through superior financial performance. However, the product produced needed to be equal or superior to other products on the market. In a national context, the superior performance leads to a competitive industry, which can sustain its position through investing in efficiency and innovation and adapting to market changes.

Figure 4. Comparative advantage in resources can lead to a competitive advantage for firms and nations industries (Hunt & Morgan 1995)

In *A Competitive Advantage of Nations,* Porter (1990) raises the view of competitiveness to national level by stating that each nation has key factors that lead to and affects the competitiveness of their industries. These factors can lead to innovation and could develop from firms' resources and capabilities. Porter (1990) states that a competitive advantage does not only evolve out of countries natural endowments such as location, resources and labor pool but is also created by specialized factor conditions, demand conditions, the related and supporting industries and the structure, strategy and rivalry of firms.

Factor conditions are national production factors which refer to all inputs and uses. These factors can be divided into general use factors like raw material or the labor pool or specialized factors as a result of development and investments. The more specialized these factors are towards an industry, the more competitive is the industry (Porter 1990). For instance, Cukrowski & Fischer (2000) found that a nation with a developed economy of scale in transportation could be at a competitive advantage despite being in a disadvantage in factor endowments or technology.

Domestic market conditions have proven to be a driver of comparative advantage. A well-developed home market demand sends early signals of emerging consumer needs. This forces companies to innovate and create new forms of competitive advantages earlier than competitors in other countries. This effect is particularly true when the industry segment in the domestic market is much larger than that of foreign markets. (Porter 1990)

Competition also affects the state of the industry. Strong domestic rivalry stimulates innovation and efficiency where firms are trying to create competitive advantages. The structure of the industry and the organization of the existing firms have also shown to be factors for success. There is no optimal way to design a successful industry as there are many differences between countries and sectors. For instance international competitors in Italy are often privately owned small to medium-sized companies operated like families while internationally successful firms in Germany tend to be large hierarchal organizations with top managers from a technical background (Porter 1990).

Related and supporting industries can also be a source of comparative advantage. Home based suppliers that are internationally competitive create many advantages for down-stream companies as they supply efficient, rapid and cost-effective inputs. It also provides close working relationships which is a base for innovation and development. A large sector of related industries can also provide similar benefits as technological interchange and innovations can spill over to similar industries.(Porter 1990)

Another factor influencing the national environment is governmental influence. Protection, import promotion and subsidies are usual instruments applied on a market setting to skew the competitiveness of their domestic industries. This is more often seen where there is only one national rival such as aerospace or telecommunications where government contracts reduces a company's experienced competition or subsidies artificially creates a stronger market position. However market based competitiveness can be achieved by more constructive options such as investments in educational institutions or research and assistance in opening foreign markets. (Porter 1990)

2.1.3 Industry environment

While macro-economic factors influences an industry as a whole, the changes *within* an industry are vital for the profitability of singular firms. In turn, a firm's profitability depends on creating a superior value for their customers relative to other firms seeking the same value creating opportunities (Grant 2005). While competition affects the industry by other firms seeking to achieve better prices, qualities or provide additional services, the profitability of the industry decreases (Porter 2004).

Part of a firm's competitive position can arise from its bargaining power in relation to consumers and suppliers. A firm in a weak bargaining position, has less power to influence its own profitability (Grant 2005). The power of a buyer group is determined by the importance that group has on the overall market and the characteristics of that market. If the buyer group is concentrated or buys large volumes relative to the sales of the seller, then the buyer group is powerful. If the large volumes are sold to one buyer relative to the sales of the firm then that buyer or buyer group has a significant impact on that firm's results. Large buyers are especially important in industries with high fixed costs where capacity utilization is a key factor for profitability. (Porter 2004)

Supplier power mirrors buyer power and is greatest if the supply of inputs is dominated by a few large actors. These actors are most powerful when there are no substitutes for their products, when the industry is not an important customer of the supplier group, when the supplier's product is important to the buyers' business and/or the product is differentiated from that of other suppliers (Porter 2004).

Competition on markets can further be divided into direct competition and indirect competition. Indirect competition refers to firms from another industry that offers a substitute with similar consumer benefits. If the two products have the same benefit to customer then the price and switching costs will be a determinant factor of which product is bought. (Porter 2004).

2.1.4 Model for analysis

The theories behind competitive advantage are compiled in figure 5 below. Grant (2005) defines the industry environment as customers, suppliers and competitors. However, the international wood pellet industry exists because subsidies and support programs fuel pellet demand in some countries. This leads to improved competitiveness against fossil fuels and results in international industry competition. Since government support is vital for the pellet industry, it is added to the industry environment. Further Grant (2005) suggests that in commodity markets, cost advantage is the dominating view. Since wood pellets are considered a fuel commodity, cost advantage has been the focus of this study.

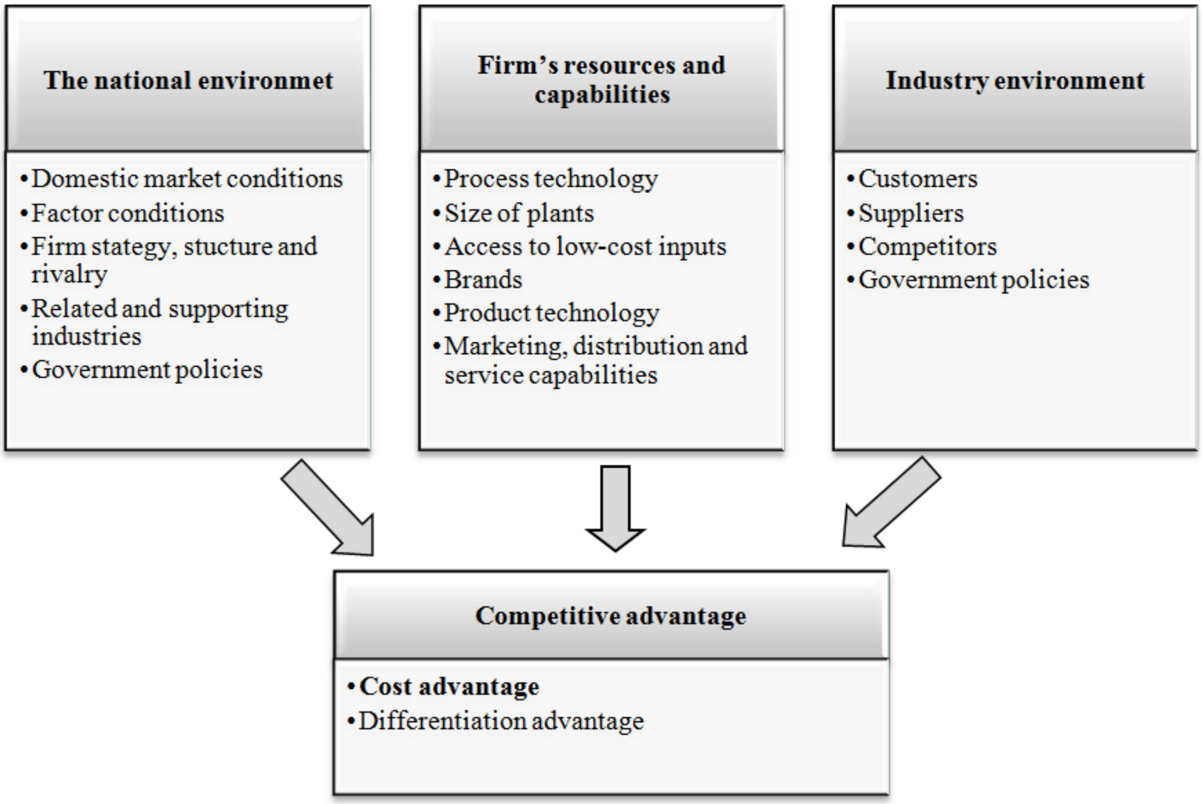

Figure 5. Framework of competitive advantage theories used as the model for analysis.

3 Methodology

This section describes under which premises the study was conducted and which methods were used to collect data and calculate costs competitiveness.

3.1 Case study research method

Yin (2009) defines a case study as an empirical inquiry about a contemporary phenomenon, set within its real-world context—especially when the boundaries between phenomenon and context are not clearly evident. Studying both the case and the context can lead to better understanding of the case itself, while resulting in a wider coverage of topics in one study. A case study can be exploratory, descriptive or explanatory. Exploratory case studies are conducted when there is little knowledge of a phenomenon, often to identify research questions or a hypothesis. Descriptive case studies aims at describing phenomenon's in their real-world context. Explanatory case studies seek to explain the occurrence of events by investigating causality (Yin 2009).

In this study a case study research method was chosen. The diverse theories behind competitiveness provide a complex background. The lack of clear boundaries and the importance of including the dynamics between producers, consumers, policy makers and other actors lead to the use of the case study research method. The need to gather a wide range of information also prompted the use of an exploratory research design, thus accommodating the wide scope under which research was conducted.

3.1.1 Research approach

The relationship between research and theory can be deductive or inductive. A deductive approach uses existing knowledge about a domain to deduce a hypothesis which is then tested by empirical research. In this case the theory and the hypothesis guide the process of gathering data. Using and inductive approach to theory means first gathering data which is then analyzed with theory based on the domain of inquiry. This allows a researcher to be completely open to all information during the investigative phase. These methods are not exclusive, but can be used simultaneously (Bryman 2008).

According to Kjær Jensen & Andersson (1995), basing research in theory can be both a strength and a weakness. Theories can help interpret reality by expressing it through a general framework, thus increasing the understandability. Theories can also provide a well-structured base for data collection. However, when investigating a specific phenomenon, the use of existing theories might lead to self-fulfillment. In moving between theory and reality, the theory might control the researcher to a degree where the observations become bias.

This study was performed using both a deductive and inductive approach to theory. The base in theory was important to identify the sources of competitiveness and how it can be assessed. However in agreement with weaknesses proposed by Kjær Jensen & Andersson (1995), the theory was not used to the extent that restrictions were imposed on the data gathering process. Focus was instead of gaining knowledge based on the study objective. Data was collected based on the research questions coupled with theory to provide a holistic view of the Latvian pellet industry. The theory was also used to analyze the results in order to find and assess sources of competitive advantage.

3.2 Data collection

Qualitative data gathering methods were chosen to achieve the aim of the study. The exploratory nature of the research was better suited for qualitative than quantitative methods, which allowed for a comprehensive information gathering of the topic (Bryman 2008).

3.2.1 Methods for collecting data

Data collection in case studies differs from other research methods. In experimental studies for instance, there needs to be environmental control to be able to measure a few variables separate from its real-world context. In surveys it is possible to collect data on both the phenomenon and its context but there are limitations on the number of variables that can be collected. Histories can be used for a broad range of research answering similar types of questions as the case study but rarely include direct observation of events or interviews of persons involved in the events (Yin 2009). However, a case study is not limited to one data collection approach but includes the possible use and mix of all scientific data collection and analysis methods to further the research process (Merriam 1994). A major strength of conducting a case study is using different sources of data to triangulate the results, which helps strengthen the validity (Yin 2014). The main methods for collecting data in this study were through a literature study and interviews. Direct observations were also used to a minor extent.

The literature study uses documents as a source of information. Documented information can for example be letters, reports, internal records, formal studies and news articles. The strength of documents is that they can be reviewed repeatedly, are separate from the case study, can contain specific information and provides both broad and in-depth views into the researched domain. In case studies, documentation is often used for verification of information from other sources and to provide specific details about events or subjects. However, documents should be carefully used as they may not be accurate or contain bias views. The accessibility of documents can also be an issue as certain data might be withheld for privacy reasons, leading to a bias in document selectivity (Yin 2014).

Interviews are often the most important source of information when conducting a case study (Yin 2014). The main purpose of a case study interview is to find specific information based on an individual's knowledge or opinions. The information is usually of a character which will not allow a researcher to gain the knowledge elsewhere through other research methods (Merriam 1994). Interviews have the advantage of being targeted, focusing directly on the case study topics. Interviews are also insightful, providing not only explanations, but personal views and opinions. However, poorly formulated or articulated questions as well as leading questions can lead to biased results. Inaccurate recall and subjectivity can also have a negative effect on results (Yin 2014).

The research methods were executed in two phases. The literature study was the preliminary gathering of secondary data aimed at identifying and understanding the industry environment (competitors, suppliers, customers and government support), possible resources of the pellet firms and a background on the domestic condition for the pellet industry, factors related to competitiveness and the Latvian pellet industry. The second phase was aimed at gaining empirical knowledge about the pellet industry, the domestic production conditions and the Latvian industry's competitive position in the industry environment. Some e-mail correspondence and phone calls have also been made to gather and verify some of the data in the literature study and cost calculations.

3.2.2 Literature sources

Through the literary study it was possible to gain knowledge and identify parameters of interest to facilitate the empirical study. The study provided insight into areas such as global trade flows, resources needed for pellet production and the industry's competitive layout which could be used to further specify areas of interest and raise the researcher's knowledge prior to the interview phase. Thus, the literature study provided support to the scope and limitations of the study as well as base for further data collection and analysis.

Scientific sources were prioritized during the literature study. However, the research also included non-scientific sources to account for a lack of data and information in scientific literature. The effort of including support schemes and other policies into the study has also meant relying on information and data from governments and the EU commission.

The search process was started using scientific search engines, such as Web of Science and Google scholar to collect and assess the current scientific literature on and related to the topic. It also included books and published papers gained through library search engines and online databases. Based on this data, the need for further information could be identified and the search process was targeted to fill information gaps, find current data and increase the depth of the study. This search was widened to include other documents by using generic search engines and information and documents received through personal communication. During this stage, reports from corporations, governments and interest organizations were gathered. Different authorities' web pages were also used to collect data on support schemes and renewable energy policies. A small amount of data was also collected from seminar presentations to gain market research which was not otherwise available. Statistics were collected from reports and the databases of FAOSTAT, Eurostat and the Central Statistical Bureau of Latvia. Most information in the published paper's literature study is publicly available. A table of the documents used in the literature study shown by type and search method is available in Appendix A.

3.2.3 Interviews

Interviews in qualitative research are often less structured than in quantitative research. The interest in the interviewee's knowledge and opinions is greater than creating a measurable result of key concepts (Bryman 2008). The structure of the interview should be a result of the information needed and the researcher's knowledge of the research topic. Unstructured interviews are often performed when researchers lack the knowledge to ask relevant questions. A structured or standardized interview is on the other hand suitable when the topic is well known and the researcher can specify the information needed. This type of interviews are also referred to as surveys (Merriam 1994).

Between the two extremes are the qualitative semi-structured interviews. The semi-structured interview is often based on a protocol or interview guide with thematic topics or questions which are intended to guide the processes (Kvale & Brinkmann 2009). However, interviewees are encouraged to influence the process. This provides insights to what is relevant to the individual and can lead to gaining knowledge which would not have been supported by an transcript composed before the interview (Bryman 2008). An equally important part of the semi-structured interviews is that it allows for follow up questions, which requires an active interviewer with knowledge of the topic, to further investigate interesting issues that arises. This exchange between the two parties can also lead to a relaxed and conversation like interview medium which could increase the interviewee's openness and facilitate the thought process (Kvale & Brinkmann 2009).

The interview format chosen for this study were semi structured qualitative interviews. When restructuring the research question into areas of interest it was clear that the information gathered needed to be more comprehensive than what could be gained through structured interviews. The lack of literature sources on Latvia's wood pellet industry promoted an open ended interview format. It was imperative to identify factors influencing Latvian pellet production not only as explained in literature but as actually perceived by the actors in that context. This need was further proved during a pilot interview were the respondent repeated that "*Many aspects of the pellet industry cannot be learned through literature...*"

The interview questions were derived from the research question through a process of creating thematic topics of interest (Kvale & Brinkmann 2009). With the research questions as a base, coupled with the literature study and theory, topics were formulated providing a base for the needed information. The topics were further divided into specific aspects, providing a protocol for the interviews. The protocol was also used as a checklist reassuring coverage of the specific aspects. As the interviews were conducted with actors in different position and relations to the Latvian pellet industry, no standardized questions or questionnaire was used. Instead the interview questions were formulated based on the interviewee's topic of expertise from the protocol. The protocol is shown in Appendix B.

Determining the interview sample

The initial idea for sampling was to identify the population of pellet producers in Latvia, contacting them, providing them with information about the study and ask for their participation. This strategy had a low success rate as there was high skepticism about reveling details about the company. One individual proved to be much helpful and have great insight into the pellet industry in Latvia. The sampling strategy then changed to the snowball method, using that individual's knowledge and contacts to gain more interviewees (Bryman 2008).

The total interview sample comprised of 9 individuals divided into two categories, generalists and specialists, based on their knowledge. The generalists comprised of four individuals, three working at different pellet producing companies and one from a bioenergy trading company. They provided knowledge of the overall workings of their companies and the wood pellet industry in Latvia in a national and global context. The specialists were five individuals with specific knowledge of the wood pellet value chain concerning raw material, transportation, terminal handling, shipping and certification. The interview respondents are shown anonymously in Appendix C by position at the company, type of company and interview medium. Since the Latvian pellet industry is relatively small, further detailed information about the individuals and companies has been avoided to ensure anonymity.

The process of interviewing, transcribing and compiling results

6 of the interviews were conducted face-to-face in Latvia which also included visits to 3 pellet mills and 3 pellet handling terminals in Riga port. 3 interviews were conducted over the phone. It would have been preferable to conduct all interviews in person, but because of timing, distances and budgetary concerns, this was not possible.

Interviews ranged between 30 minutes and 2 hours (excluding mill and terminal visits) and were conducted in English. The telephone interviews were generally shorter than the face-to-face interviews. Most generalists' interviews were longer due to a wider coverage of topics and their generally better English speaking skills. The interviews were recorded when possible and in the other cases, notes were taken and the interview was transcribed immediately after.

All recordings were transcribed with the voice recognition software, Dragon Naturally Speaking 10.0, trained to the researcher's voice. This was done because of a temporary physical impairment. However, simultaneously listening and repeating the interviews verbally was a convenient and fast way of transcribing. After transcribing, the interviews were proof read and required alterations were made.

All responses from the interviews were then sorted and structured by the topics of interest in the interview protocol. The information needed in the calculations was also extracted and compiled. Then the interview responses were read again to identify the material in line with the motive, objective, research questions and theoretical framework of the study, which was then condensed into the interview results. Some quotes were also gathered to enhance or clarify the views of the respondents.

3.3 Ethical considerations

The ethical considerations used in this study are the requirements of information, consent, confidentiality and use proposed by the Swedish Research Council. The information requirement states that the researcher must inform the respondent of the condition and purpose of their participation. The consent requirement means that respondent's participation must be voluntary. The respondents also have the right to decide the conditions of participation and when their participation has come to an end. Under the requirement of confidentiality, all information must be stored and presented in such a way that no individuals can be identified by others. The requirement of use states that information gathered about individuals cannot be used for non-scientific purposes. (Vetenskapsrådet 2002)

To fulfill these requirements, all participants were sent an email or were contacted by phone. Then they were informed about the study, its purpose and the information that was intended to be collected and asked to voluntarily participate in the study. Furthermore, the interviews were initiated with a brief presentation of the same information as described above. The participants were also informed about the use of the collected information and that it would be published. They have also been kept anonymous in the study to ensure confidentiality.

3.4 Cost calculations

The cost competitiveness of Latvian pellet producers on the selected markets was based on using literature and interview results. Calculations are described below.

3.4.1 Cost profile of wood pellets from Latvia

In the cost calculations, the cost profile per tonne pellets produced and transported was calculated for four pellet mills from raw material to end market. Calculations for mill 1, 2 and 3 were based on information gathered through interviews and company documents. Calculations for mill 4 were based on official statistics of raw material consumption and reported Latvian raw material prices (Fig. 20, 21, 22, 23). The intent of creating the fourth mill was to increase the study's degree of generalization by using national averages. The distance to port for mill 4 was set at 100 km, which locates it in the middle of Latvia. The transportation costs were calculated using average cost per tonne and km based on the interview responses. The other costs categories for all mills are described below.

The cost profiles cover raw material, production, domestic transportation, port and shipping (Table 1). The costs of raw material and transportation are mill specific, but the production costs are based on average costs from two different mills in Latvia. This was done as the study resulted in some information gaps regarding equipment and costs. The same shipping costs were used for all mills, which is described in the interview results.

Table 1. Cost profile of Latvian pellet mills shown with costs included in each cost category (methodology adapted from Thek & Obernberger 2010 and Grammelis 2010)

Cost category	Included costs
Raw material	*Raw material delivered*
	Chipping
Production	*Raw material handling*[1]
	Fuel
	Electricity
	Maintenance (spare parts etc.)
	Salary
	Insurance
	Administrative
	Depreciation[2]
	Bank interest
	Pellet handling
	Other production cost[3]
Domestic transportation	*Transport from mill to terminal*
Port	*Pellet handling*
	Storage
	Loading ship
Shipping	*CIF Freight rates*

[1]Handling refers to loading, offloading and transportation of goods within the specified cost category.
[2]Depreciation refers to the decreased value of assets such as equipment, machinery and buildings.
[3]Other production costs were costs not reported to or documented under any other cost group.

The raw material costs were calculated from feedstock costs, average transformation factors and chipping costs from three Latvian pellet mills received through interviews (Table 2).

Table 2. Transformation factors and costs used to calculate raw material prices per tonne pellets

Raw material	Fuel wood	Chips	Sawdust
Transformation of fuel wood from solid to chips (m^3s/ m^3l)	2.7		
Chipping costs (€/ m^3l)	1.0		
Raw material used to produce 1 tonne pellets (m^3l/t)		0.17	0.14

3.4.2 Cost competitiveness of wood pellets against coal

The cost competitiveness of wood pellets against coal was calculated in Belgium, the UK and the Netherlands. The calculations are based on the spark spread model which is an industry measure to relate the cost of feedstock to the revenue of selling electricity. The model was originally developed in energy market, between the price of electricity and natural gas, as a measure of the electricity generating assets economic value (Fusai & Ronocoroni, 2008). The spark spreads in this study were calculated for pellets and coal, including support for RES-E production and the cost of carbon emissions (Argus Media 2013b; McDow & Qian 2013).

General spark spread model:

*[Spark spread] = [Electricity price] – [Cost of feedstock] * [energy content] * [plant efficiency]*

Specific wood pellet and coal spark spread model:

*[Pellet spark spread] = [Electricity price] + [Government financial support] – [pellet price per tonne] / ([pellet calorific value] * [power generation efficiency])*

*[Coal spark spread] = [Electricity price] – ([Coal price per tonne] /([Coal calorific value] * [power generation efficiency]) + [Coal carbon factor] * [Cost of emissions])*

All calculations uses MWh as the base value of electricity produced. Table 3 further explains the parameters in the calculations.

Table 3. The parameters for the cost calculations on wood pellet competitiveness against coal. (Methodology adapted from Argus Media (2013b) and McDow & Qian (2013). Data compiled from literature, Argus Media (2013b) and through personal communication

	The UK	Belgium	The Netherlands
Power generating efficiency	[Energy produced] / [Feedstock energy content] In co-firing installations, pellet efficiency is reduced with 10% compared to coal		
Electricity price	Wholesale price of electricity		
Government financial support	Market value of ROC and LEC	Market value of Green Certificates	Price pemium in the current phase (FIT)
% of support awarded	Depends on technology and co-firing levels (i.e. banding levels)	Depends on energy usage in production and transportation of pellets	N/A
	Wood pellets		
Pellet price per tonne	Price per tonne pellets delivered to port (CIF ARA)		
Pellet price per MWh	[Pellet price per tonne] / [Pellet calorific value]		
Pellet efficiency adjusted cost	[Pellet price per MWh] * [Power generating efficiency]		
Pellet spark spread	[Electricity price] + [Governmental financial support] – [Pellet efficiency adjusted costs]		
	Coal		
Coal price per tonne	Price per tonne coal delivered to port (CIF ARA)		
Coal price per MWh	[Coal price per tonne] / [Coal calorific value]		
Coal efficiency adjusted cost	[Coal price per MWh] * [Power generating efficiency]		
Coal carbon factor	Tonne CO2 emitted per every MWh pellets produced		
Cost of emmissions	[Coal Carbon factor] * ([Price of EU ETS emission allowances] + [The carbon price support (CPS)]	[Coal Carbon factor] * [Price of EU ETS emission allowances]	
Coal spark spread	[Electricity price] – ([Coal efficiency adjusted costs] + [Cost of emissions])		

4 Results from literature study

This section is based on the literature study which is focused on gaining knowledge of wood pellets, the global industry environment, the wood pellet value chain and the Latvian wood pellet industry.

4.1 Wood pellets

Bioenergy can be produced from biofuels which includes solid, liquid and gaseous fuels consisting of or produced from biomass. Within the group of solid biofuels are solid wood fuels which derives from woody biomass (Fig. 6) (Olsson 2012).

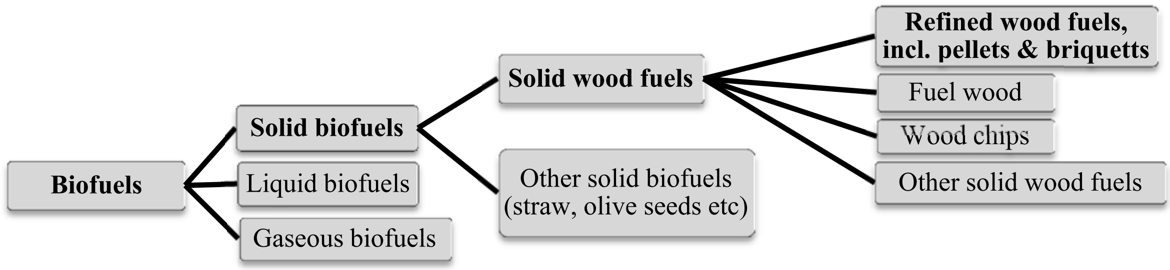

Figure 6. Categorization of biofuels, solid biofuels and solid wood fuels (Olsson, 2012).

An important distinction in solid wood fuels is between the refined and unrefined fuels. The unrefined fuels have not been altered significantly from its original state, whereas the refined wood fuels have been industrially processed to enhance certain properties. Wood pellets are refined solid wood fuels that have been dried and compressed to a higher density (Olsson 2012).

The pelletizing process increases the energy content of the wood. This reduces cost sensitivity to transports, as more energy can be transported per volume and weight unit. The lower moisture content and homogeneity within the material also allows boiler designs for better combustion efficiency (Thek & Obernberger 2010). The calorific value of wood pellets is 4.8 MWh/tonne, almost twice as high as other wood based solid fuels (Fig. 7).

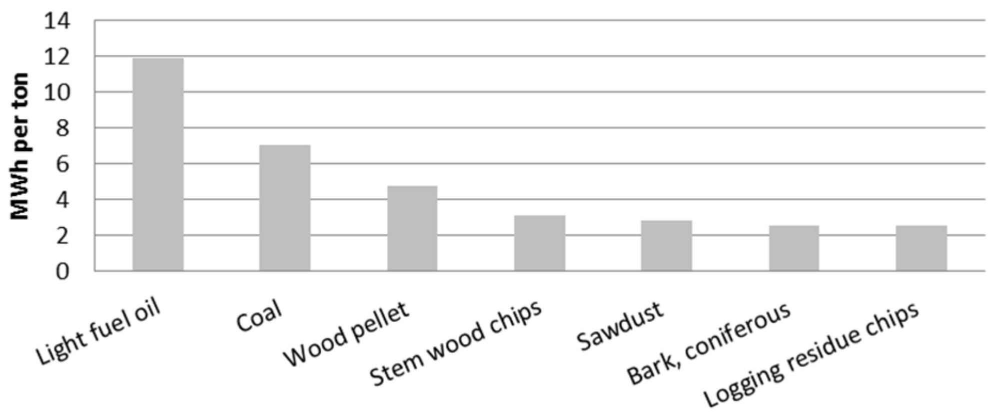

Figure 7.Net calorific value of wood products used as solid fuels compared to Coal and light oil fuel (Alakangas 2009).

Wood pellets can further be divided into two categories defined by end user; residential and industrial. Residential wood pellets are used in small-scale furnaces for domestic heating which require high and consistent quality and a low content of residuals and ash. Industrial users have a higher tolerance for larger diameters and higher ash, nitrogen, chlorine and sulfur contents. The higher residue content broadens the feedstock base as bark is allowed to a certain extent. (Thek & Obernberger 2010)

4.1.1 Standards

In 2010 The European Committee for Standardization (CEN) published a common EU standard for solid biomass. This included the EN 14961-6 standard for woody pellets for non-industrial use. Before the standard, countries had their own national standards where quality regulations and control could differ greatly between nations (Thek & Obernberger 2010). The current standards are based on the ISO system and regulates the origin of the wood, physical properties and chemical properties (Alakangas 2010).

However, there have been no common CEN standards for industrial pellets. Instead the Wood Pellet Buyers Initiative (WPBI) has developed an industry standard based on the needs of the large scale wood pellet users in Europe. Combustion technologies and logistic facilities have been key issues when developing the standards which has made the percentage of fines, ashes and chlorine, the durability and the particle size distribution aspects of focus regarding pellet quality requirements (Verhoest & Ryckmans 2012).

4.2 Global pellet market overview

4.2.1 Pellet production

Wood pellet production started in the 1970's during the oil crisis but the presence of cheaper fuels constrained the global pellet market. In the 1990s Sweden and Austria pioneered the pellets industry by the development of both domestic production and demand for the fuel commodity. The increased wood pellet demand led to the construction of pellet mills in other forest rich countries, like Finland and the Baltic States, manufacturing pellets for export (Hiegl & Janssen 2009). From this point, the global pellet industry has increased tremendously and global consumption was estimated to be between 22.4 and 24.5 million tonnes in 2012 (AEBIOM 2013).

Wood pellets are mainly produced in areas where woody biomass is locally available and most pellet mills are found in North America and Europe (Vakkilainen & Kuparinen 2013). Half of the global production of wood pellets in 2012 was within the EU27 while North America accounted for 28% (AEBIOM, 2013). Germany, Sweden and Latvia are the three largest producers in the EU (Fig. 8). While Germany has increased production over the last couple of years, production in Sweden has been decreasing from 2010 due to import competition from Russia and the Baltic States (Smith et al. 2013).

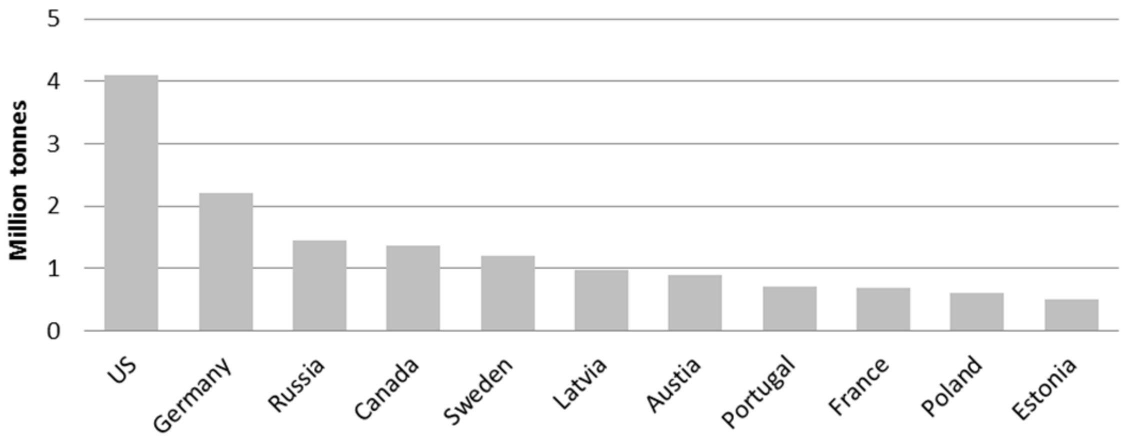

Figure 8. Wood pellet production in the world's largest pellet producing countries in 2012 (AEBIOM 2013).

Pellet producers in the US account for a majority of the North American production, with the South East region being the most productive (Sikkema et al. 2011; Biomass Magazine 2013b). During the last couple of years, large pellet plants with a capacity up to 800,000 tonnes/year have been constructed in this region (McDow & Qian 2013; AEBIOM 2012). Canada's main productive region is British Columbia on the west coast, comprising of more than half of the nation's production capacity (Biomass Magazine 2013a; Sikkema et al. 2011).

Most planned large pellet mill projects are located in North America, with a majority of the volumes destined for Europe. These plans, if realized, will further increase the global pellet trade flows within next few years. (Vakkilainen & Kuparinen 2013; AEBIOM 2013)

4.2.2 Pellet consumption

The main consumers of wood pellets and drivers of developing international markets are found within the EU. In 2012, 15.1 million tonnes were consumed in the EU27, almost double from 2008. (AEBIOM 2013) There are two primary uses of wood pellets, for heat and for power. The use of pellets for heat is dominated by residential and commercial users heating facilities with pellet boilers. Large-scale industrial power plants or combined heat and power (CHP) plants utilize pellets for power production (AEBIOM 2013; Smith et al. 2013).

Based on the main users of wood pellets, countries consuming large amounts of wood pellets can be divided into three groups. In the Netherlands, UK and Belgium the majority of the wood pellets are used for large scale electricity production by major utilities. In Denmark and Sweden the pellet users are a mix of households, district heating plants and power plants. The final group consists of Germany, Italy, Austria and France where most wood pellets are used in small residential and industrial boilers to produce heat (Fig. 9) (Smith et al. 2013; Goh & Junginger 2013).

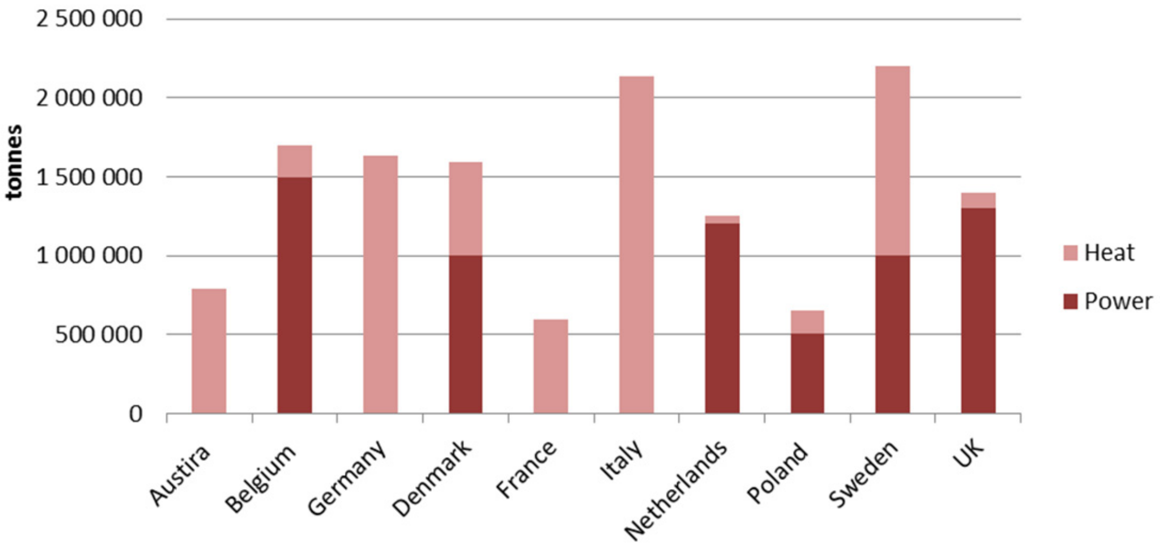

Figure 9. The highest pellet consuming EU countries in the EU and their share of pellet consumption for heat and power purposes (AEBIOM 2013).

Power plants using industrial wood pellets can either be dedicated plants using only biomass or co-firing plants, firing pellets with another type of fuel. Co-firing is usually done with coal since it is the least expensive and efficient way (Baxter & Koppejan 2005). Using wood pellets in co-firing gives an advantage over other biomass fuels due to energy density, low moisture content and low amounts of residue and homogeneity, which are characteristics similar to coal (McDow & Qian 2013). The energy efficiency of using biomass is in general 10% less than for coal in the same installation. In electricity production it varies between 30-40% but overall energy efficiency in CHP plants also producing heat is 85-90% (IEA 2007).

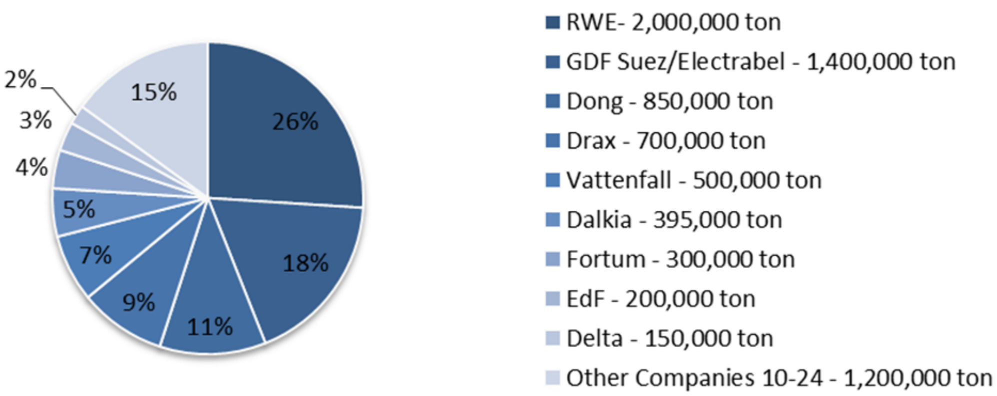

Figure 10. Estimated global consumption of industrial wood pellets by the largest consuming companies in 2012 (Blair 2013).

The global market of industrial wood pellets is dominated by a few large companies. Argus Media (2013) estimated that 9 of the largest end-users consumed 85% of the total consumption of industrial pellets in 2012 (Fig. 10). These large pellet consumers are multinational companies with utilities requiring several hundred thousand tonnes per year. For instance in 2010, RWE had two pellet burning utilities, Tilbury in the UK and Geertruidenberg in the Netherlands, with an annual capacity of 2.5 and 1 million tonne pellets. GDF SUEZ/Electrabel also had two utilities running with the capacity of 1.2 and 0.5 million tonnes in Belgium and the Netherlands. Meanwhile DRAX was co-firing about 1 million tonnes in the UK and Dong energy was consuming 0.6 million tonnes in the Avadore power plant in Denmark (Verhoest & Ryckmans 2012).

4.2.3 International trade

The growth of the pellet demand in Europe has resulted in many import dependent national markets. They rely on the supply from main exporters such as North America, Germany, Austria and eastern European countries. While the European pellet production already falls short of meeting the demands, the use of pellets is believed to continue to increase (Sikkema et al. 2011; AEBIOM 2012; Hiegl & Janssen 2009; Cocchi et al. 2011).

Residential pellets for heating have predominantly been exchanged between neighboring countries except for the Baltic States to Scandinavia and Italy's imports from different European countries. The long distance transports have instead been dominated by large bulk loads of industrial wood pellets by ship (Hiegl & Janssen 2009). The main exporting nations of wood pellets are the US and Canada shipping large volumes to the European industrial markets, mainly imported by the UK, Belgium and the Netherlands. Other imports to European countries mainly originate from producers within Europe and Russia (AEBIOM 2013).

The largest importer of wood pellets in the EU in 2012 was Denmark followed by the UK, Italy, Belgium and the Netherlands (Fig. 11). However in a prognosis of the industrial markets by AEBIOM (2013), the UK is expected to have the largest increase industrial wood pellet consumption, reaching 4.5 million tonnes in 2013. The expected increase in demand requires stable and long term supply options to ensure capacity utilization. Countries like Belgium, the Netherlands and UK will have an advantage in creating efficient supply chains due to large port infrastructures (Verhoest & Ryckmans 2012).

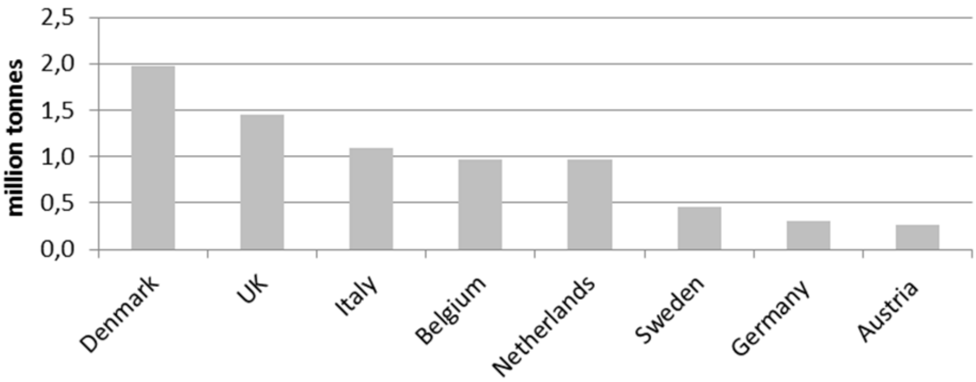

Figure 11. The largest wood pellet importers in the EU in 2012 (AEBIOM 2013).

4.3 EU support affecting the competitiveness of wood pellet producers

The EU direction towards renewable energy sources has led to the development of policies such as tax incentives and subsidies supporting the development of RES technology (Fürsch et al. 2010). EU has also implemented an EU-wide Emissions Trading Scheme, requiring non-RES users to purchase emission allowances to compensate for their greenhouse gas emissions (European Comission 2013b). Subsidies and support concerning industrial wood pellets in the EU and Belgium, the UK and the Netherlands are explained in the following sections.

4.3.1 Support schemes in general

The main support schemes within the EU can be divided into quantity-based or price-based and technology-neutral or technology-specific instruments. *Quantity-based instruments* focus on reaching a specific amount of RES-E. This is usually done by setting a quota obligation on producers or suppliers, requiring certain percentage of their electricity to be produced from RES. The most common scheme used is Tradable Green Certificates (TGC). TGC-schemes awards green certificates under a specific period for the production of energy from RES. In the scheme, a target quota is set for the percentage of each producer's energy output that needs to come from RES. Suppliers or producers submit their GCs to verify that they have reached their obligations. If the obligation is not met, a penalty fee is issued. GCs are tradable which means that companies can reach their quota through purchasing certificates from other producers. (Fürsch et al. 2010)

Price-based instruments stimulates the development of electricity from RES by setting a fixed price or awarding price premiums to producers of renewable energy. The abatement will be determined by the reactions to the premium or price level, which results in an uncertainty about the quantity. The most common scheme used is Feed-in tariffs (FIT). The tariffs are regulated by the government and granted to producers of RES-E in terms of a fixed price per energy unit produced. FIT schemes can be very effective in stimulating RES-E expansion but could be inefficient in reaching the right levels or promoting the best fitted technology. (Fürsch et al. 2010)

Technology-neutral means that every produced unit of RES-E receives the same value in terms of tariffs, premiums or certificates. This approach leads to the most cost efficient way of producing RES-E as the cheapest technology will dominate. *Technology-specific* systems are engineered to support specific technologies and lower entry barriers. It can be used to increase the electricity from specific sources such as biomass or wind power. (Fürsch et al. 2010)

4.3.2 RES-E support in the UK

The main financial incentive for industrial producers of electricity in the UK is the Renewable Obligation (RO). The RO is a TGC system where the government dictates the amounts of electricity that must come from RES for licensed suppliers to the UK grid. If the suppliers cannot fulfill the initial renewable requirement they are obligated to make a payment to a pay-out fund or purchase renewable obligation certificates (ROCs) from a RES-E producer. (Ofgem 2013a)

When the obligation was first introduced in 2002, 1 MWh of renewable electricity produced was awarded with 1 ROC. However the system has been reformed to be technology-specific system is based on cost, market maturity and large scale potential. Different technologies receive a different amount of ROCs according to banding levels determining how many certificates per generated MWh. (DECC 2013)

The amount of ROCs needed every year increases, following the national target rates for renewable energy mix. In 2002/2003 this level was set at 3.0% (0.03 ROCs/MWh produced) and is now at 0.206 ROCs for every MWh supplied (Table 4) (different rates apply to Northern Ireland). (van der Linden et al. 2005)

Table 4. Obligation levels and buy out price from 2010-2014 (Ofgem 2013c)

Obligation period (1st April - 31st March)	Pay-out price	Obligation for England & Wales and Scotland (ROCs/MWh of electricity supplied)	Obligation for Northern Ireland (ROCs/MWh of electricity supplied)
2010-2011	*£36.99*	*0.111*	*0.0427*
2011-2012	*£38.69*	*0.124*	*0.055*
2012-2013	*£40.71*	*0.158*	*0.081*
2013-2014	*£42.02*	*0.206*	*0.097*

The RO-scheme is proposed to be maintained until 2037 but it will not be open to new applicants after 31 March 2017. A new FIT scheme called Contracts for Difference (CfD) was introduced in 2014 and will eventually replace the RO system (Ofgem 2013b).

4.3.3 RES-E support in Belgium

The Belgian government's renewable electricity promotion scheme is, like the UK, a TGC system called the Green Certificate (GC) Scheme. One certificate represents 1MWh "green" electricity (Flach 2013). Belgium is a federal state with three regions; Flanders, Wallonia and Brussels. Each region has their own authorities responsible for energy policy which includes development of renewable energy sources (Greunz 2011).

The certificates are directed towards the electricity suppliers who need to submit a specific amount of certificates to fulfill their quota obligation. Certificates can be bought from producers of renewable energy on an open market (VREG 2013a; VREG 2013b). The obligations of green energy production increase every year. In Flanders for instance, the obligation started at 0.8% in 2002 when the GC scheme was first implemented and is currently at 15.5% (Table 5). The fine for not fulfilling the GC obligations was 118 Euros per certificate until March 2013 when it was lowered to 100 Euros (VREG 2013a; VREG 2013b; Febeliec 2013).

Table 5. The basics of the support schemes in Wallonia, Flanders and Brussels (Data compiled from Céline & Robert 2013; EREC 2009)

Region	Price Level [€/ MWh]	Share of RES-E%	Comments
WALLONIA:	Fine for missing GC: € 100 Minimum price per GC: € 65 Average market price 2012: € 88	15.75% in 2012 19.4% in 2013 23.1% in 2014 26.7% in 2015 30.4% in 2016 37.9% in 2020	GCs given are based on the voidance of CO_2 emissions in relations to energy from gas fired turbines.
FLANDERS:	Fine for missing GC: € 100 Minimum price per GC: € 93 Average market price in May 2013: € 95.23	14% in 2013 15.5% in 2014 16.8% in 2015 18% in 2016 19% in 2017 19.5% in 2018	GCs awarded are based on the energy balance with feedstock production and transportation. (The quota is adjusted annually based on total GCs and energy produced and the levels shown are maximum levels)
BRUSSELS:	Fine for missing GC: € 100 Minimum price per GC: € 65 Average market price in 2012: € 81 - € 92	3.75% in 2007 4.90% in 2008 5.25% in 2009 6% in 2010	GCs awarded are based on the energy balance with feedstock production and transportation.

In Wallonia, GCs are awarded according to CO_2 emission avoidance. The base value is CO_2 emissions from electricity produced in gas-fired turbines. In Flanders, GCs are awarded based on the energy balance of the source material. The energy used for transportation and production is retracted from the amount of energy that is awarded certificates (VREG 2013a; VREG 2013b). This results in different support levels depending on the origin of wood pellets (Table 6).

Table 6. The percentage of Green certificates awarded per energy unit produced from wood pellets from different regions and countries in Wallonia and Flanders. Full calculations are shown in Appendix D (Ryckmans 2010)

	Belgium	Germany	Portugal	Latvia	Canada	S.A.	USA	Australia	Russia
Flanders	87%	87%	87%	86%	80%	79%	75%	74%	73%
Wallonia	86%	88%	86%	85%	77%	76%	72%	70%	67%

The schemes are also based on the share of biomass burned. For instance, co-firing in Flanders receives only 50% of GCs per biomass used up to a co-firing level of 60%. If the biomass share is over 60% then the remaining percentage of green electricity produced receives full GC support (K. van Staeyen, personal communication, April 29, 2014).

4.3.4 RES-E support in the Netherlands

The Netherlands uses a FIT scheme to support renewable energy sources by subsidizing production of energy from renewable resources. In 2003 the Dutch government implemented the Milieukwaliteit Elektriciteitsproductie subsidie (MEP) scheme supporting energy production from RES with 60-70 €/MWh. The scheme covered both dedicated biomass plants and co-firing utilities. This scheme was calculated to be equal to 120-135 € per tonne pellets. (Junginger & Sikkema 2009)

The MEP ran until 2006 when the government implemented the new FIT scheme Subsidies Duurzame Energie (SDE). The idea behind SDE was to compensate energy producers for the difference in costs between using fossil fuels and renewable sources for electricity production. The subsidy amount depended on the technology and amount of power produced (Statistics Netherlands 2009).

In 2011 the SDE was amended to the SDE+. While supporting a range of RES including clean wood and wood wastes, the SDE+ does not support large scale co-firing. However contracts written under the MEP scheme ensured electricity producers support 10 years after signing. Co-firing could be supported in the future as the alternative is under investigation for a new decree in 2015. Electricity producers using only biomass, who were supported through the MEP, can apply for support through the SDE+. However, new electricity producers are not supported through the SDE+ as support for biomass is only directed towards CHP and heat producing plants. (J.B. Agterhuis, Personal Communication, March 9, 2014)

4.3.5 European Union Emission Trading Scheme

The European Union Emissions Trading Scheme (EU ETS) was first lunched in 2005 as a part of EU climate policy against climate change. The emission levels are set centrally and emission allowances are then auctioned out to the highest bidder. Each year the emission cap will decrease to reach the goals of the EU climate policy. If an installation exceeds the allowed emissions, more allowances must be acquired. If emissions are lower than the allowances acquired, an installation can sell its allowances to other installations (European Comission 2013b). The EU ETS is proposed to run through 4 phases. During the first two phases, general allowances were mainly (90%) given for free. Under the EU ETS rules, biomass is considered renewable and has a zero net emission rating:

"'Biomass' means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries…" (European Comission 2012a)

Table 7. The supply-demand balance of allowances in the EU ETS (European Comission 2012b)

Million tonnes of CO_2 per year	2008	2009	2010	2011	Total
Supply of allowances	2076	2105	2204	2336	8720
Demand (reported emissions)	2100	1860	1919	1886	7765

During the first two ETS phases there has been an allowances surplus issue (Table 7). The spot price of ETS reached its peak in 2006 at € 29.20 per tonne CO2, but fell when awareness spread that aggregated allowances surpassed the emissions (Ellerman & Buchner 2006). In trying to stabilize the ETS in phase II (2008-2012), the emissions cap was lowered and banking between periods was allowed. However, the economic recession led to lower industrial activity and the price of allowances fell to below €10 in 2012 (Fig. 12). (European Comission 2012b)

In implementing phase III (2013-2020), the EU ETS has seen some significant changes:

- The cap on emissions is EU-wide and no longer based on national caps
- Increasing the share of allowances issued through auction. All allowances for power generation will be sold on auction.
- More sectors and greenhouse gases are included in the scheme. (European Comission 2013b)

The Commission will also postpone 900 million allowances until 2019-2020 for demand to pick up. However, the current structural surplus is not anticipated to change significantly during phase III. (European Comission 2013c).

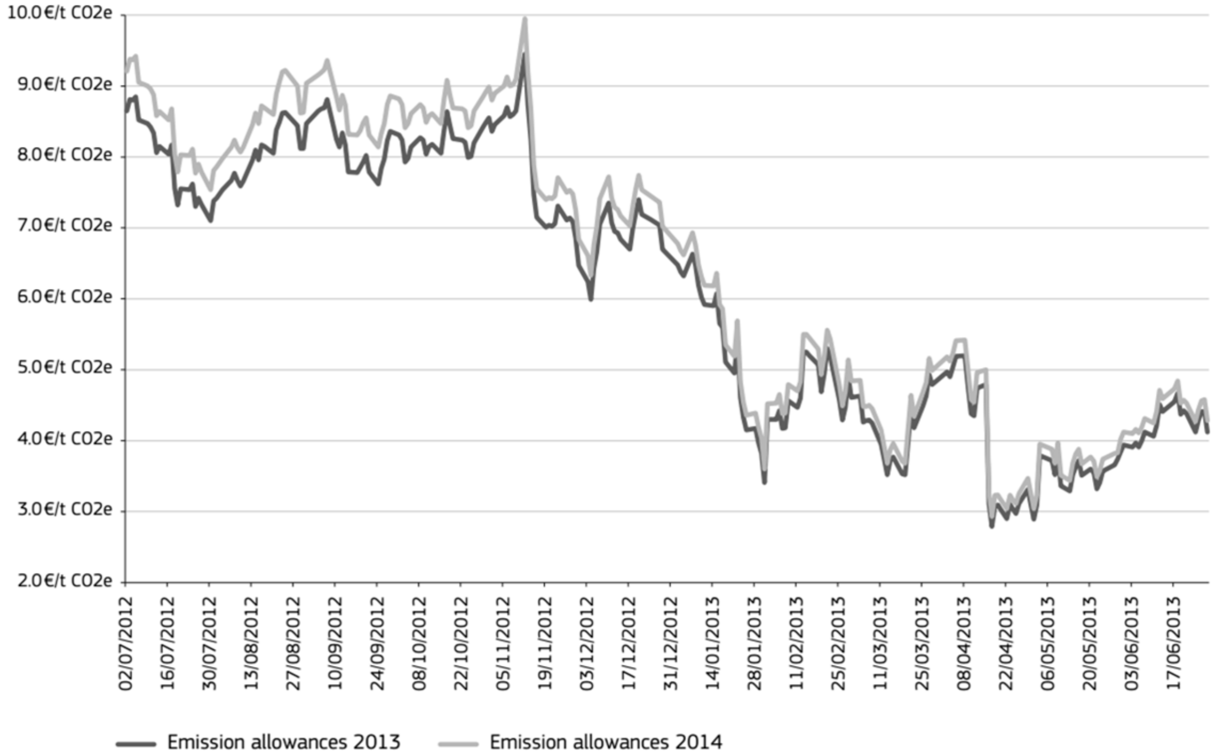

Figure 12. The price of EU ETS emission allowances in euro per tonne CO_2 equivalent from 2012 to June 2013 (European Comission 2013a).

4.4 Coal Prices

Industrial wood pellets are mainly a substitute for coal as current installations can be retrofitted to both co-firing and fully dedicated to biomass combustion (Baxter & Koppejan 2005; IEA 2007). The price of coal will then play a role in the profitability of wood pellets for power production. During the last two years the world market price has continued to fall (Fig. 13). From above 120 USD/tonne in September 2011, it reached it reached a record low of 73 USD/tonne CIF ARA in June 2013 (VDKi 2013).

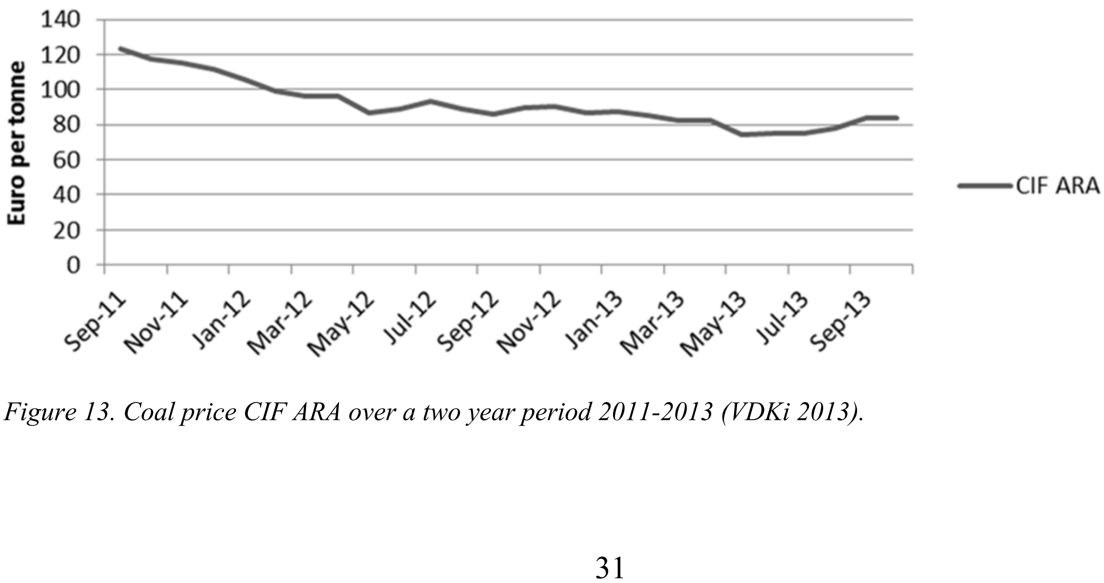

Figure 13. Coal price CIF ARA over a two year period 2011-2013 (VDKi 2013).

4.5 The wood pellet value chain

4.5.1 Raw Material

Industrial by-products like sawdust and wood shavings are the preferred feedstock for the pellets producers because the particle sizes are small and planer shavings are already dry. Wood pellets are usually made from conifer wood but can be mixed with hardwood although pellets from hardwoods are harder to bind without additives (Kofman, 2007).

However, high pellet demand and further use of milling by-products in-house have outstripped the supply in several parts of the world which has forced pellet manufacturers to diversify. There is an increasing use of sourcing alternative feedstock such as wood chips, round wood, forest residues, bark, recycled wood and wood from short rotation plantation (Cocchi et al., 2011). This can affect the quality of the pellets and the feedstock needs to be compliant with the intended pellet consumer (Janssen, 2009). Using forest residues as feedstock could increase the handling costs and have implications on the quality of the pellets. However, it can offer benefits by being a supplementary energy source to reduce production costs, especially in the drying process (McDow & Qian 2013).

Industrial by-products or residues are supplied from wood processing industries (Table 8). On average, sawmills in Sweden with a capacity over 5000 m^3 lumber per year has shown to produce 48% by-products were 35% is wood chips, 10% is sawdust and 3% is shavings (Lundmark & Söderholm 2004).

Table 8. Amount of residue production in three wood processing industries (FAO 1990)

	Sawmilling (%)	Plywood Manufacturing (%)	Particleboard Manufacturing (%)
Finished product (average)	45-55	40-50	85-90
Residues/Fuel	43	45	5
Losses	7	8	5
Total	100	100	100

4.5.2 Pellet production

Wood pellets are produced by compressing dried and grounded material under high temperature and into small cylindrical pellets 6-10mm in diameter. The manufacturing process normally include the following steps; feedstock reception, screening, grinding, drying, pelletizing, cooling and packaging/storing (Peksa-Blanchard et al. 2007). However the process differs depending on what feedstock is being used (Peksa-Blanchard et al. 2007; Ciolkosz 2009).

Production process

Pellet production is a continuous process and raw material arrives in batches to the wood pellet plant. If roundwood, harvest residues or other large size woody material is being used, it must first be processed through a chipper to make the material easier to handle and homogenous in size. If plants are receiving a wide range of feedstock there could be quality differences in the end product. Some facilities bled different batches to create an even end product (Peksa-Blanchard et al. 2007).

The feedstock's particle size is reduced through grinding before pelletizing, usually in a hammer mill (Peksa-Blanchard et al. 2007). Drying the feedstock consumes large amounts of energy which has a negative effect on the net energy value and production costs. Drum dryers are the most common type of equipment for large scale operations (Peksa-Blanchard et al. 2007) Moisture is one of the binding agents in the pelletizing process but the preferable moisture content is below 12% (Lehtikangas 2001; Peksa-Blanchard et al. 2007).

After the material has been pre-conditioned it is sent to the extruder to be pelletized. During the pelletizing process, raw material is compressed in a rolling press and pressed thru a die block. The pressure and friction increases the temperature of the wood and helps reshape the material into pellets as it passes thru the holes in the die. When the material leaves the extruder the pellets need cooling for the lignin to solidify (Peksa-Blanchard et al. 2007). This increases the durability of the pellets and reduces dust formation in the latter handling stages (McDow & Qian 2013).

Production costs

Production costs vary greatly between mills due to a number of factors such as the type of feedstock used, the size and type of equipment and energy used. These differences are displayed by Obernberger & Thek (2004) in two model pellet plants, one in Sweden and one in Austria (Table 9).

Table 9. Cost structure of two pellet plants in Sweden and Austria (adapted from Obernberger & Thek, 2004)

Cost structure of framework models	**Swedish (capacity 80,000t)**	**Austrian (capacity 40 000t)**
Consumption of which	20%	35%
1. electricity	*(6%)*	*(8%)*
2. drying	*(13%)*	*(25%)*
Raw material	50%	36%
Capital costs	20%	11%
Personnel	9%	14%
Other costs	1%	0,5%
Maintenance costs	N/A	3%
Cost per tonne pellets produced	€ 62,4	€ 90,2

The raw material, sawdust (moisture content 55%) from sawmills, is the largest cost for both mills. Based on the average amount of raw material needed and the average roundwood price in US, Qian & McDow (2013) calculated the feedstock cost to be between 38 and 53 €/tonne pellets not including biomass for energy purposes.

Drying is the major energy consumer and represents almost 70% of the total energy input (Pirraglia et al. 2012). Many pellet producers try to reduce the cost of drying by producing their own heat for the drum dryers using harvest residue (McDow & Qian 2013). Swedish pellet mills are usually constructed combined with a biomass CHP-plant. This provides direct heat to the drum drier as well as recovering about 50% for the district heat network. The CHP-plant and the additional expansions needed, increases the capital cost for the Swedish plant in comparison with the Austrian plant but provides reductions in energy costs (Thek & Obernberger 2004).

4.5.3 Storage

The need for storage can be identified in four stages of the pellet supply chain; feedstock reception, pellet plant, exporting harbor, importing harbor and at the industrial consumer. The requirements for raw material storage are low as wood and residues often are left in piles on the ground or in large open containers, but roofed facilities are also used (Peksa-Blanchard et al. 2007). Requirements for storing pellets are greater as the moisture content must remain low both to ensure a high energy value and keeping the pellets from falling apart. Pellets are usually stored in closed halls, silos and under fly roofs (Grassi et al. 2009).

4.5.4 Transportation

Transportation plays an important role in the costs of wood pellets. Trading between nations can result in long distances and transportation costs exceeding half the cost of production. (Sikkema et al. 2011)

Land transportation

The main way of transporting pellets within Europe is by truck. Only a small fraction is transported by ship within the region. Transporting pellets on railway is not common within Europe. One reason is that intermodal transportation often is required which raises the costs of using trains. In the US there are plants with integrated railways from the plant to harbor which avoids costs due to transshipment. Different studies show that distances over 100 to 300 km is more cost effective when done by train or ship (Grassi et al. 2009).

Shipping

Depending on the distance pellets need to be transported, shipping can be divided into two groups; short sea shipping and long distance marine shipping. Short sea shipping includes shipments that remain on the same continent (Resch & Panzer 2011). The main pellet sea shipping routes is from the Baltic States and Russia to European countries. The average shipping volumes are 4,000 to 6,000 tonnes (Sikkema & Steiner 2009). Shipping pellets from North America to Europe is considered long distance marine shipping. This route is covered by large dry-bulk carriers with an average of 20,000 to 30,000 tonne loads. The main trade routes from North America are to the Netherlands, Belgium and the UK (Resch & Panzer 2011).

Freight rates for shipping are based on demand. The fleet of ships is constant in the short term as building new carriers take time and in times of high demand for shipping the prices increase accordingly. Long distance freight rates from North America to Europe ranged from 27-69 €/tonne pellets between 2002 and 2008. However in 2008 the dry bulk shipping sector collapsed due to the financial crisis leading to lower trading activity and over capacity (Sikkema et al. 2011). Recent spot freight rates for bulk transportation of wood pellets wood pellets are shown in Table 10.

Table 10. Spot freight rates in 2013 for bulk shipments of wood pellets (Argus Media 2013a, 2013b)

Route	**Tonnage (t)**	**Freight rates (€/t)**	
		Feb-13	**Nov-13**
Riga – ARA	5000	16.9	19.0
Riga – Copenhagen	5000	13.2	13.8
Riga – Stockholm	5000	12.4	11.9
Mobile – ARA	25000	19.8	24.4
Mobile – ARA	45000	15.7	19.4
Savannah – ARA	25000	18.7	22.8
Savannah – ARA	45000	14.3	18.5
Vancouver – ARA	45000	26.9	27.9

4.5.5 End markets

Most large scale pellet users have long term contracts with suppliers, but pellets are also traded on spot markets especially during low prices (Sikkema et al. 2011). The lowest spot prices have historically been during the summers when Northern Europe fills up their storage capacity. Sikkema et al. (2009) reported that the difference between long term contracts and spot market prices could be 10 €/tonne or more.

Market monitoring is done by private institutions collecting prices and information from the trading. The dominating price index for Europe's large scale industrial pellet markets is the CIF ARA price, which is the market price of pellets delivered to Amsterdam, Rotterdam and Antwerp. Starting from around 115 €/tonne in 2007, the industrial pellet price reached over 140 €/tonne at the end of 2008 (Fig. 14). From those levels the price declined resulting in a price between 115 and 125 €/tonne for most of 2009/2010. Prices recovered in 2011 and hovered between 130 and 135 €/tonne. The average price during this period was 125 €/tonne (Cocchi et al. 2011).

Figure 14. The spot price of industrial wood pellets CIF ARA, between 2007 and 2011 (Cocchi et al. 2011)

Current pricing data from April 2013 to March 2014 show the price on the 90-day spot markets was between 120 and 130 €/tonne for most of the period only to reach above 130 €/tonne during the winter months of December and January (Fig. 15).

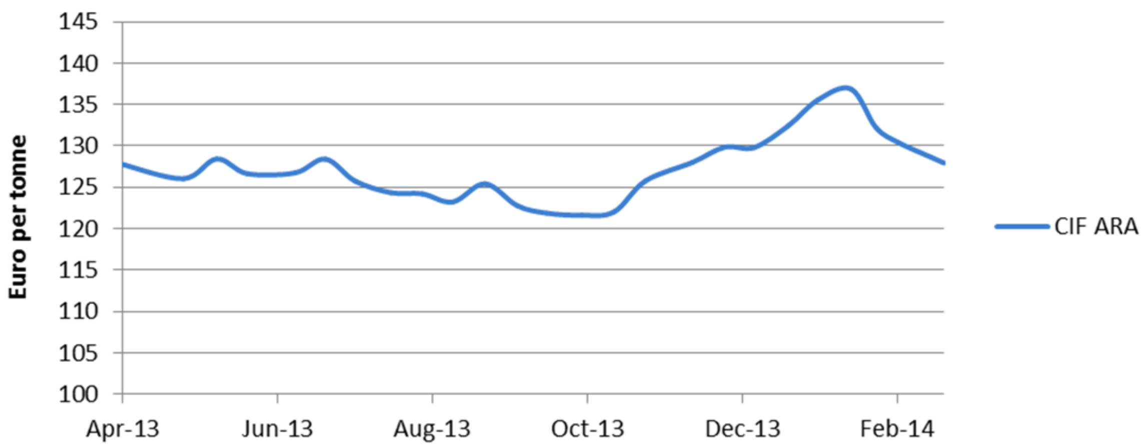

Figure 15. Wood pellet 90 day index CIF ARA price in euro per tonne (Anonymous, Personal communication, March 27, 2014).

4.6 Background on Latvia

Much of Latvian economy has been reliant on foreign investments. With capital inflow reaching peak levels from 2005 to 2007 and an increased economic activity, Latvia's average annual GDP growth rate reached 10.3%. However, the financial crisis damped Latvian progress during 2008 and 2009 leading to significant drops in wages and employment. During 2010 the economy showed signs of recovery and since then the Latvian GDP has continued to grow (Barānovs et al. 2013).

The majority of Latvia's GDP is contributed by its industrial sectors. 74% of Latvia's industry consists of its manufacturing sectors. The single largest industry is manufacturing of wood and wood products which represents 28% of total manufacturing (Fig. 16) (Latvijas Statistica 2013c).

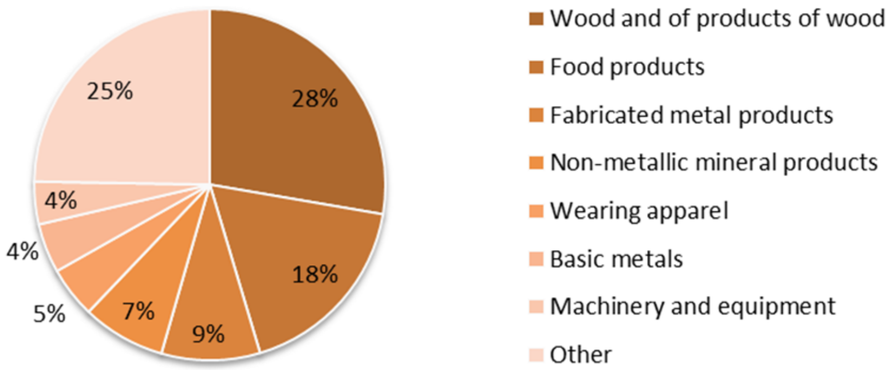

Figure 16. Manufacturing industry sectors share of the total manufacturing industry in Latvia (Latvijas Statistica 2013c).

4.6.1 Forestry in Latvia

3.6 million hectares of Latvia's 6.5 million land base is forested. The amount of forest cover differs between regions from 30% to 60% with the highest coverage in the western Ventspils district. Conifers dominate 61% of the forest with pine being most common. The rest is dominated by deciduous species, mainly birch at 62%. About 50% of the forested land is owned by the state, 43% is owned privately and 7% is under other ownership. The state owned forests are governed by Latvia's state forests company, LVM. The privately owned forests have been given back to private owners after the Soviet occupation ended, a process which is still ongoing in Latvia today (LVM 2013).

Since the forest products industry is important for the country's economy, the state increased the timber harvest on public land to counter the effect the economic downturn had on the forest industry (Fig. 17). Since 2010 the annual harvests are back to pre-crisis levels (LIAA 2012).

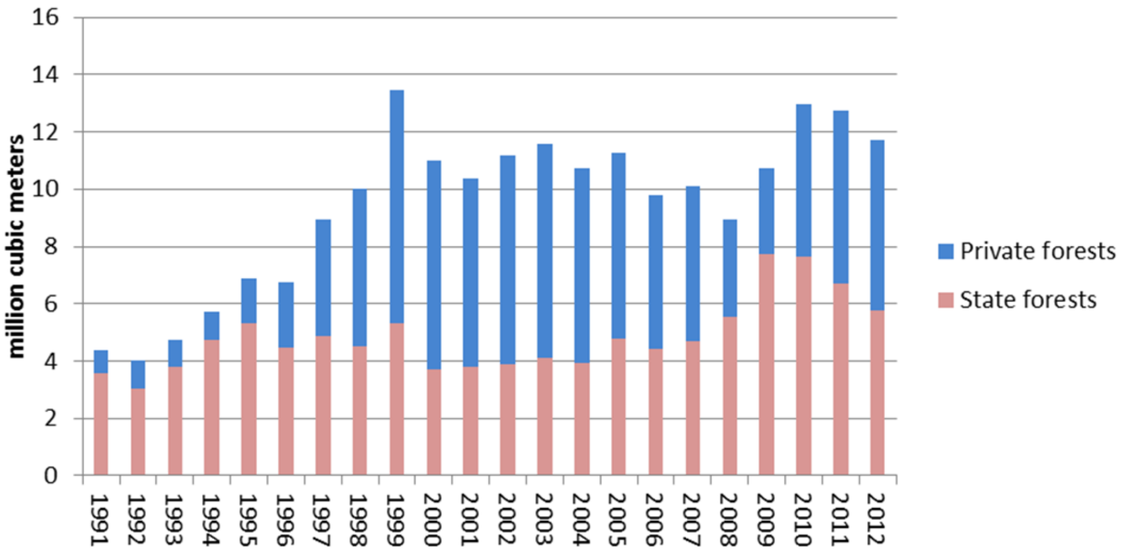

Figure 17. Harvest volumes in Latvia from 1991-2012, divided by forest owneship (Latvijas Statistica 2013a).

In total Latvia produced 10.2 million m^3ub of roundwood in 2012, of which 64% were saw logs and veneer logs, 28% pulp logs and the remaining 8% was industrial roundwood for other purposes (FAOSTAT 2013a). There are no pulp mills in Latvia and a majority of the pulp wood is exported to the Scandinavian pulp and paper industries in Sweden and Finland. Large volumes of wood chips are also exported to these countries. (FAOSTAT 2013b)

4.6.2 The pellet industry

The pellet industry in Latvia and the Baltic States is mention in literature as an area with potential, but not much research has been made compared to the North American pellet industry. According to Muiste & Habicht (2009), pellet production in the Baltic States started in the late 1990s, mainly export oriented towards Sweden and Denmark. This was because investments in production capacity came from this region, short geographical distance, a high demand and good prices. In 2008, during the economic downturn, many pellet mills shut down production and the regions exports decreased. This development was a result of weakened markets, low energy prices and declining Russian timber exports (Muiste & Habicht 2009).

Goh & Junginger (2013) summarized the potential in the Baltic States in a global perspective. They found that the Baltic States have historically had a good position for exporting to the European markets. There has been potential for low production costs due to relative low costs of raw material, labor and energy. There are also big seaports for pellets transportation across the Baltic Sea. However, they also identified a few production barriers such as a lack of domestic equipment producers, specialist knowledge, efficient supply chains and domestic consumers. A key factor to overcome these barriers would be public and private investments, especially foreign investments.

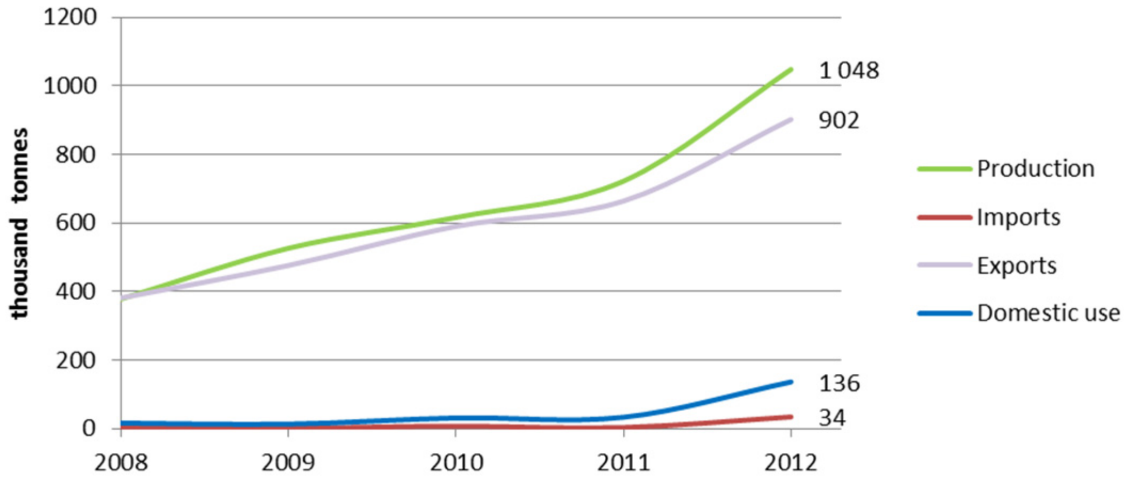

Figure 18.Latvia's production, consumption and trade of wood pellets from 2008 to 2012 (Latvijas Statistica 2013b).

Recent data shows that Latvia had a steady increase of pellet production from 2008 to 2012 (Fig. 18). Although almost 90% of the production was exported, domestic consumption has increased in recent years to 136,000 tonnes. Over 50% is for residential use while 35% is used in the commercial or public sectors. The rest is consumed by the energy sector (7% mainly for heat production) and other industries (Latvijas Statistica 2013b). The pellet industry's main export markets in 2012 were Denmark, Estonia, Sweden and the UK. Exports to Denmark and the UK have increased the most since 2009 (Table 11).

Table 11. Export destinations of Latvian pellets from 2009-2012 (compiled from Eurostat 2013a, AEBIOM 2013)

Exports (tonnes/year)	2009	2010	2011	2012
Denmark	151 637	229 417	268 035	436 993
Sweden	137 217	173 039	147 109	103 899
Estonia	95 156	104 301	108 789	131 659
United Kingdom	0	106	22 986	101 703
Netherlands	14 896	33 787	17 658	N/A
Belgium	13 950	14 099	N/A	N/A
Rest of the EU	69 029	35 419	56 228	135 350

5 Interview Results

This section presents the results from interviews with actors from the Latvian pellet industry on domestic production conditions, the state of the pellet industry and their competitive position in the global pellet industry.

5.1 The Latvian wood pellet industry

5.1.1 Development and structure

The wood pellet industry in Latvia was said to have started with the SBE plant in 1998, built by the Swedish company Lantmännen, using milling residue from an adjacent Swedish owned sawmill and exporting to Sweden. This was followed by many smaller premium pellet manufacturers, producing for the domestic market and for export to Europe.

The first export of industrial wood pellets was said to have been shipped to Electrobel in Belgium. Since then, Scandinavian energy companies, such as Fortum, Vattenfall and Dong have been very active in sourcing from the Baltic States and Russia. *"Basically the whole industrial wood pellet industry in the Baltic States has developed from Scandinavian demand."*

Today the Latvian pellet industry is characterized by a mix of large and small pellet mills (Table 12). The small mills have a production capacity of around 1,000-2,000 tonnes/month and rely on sawmills for feedstock as they only use sawdust and wood shavings.

Table 12. Pellet producers in Latvia identified thru interviews and literature (main source: Bioenergy International, 2012)

Map no.	Pellet producer	Location	Production capacity (tonnes/year)	Ownership
1	AKZ	Aizkraukle	35000	Unknown
2	AT Ekogran	Baldone	12000	Latvian
3	CED	Cesu, Latvia	12000	Latvian/German
4	Ecosource	Alūksne	12000	Unknown
5	Eko liesima	Madona	Unknown	Unknown
6	Frix	Valmiera	24000	Unknown
7	Graanul Invest	Inčukalns	180000	Estonian
8	Kurzemes Granulas	Ventspils	70000	Latvian
9	Agroenergi	LAUCIENES	70000	Swedish
10	LatGran	Jaunjelgava	83000	Swedish/Finnish
11	LatGran	Jēkabpils	155000	Swedish/Finnish
12	LatGran	Kraslava	155000	Swedish/Finnish
13	Latgranula lncukalna	Riga	30000	Unknown
14	Priedaines	Varaklani	12000	Unknown
15	Graanul Invest	Launkalne	180000	Estonian
16	Baltic Biogran	Riga	Unknown	Unknown
17	*LatGran (under construction)*	*Gulbene*	*(155000)*	Swedish/Finnish
	Total Latvian capacity		**1,030,000 (1,185,000)**	

The small mills were considered to either be integrated with other wood processing units or purchasing sawmill residue and produces residential pellets in small bags of 5-40kg or larger 1 tonne bags.

The larger pellet producers in Latvia have production units with capacities between 35,000 and 180,000 tonnes per year and serve industrial markets and residential markets to some extent. These mills were said to have a more dynamic resource profile as they rely both milling residue and round wood to supply the production capacity.

The largest pellet producer in Latvia is LatGran with 3 pellet mills with a capacity of almost 400,000 tonnes. LatGran is also building a new factory in Gulbene with a capacity of 155,000 tonnes per year. The second largest producer in Latvia and largest in the Baltic States is Graanul Invest. The company currently operates two factories in Latvia.

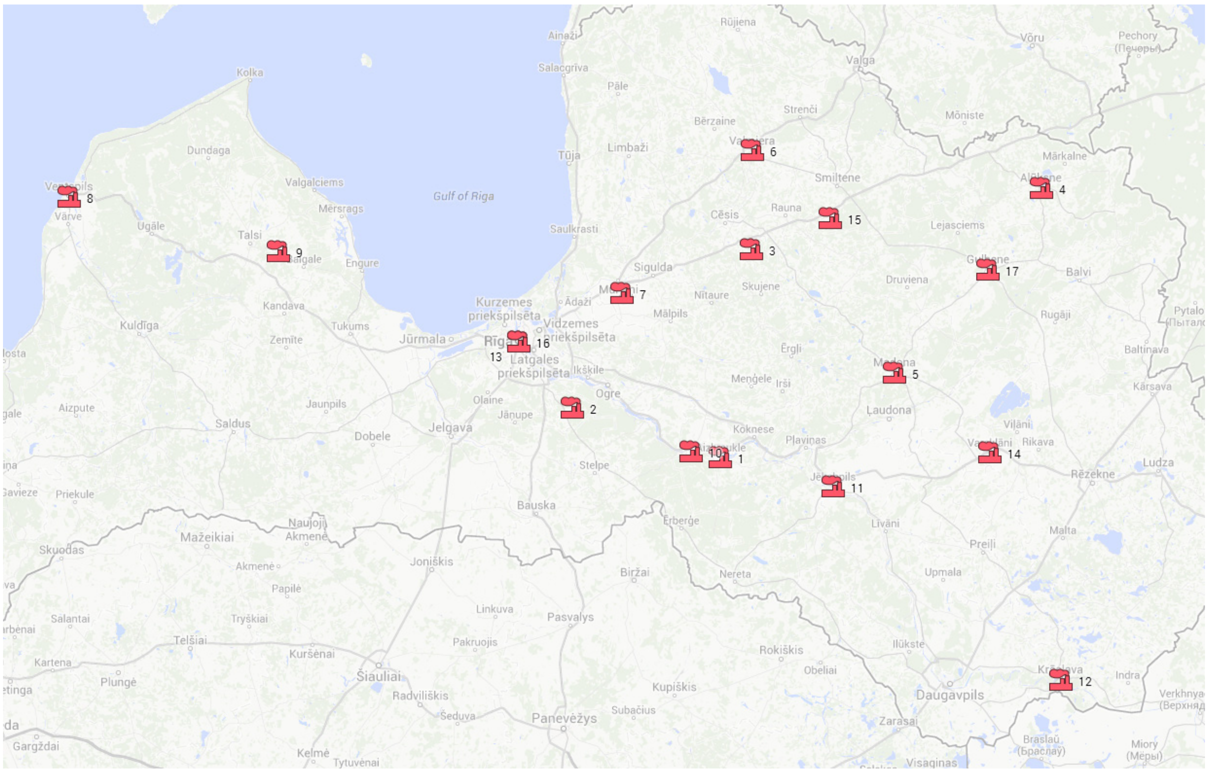

Figure 19. Map over pellet producers in Latvia created from Table 12 (Full scale map in Appendix E). Image source: Google Maps

5.1.2 Domestic Consumption

Domestic sales of both residential and industrial pellets were reported in the interviews, while the residential pellet market was said to be dominating. *"Nobody really knows how large the domestic market is in the Baltic States because there is no pellet association to report to as in most other European countries. The problem is that not all pellet mills pay taxes so production is never registered and the pellets are only traded between small producers and users."* One generalist respondent gave an estimation of almost 300,000 tonnes domestic consumption of wood pellets in Latvia.

5.2 Raw Material

The by-products from the wood processing industries have been the main feedstock for the Latvian wood pellet industry, consisting mainly of sawdust and wood chips. However, with the pellet industry expanding, the competition for the raw material has increased. Respondents reported that wood pellets producers have diversified and roundwood (fuel wood) is now commonly used in production. The mix between the raw materials depends on availability, pricing and firm strategy which is covered further in section 6.3.

Raw material was reported as the largest cost when producing wood pellets in Latvia and was also seen as the biggest uncertainty. *"While pellet contracts are made long term, there is no way to hedge against increases in the cost of raw material."*

5.2.1 Fuel wood

Fuel wood was said to come from younger stands or previously unmanaged forests and is roundwood graded non-suitable for pulp production due to species or quality. The amount of fuel wood in the forests was considered much higher than in other countries where forest have been managed for quite some time to produce wood for the pulp and sawmilling industries. All species were accepted at the pellet mills except for deciduous species with dense wood, like oak and birch, which are hard to pelletize. According to respondents, fuel wood was normally purchased delivered at mill gate. Some volumes were bought at road side and some pellet producers also used wood purchasing organizations. There was no knowledge of long term contracts for buying fuel wood.

One respondent referred to the *"shit wood density index*" being 10-20%, which means that 10-20% of the harvest would be non-merchantable wood in the traditional forest products industry. However, the existence of fuel wood in the forest was said to not necessarily correspond to availability of feedstock. It also depended on if active forest management was carried out in the area. A lack of forestry culture amongst the owners was said to result in much unmanaged land; *"…and there are no forest owners associations that promote forestry and pool owners together. This can develop in the long run but there are many obstacles to overcome"*.

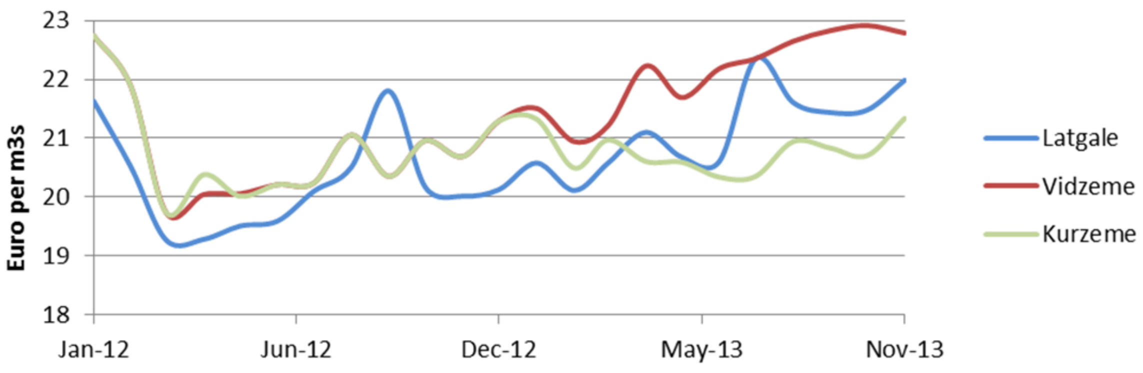

Figure 20. Fuel wood prices per solid cubic meter in three Latvian regions for 2012 and 2013 (Meža nozares informācijas Centrs 2013).

An experience from a newly built pellet plant was that forest management increased once the plant started production. The new mill resulted in an offset market for the previously non merchantable timber. However the pellet industry was considered unable to sustain forest management without the sawmilling industry. The purchasing power of the pellet mills could not cover the cost of both harvesting and transporting. But leaving roundwood in the forest was not allowed and if transport costs are covered, the remaining net will cover some of the harvesting costs.

Most generalist respondents made the prognosis that the supply of fuel wood was going to decrease. It was said that managed forests would lead to less fuel wood and in 15-20 years the supply would run out or not be sold as fuel wood. Latvia was compared to Scandinavia, with well managed forests where the pellet industry does not have the purchasing power to compete with the rest of the wood processing industries in the low priced round wood market segment.

5.2.2 Milling residue

The reported milling residue used was sawdust and wood chips. It was said that wood chips on the Latvian market could be divided into bark free cellulose chips and fuel chips containing both wood and bark. Cellulose chips were produced from chipping the cutoffs from sawmills debarking timber. The current price of cellulose chips was considered too high for pellet production due to competition from Scandinavian pulp mills. However, it was thought to be a future option in the interior of Latvia if prices go down. Fuel chips were generated by sawmills using non-debark timber which was said to be the general the case with smaller mills in Latvia.

There was considered to be a tradeoff for sawmills between supplying wood chips for the pellet industry or energy utilities instead of cellulose wood chips. Manufacturing cellulose chips from by-products required debarking of logs before sawing and screening of the wood chips before selling. This increased investment and production costs. Sawing with the bark, chipping and selling directly as fuel chips gave a lower chip price but a higher price for the bark than if it is sold separately. It was said that with the purchasing power of the pulp industry greatest at ports, selling fuel chips might be a more profitable option for sawmills located in the interior. For example, the price to transport wood chips from 200 km inland to port would be almost 5 €/m^3l. In relation, the cellulose wood chip price is between 12 and 14 €/m^3l and the fuel chip price is around 8 €/m^3l (Fig. 21).

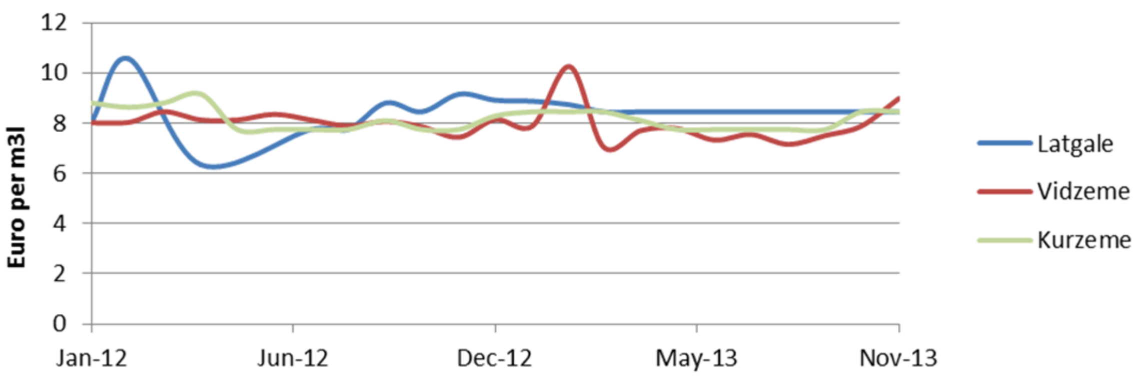

Figure 21. Fuel chip prices per loose cubic meter in three Latvian regions for 2012 and 2013 (Meža nozares informācijas Centrs 2013).

There was said to also be a difference in the sawdust produced in sawmills depending if they are sawing debarked timber or not. However, sawdust is not demanded by pulp manufacturers and the experienced competition originated from other industries, mostly other pellet producers and smaller utilities producing heat.

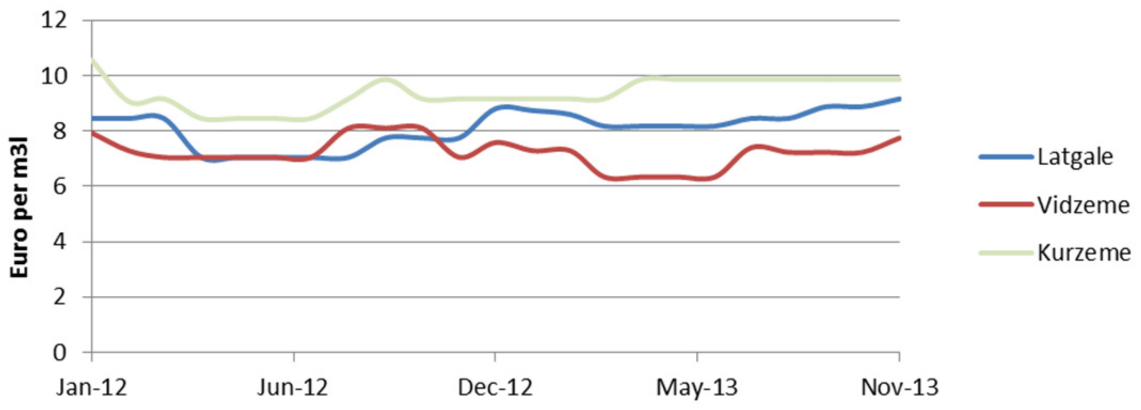

Figure 22. Sawdust prices per loose cubic meter in three Latvian regions for 2012 and 2013(Meža nozares informācijas Centrs 2013).

One specialist respondent said that it is preferable to have some of your feedstock from the wood processing industries because it is contracted on a longer term and provides some stability in acquiring raw material. Most sawdust purchased was also coniferous in origin, which was said to increase the durability of the pellets.

5.2.3 Harvest residue

Harvest residue was not used to produce pellets because of the high ash content. However some respondents said that it was burned to generate heat for the drying process in some of the large pellet mills. One specialist said that the harvesting residue was currently bought for a price that didn't even cover the sellers transport costs to the mill. This was a result of there being many suppliers and that contractor was paid to clean up bushy areas and remove the slash mostly on state land. *"It is not a stable situation and the price of harvest residue will increase."*

5.2.4 Competition

Fuel wood, mill residue and harvest residue were considered cost sensitive to transports. This resulted in a more local market than for example pulp wood or cellulose wood chips. Excluding other pellet mills, municipality heat plants were seen as the biggest competitor for the raw material. The usage of wood based fuel was said to have increased the last couple of years and the municipalities could afford to pay better than pellet producers. This development was said to be a result of subsidies to support the production of renewable energy in Latvia which increased the price of raw material.

Closer to port the wood paying capacity of overseas consumers was higher and one respondent stated that all possible pellet feedstock types were experiencing demand at ports. Examples of competitors for the low priced assortments were CHP plants in Denmark, Poland and Sweden. Figure 23 shows the final consumption and export by categories of possible pellet feedstock in Latvia.

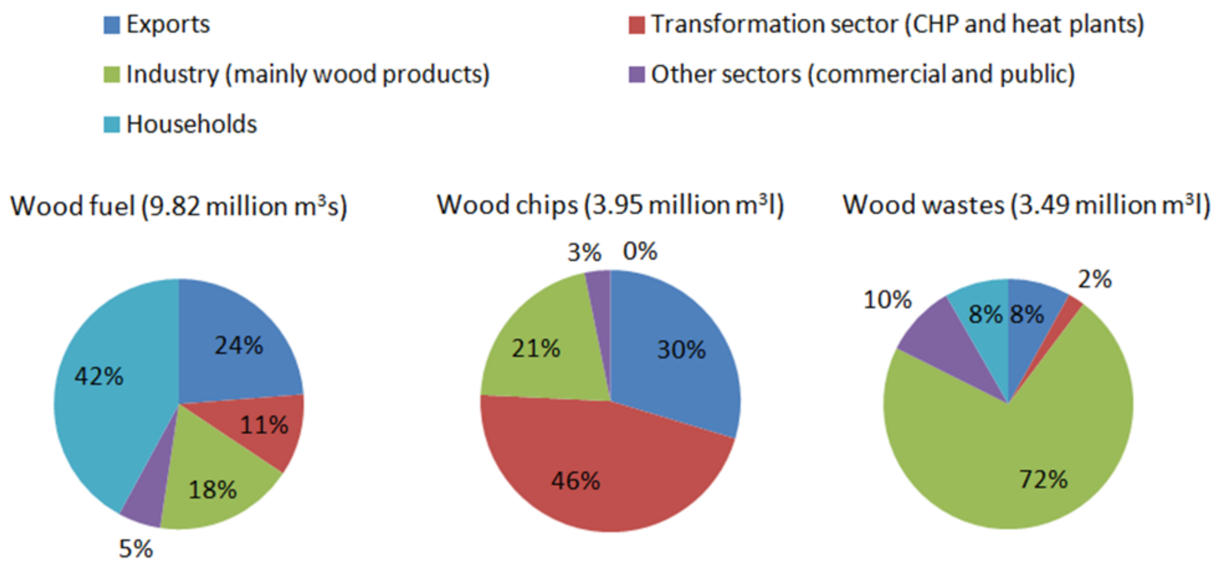

Figure 23. Consumption of wood fuel, wood chips and wood wastes in Latvia in 2012 by consumer category (Latvijas Statistica 2013b).

5.3 Production strategies of wood pellet producers

With the growth of the Latvian pellet industry, pellet producers were said to have adopted different strategies. One was to be located closer to port where there was a logistic advantage in exporting wood pellets and a greater density of sawmills. This allows for a bigger supply of sawmill by-products. Another strategy was to be located further inland where there was said to be less managed forests. This led to a greater availability of fuel wood, which is evident in the pellet mills raw material profiles. For instance, pellet mills located in interior Latvia responded using around 40% fuel wood while pellet plants closer to port used more milling residue (Table 13).

Table 13. Raw material profile of four active pellet mills in Latvia shown by distance to port of export

Estimated distance to port	Sawdust	Chips	Fuel wood
100 km	38%	23%	39%
260 km	32%	27%	42%
<50 km	70%	------ 30% ------	
<10 km	65%	30%	5%

One view was that being close to port goes against the fundamental idea of producing wood pellets. By compressing and drying material you can transport the same energy value based on the same material for much less than if you transport the raw material. *"When a pellet mill is built close to port, half of the supply circle is covered by water. You need to increase the supply area to include the same amount of raw material compared to a mill in interior Latvia."*

Some mills were said to be built in connection to a sawmill. These feed sawdust directly into the pellet plant site which provided the advantage of a stable feedstock supply. It was also said that the pellet producers using a high share of sawdust could diversify and produce both premium and industrial pellets. The interviewees active close to port said that they produced a mix of pellet grades to cater to different markets and take advantage of price differences and offset some seasonality in different markets. *"The price of bulk pellets is currently 20 euro more per tonne for premium pellets than industrial grade."*

In 2007-2009 the industry experienced shut downs during the start of the financial crisis. None of the interviewees was affected to great extent saying they still experienced wood pellet demand and were able to procure raw material. One respondent even saw an increase in raw material availability. *"We were seen as a stable business partner when other raw material purchasers failed to pay their bills."* A reason for the shutdowns was said to be because in some locations, like Riga, it was hard to procure raw material at a reasonable costs. It was also said to be an effect of poor planning and mismanaged mills as *"...some producers were set on gold mines and invested in bad projects."*

Compared to production units in the US with capacities up to 800,000 tonnes per year, the Latvian pellet mills were considered small. The reason given was the availability of raw material and sensitivity to transport costs. Building larger pellet plants would result in larger sourcing areas and increased transport costs, which would lead to lower profits. The situation was said to be different in the south US where the failing pulp industry had led to readily available resource. *"Fast growing plantations, originally destined to another industry, are now utilized by the wood pellet industry."*

5.4 Logistics and Infrastructure

5.4.1 Domestic transportation

The storage capacity of the Latvian pellet producers is located at the port terminals and not at mill site. Transportation to ports was said to be mostly done by truck. Firms trucking long distances were said to be able to offset some of their return costs and increase the raw material supply. This by purchasing milling residue close to the port areas where sawmills are more concentrated.

The railway system was used only to a minor extent. The reason given was a lack of infrastructure when pellet mills were built coupled with the fact that many pellet producers are located within a close radius of their exporting ports. A firm using the railways to transport pellets experienced high initial costs which decreased from 10€/tonne to 6.3€/tonne with experience and higher turnover.

5.4.2 Port procedures

Industrial pellets were transported in bulk by sea to its consumer markets. The largest exporting port was Riga Port with multiple pellet export terminals. The ports of Ventspills and Leipaja were also used for storing and shipping wood pellets.

The export terminals used were said to be used by the forest industry. This was considered positive for pellet producers as similar infrastructure and equipment was used by the pellet industry. However, indoor storage facilities and an automatic unloading railway system had been built to accommodate specific wood pellet requirements.

The wood pellet industry in Latvia was said to need large storage facilities because of seasonality in demand and the need to keep high capacity utilization all year around. The bulk storage capacity of pellets in ports covered by the interviews ranged from 10% to 25% of companies total production capacity. One company also shipped pellets for storage closer to one of their main residential markets. The main storage facilities were said to be located at port terminals which provided two advantages. It resulted in regular transports which improved efficiency and reduced costs. It also reduced the time from order to destination by moving the product closer to consumer.

In Riga, ongoing projects of terminal efficiency of pellet handling were reported. For instance, installation of conveyor belt systems and trials with different equipment setups were being carried out to reduce costs and increase speed.

5.4.3 Shipping

The Baltic Sea industries have traditionally had a shipping industry that they call Baltic coasters. These are small vessels up to a couple thousand tonnes transporting goods across the Baltic Sea. The bulk vessels covered in this study carried between 2,000 and 12,000 tonnes of pellets. Generally the smaller vessels were used for transports in to the Scandinavian countries and not to UK, Belgium and the Netherlands.

The freight rates of shipping were said to have been low for a couple of years, both in the Baltic Sea and for long distance shipping. The shipping companies were considered pressured and *"...prices have nowhere to go but up"*. Rising spot prices were seen as a possible sign of a future increase. Shipping could be contracted and one company disclosed following shipping rates for 1-2 year contracts:

Riga – Copenhagen	11.25 €/tonne
Riga – ARA	14 €/tonne
Riga – UK	15 €/tonne

Industrial wood pellets were said to be sold both FOB and CIF and the current FOB Latvia price reported in interviews was 120 €/tonne.

5.5 Competition

5.5.1 Competitive layout

The generalists saw North American pellet producers as the main competitors for the industrial consumers in the UK, Belgium and the Netherlands. The competition was however not evident on the Scandinavian markets. *"The ports in Sweden and Denmark are using Baltic coasters which means shallower drafts and smaller ports. The size of the North American transports is too big for the Scandinavian markets."* It was said that receiving pellet loads of 40,000 tonnes required deep drafts, large port infrastructure and large storage facilities and in Scandinavia, most of the utilities were smaller and do not have the capacity to handle the size of load.

A Fortum bioenergy facility in Stockholm was given as an example of a larger energy producer in the Baltic region. The facility use 350,000 tonne pellets annually which is supplied by Baltic coasters at around 3,000 - 5,000 tonnes. It was considered much cheaper to have regular shipments from across the sea to keep firing than to build new facilities, infrastructure and to expand storage to accommodate 40,000 tonne vessels. Another example was a Dong utility in Copenhagen with a possible storage of 120,000 tonnes and nonstop unloading of vessels. *"Even though it can use the volumes, the draft is 6.5 meters which is to shallow for a large vessel to enter. Large vessels have to be reloaded to reach these destinations which add to the consumer price of the pellets."*

However it was said that the large industrial users in UK and the Benelux were power plants in need of large volumes such as RWE's Tilbury power plant at 2,000,000 tonnes a year or the

Eggborough power plant at 6,000,000 tonnes. The Latvian respondents involved with exporting to these markets stated that because of their location and storage abilities, they had a shorter transport time and were able to ship with shorter notice than North American producers. One generalist explained that utilities on these markets contracted them to *"not put all their eggs in one basket"*. The view was that flexibility and service was the key to compete successfully for Latvian producers in this market segment. However it was considered difficult to compete through costs with US producers.

5.5.2 North America

The pellets exported from North America were said to be "clean" pellets possible to be sold on residential markets. However the scale of the operations made it easier to sell to industrial consumers. The residential markets consist of smaller wholesalers and it was considered hard to make long term contracts on the residential markets, especially with large volumes.

Large North American producers were seen as most successful in serving the large industrial consumers in the UK and the Benelux such as RWE and Drax. *"These companies have utilities in need of large volumes and are close to port facilities that can accommodate large vessels."*

The generalists with knowledge about the US pellet industry said it had grown quickly and is built on debt. These large pellet mills have been built to supply the large scale consumers using millions of tonnes per year. To borrow capital, producers had been forced to make long term contracts with large utilities for a long period of time, up to 10 years. This was considered a good deal for the pellet consumers, but pellet producers are unable to hedge against rising production or transportation costs. *"It is risky tying all of your production volumes to one customer."* An example given was an accident in 2012 at the Tilbury power plant in the UK that led to an excess supply on the European market because North American volumes had to find other buyers.

5.5.3 Threat of new competition

South America and mainly Brazil has been talked about as the world's next large wood pellet producing country. One respondent gave two reasons why this would not happen any time soon. *"There is no large scale export of dry bulk in this region so there is no infrastructure to support an industry."* The second reason was said to be a matter of public opinion. *"To use pellets from areas where there once was rainforest comes with a large risk. Electricity producers such as RWE and Drax are very aware of the importance of their public reputation and are very nervous about importing from South America."*

5.6 Characteristics of export markets

The size of the support dependent market was summed up by a respondent:
"At any point in time, the demand for industrial wood pellets is the sum of all the contracts governments have made with utilities in their country – nothing more, nothing less."

Industrial wood pellets were said to mostly be sold by contracts for 1-3 years. The main export markets for Latvian pellets were considered to be the Scandinavian countries with Denmark being the largest importer of Latvian pellets. Industrial pellets were transported to the UK and Belgium, *"…and it's done while remaining profitable so it seems that there is competitiveness."*

<u>Certification</u>

Certification was seen as the entry criteria for the large scale consumer markets. *"Since wood pellets are the sustainable option there is also a need to prove it."* Common certification requirements were said to be FSC chain of custody, green gold label and third party certification of corporate social responsibility which could be acquired by Latvian pellet producers.

One requirement from industrial pellet consumers in both Belgium and the UK was said to be the calculation of carbon footprint. According to one firm's calculations the carbon savings of using wood pellets instead of coal was 93% - 94%, assuming that burning pellets is carbon neutral. Getting certified in accordance with customer demands was not seen as a problem by any of the respondents.

Industrial wood pellet standards

It was said that the current standards for industrial wood pellets are set by the users of pellets thru the WPBI while certain specific requests are made from consumers. The biggest differences between residential and industrial pellets were considered to be particle sizes and the amount of dust. *"If the particle size is too large it won't be completely incinerated which leads to lower energy producing efficiency… …dust control is also an important factor because bulk pellets accumulates free particles which can result in explosions"*

The interviewees producing pellets in Latvia said that they were able to meet the standards and requirements of the large scale electricity producers. The production process was engineered to reach an acceptable particle size and dust removal is usually done in ports. It was explained that sieving the pellets at the terminals is a method of removing dusts but there were also projects to increase the use of air filtering alongside conveyor belts to reduce dust content while loading/offloading pellets at the terminal.

Support schemes

The industrial wood pellet consumers require support schemes to be profitable in producing power because coal is much cheaper. *"Coal can just be dug out while wood pellets have to be produced from a geographically dispersed resource resulting in higher costs."*

All generalists thought the support schemes would continue for some time. An example was the UK's ROC-system which is grandfathered. This meant that there has to be a government shift before a decision can be made to remove it prior to the planned end date and the contracts span over 15 years with financial support guaranteed during that period.

"All that can happen in the near future is that new agreements could be limited strongly. The current contracts between governments and power utilities are fixed. But it is rumored that new incentives are on their way in the Netherlands and Dong will need 1 million tonnes to support a new utility in Denmark." One respondent said that the markets will continue to increase: *"…because the politicians want to show that they are doing something to combat climate change."*

Most generalists did not expect the support schemes to last forever as they believed wood pellets to be a transitional energy source towards creating a greener energy system. One generalist said that burning wood isn't thought to be green enough. In forest rich countries where there is a culture of utilizing wood for energy there is a common acceptance to the approach. In countries like UK for instance, every tree is sacred and burning wood is not as accepted. Another view was that the idea of burning biomass to decrease global warming is wrong: "*We can burn all the forest on the planet and it won't help. So it is not an infinite solution but will continue for at least 15 years until the alternative comes"*.

6 Cost calculations

In this section the cost of producing and exporting wood pellets in Latvia is calculated. To evaluate cost competitiveness, the cost is put in relation to the market price of industrial wood pellets and coal including policy instruments used to subsidize renewable energy sources.

The cost calculations are based on four pellet mills that have been created using the method described in 3.4 and data collected through interviews and from statistics. The pellet mills are located at different distances from port using a different mixture of raw material and transportation methods (Table 14).

Table 14. Characteristics of four pellet mills based on the conditions for producing and exporting industrial wood pellets in Latvia received through interviews

	Mill 1	**Mill 2**	**Mill 3**	**Mill 4**
Distance from port	140 km	260 km	2 km	100 km
Raw material mix%				
Fuel wood	39	42	7	35
Fuel chips	23	27	38	16
Sawdust	38	32	55	49
Transportation to terminal by	Truck	Train	Truck	Truck

6.1 Pellet production in Latvia

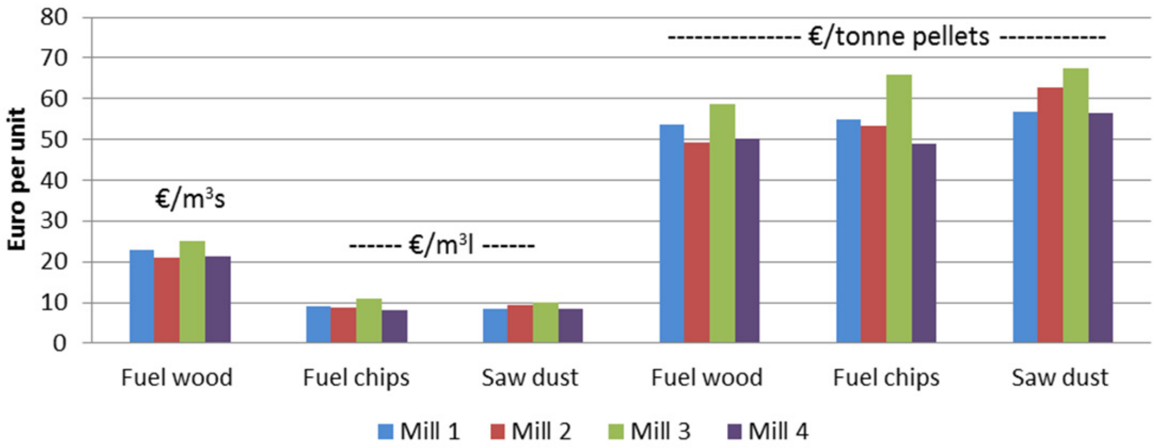

Figure 24. Raw material costs per unit for the study's four pellet mills in euro per cubic meter solid/loose consumed and per amount used to produce one tonne pellets.

At all four mills, round wood and fuel chips are the cheapest feedstock per tonne pellets produced. The highest raw material is at the mill closest to the port area (Fig. 24).

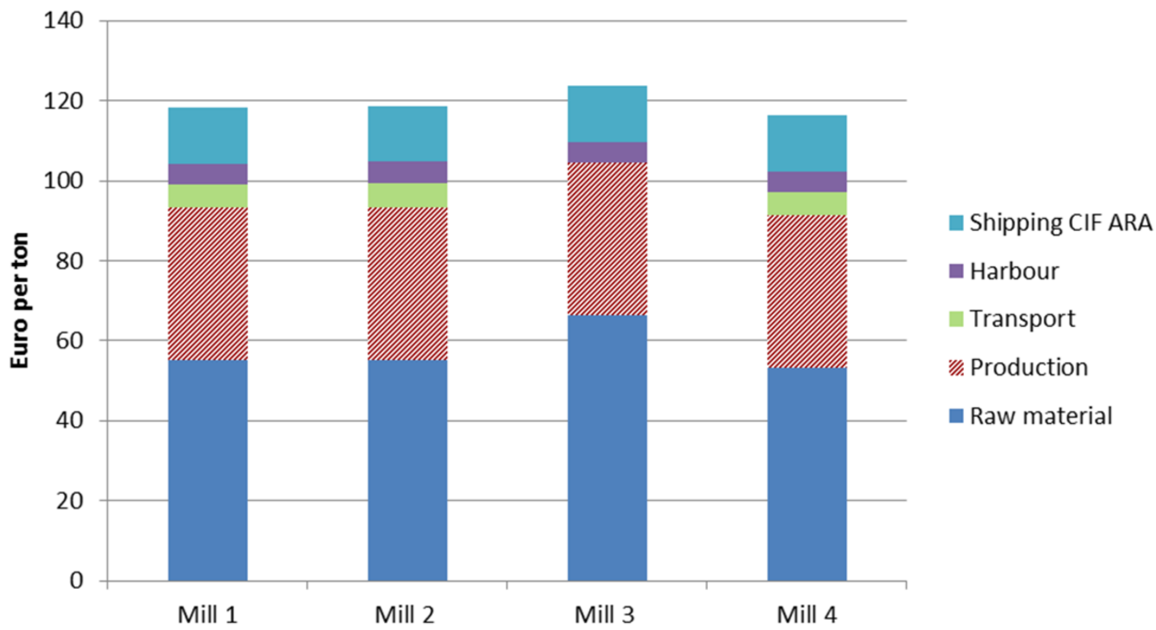

Figure 25. Cost structure of the study's four pellet mills per tonne pellet produced and shipped to ARA.

Mill 3 has the highest total costs including shipping costs to consumer market, 124 €/tonne CIF ARA. This is a result of a high share of saw dust in the raw material profile and the overall cost of raw material at port. Mill 4 has the lowest costs, 117 €/tonne. Despite having a large share of saw dust in the raw material mix, the overall lower costs of raw material results in a low total cost. The total costs for Mill 1, 122 €/tonne, is slightly higher than for Mill 2, 120 €/tonne (Fig. 25). The total raw material costs between the two are similar, based on their raw material mix, but train transports are cheaper than truck despite the difference in distance to port. Corresponding costs FOB Riga were 103-110 €/tonne (Table 15).

Table 15. Total calculated cost of wood pellets from the four Latvian pellet mills loaded in Riga harbor and shipped to ARA

Total costs (€/tonne)	Mill 1	Mill 2	Mill 3	Mill 4
FOB Riga	108	106	110	103
CIF ARA	122	120	124	117

6.2 Substitutes – coal vs. pellets

This section shows the spark spread for coal and pellets at different efficiencies, technologies and prices. The result of each calculation is based on the market price of industrial wood pellets, coal, carbon credits and government support and taxation. Market prices from December 2013 were used when spot price for pellets was 129 €/tonne CIF ARA (Argus Media 2013b). Calculations of wood pellets produced and transported are made at cost. The separation of these further demonstrates the results of the different production and transportation models.

6.2.1 Belgium - Flanders

The results show that pellets can compete against coal both based on Latvian production and transportation costs and at the current spot market price. However, the co-firing pellet spark spreads are substantially lower than for a dedicated plant. At the market price of 129 €/tonne and co-firing levels below 60%, burning only coal is a more profitable option than co-firing it with pellets from Canada and the US (Fig. 26).

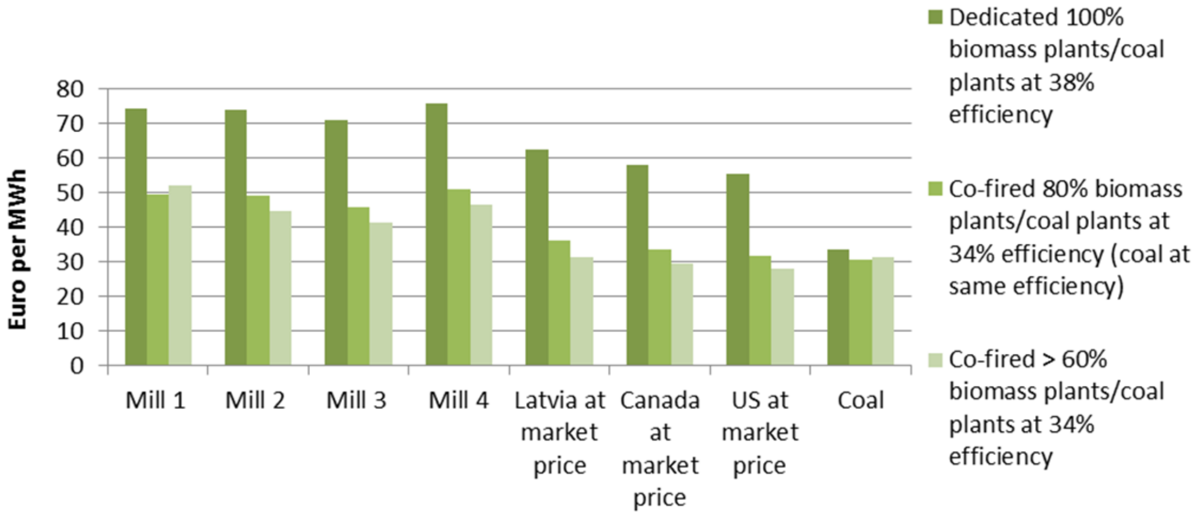

Figure 26. Wood pellet spark spreads and coal spark spreads in Flanders, Belgium. Dedicated biomass plants and coal plants at 38% efficiency. Co-firing utilities with different biomass ratios and coal plants at 34%.

6.2.2 The Netherlands

Under the current SDE+ scheme, only dedicated biomass plants can be awarded green certificates. This makes co-firing an unprofitable option because the cost of wood pellets is higher than the price received for produced electricity. However burning pellets in biomass dedicated plants is more profitable than using coal both compared to market price and mill costs (Fig. 27).

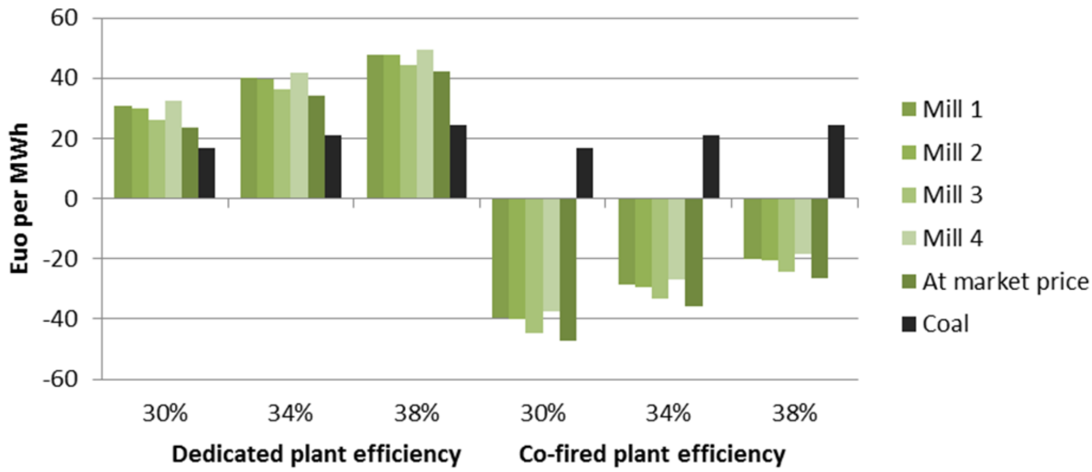

Figure 27. Wood pellet spark spread and coal spark spread in the Netherlands at different efficiencies in dedicated biomass plants and co-fired plants.

6.2.3 The UK

Utilities built dedicated to biomass combustion receives the highest amount of ROCs in the UK's RO-scheme, 1.5 per MWh produced. Converted coal plants using only biomass receives 1 ROC/MWh and co-firing less than that depending on the level of biomass used.

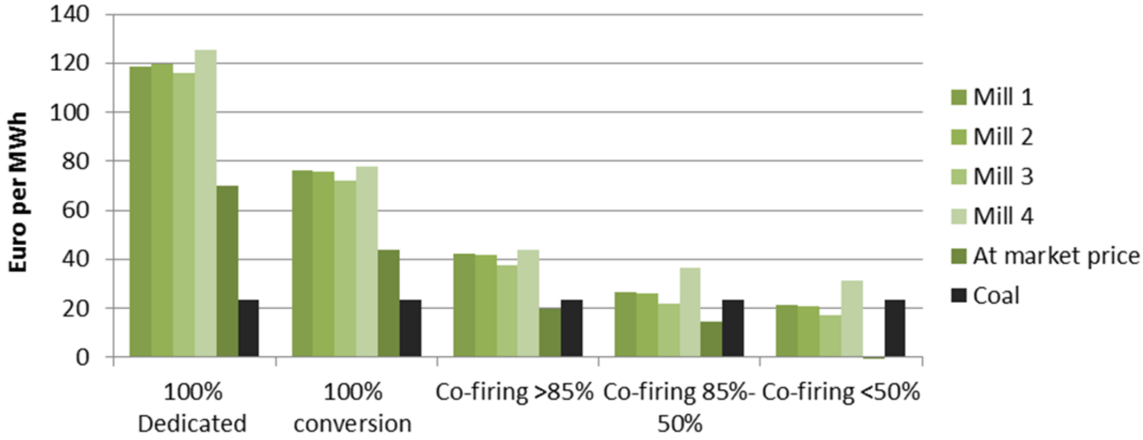

Figure 28. Wood pellet spark spread and coal spark spread in the UK at 34% efficiency for a dedicated biomass plant, converted coal plant to 100% biomass and co-firing utilities at different biomass rates.

Wood pellets can compete with coal in the UK at the current market price, but only when using a 100% biomass. Based on costs, all four mills can still sell at a profit and be a competitive option to coal at biomass co-firing levels above 85%. However, competing with coal at co-firing levels below 85% would result in small or no profits for all mills except Mill 4 (Fig. 28).

6.3 Profit margins

Based on the long term average spot price and the average spot price in December 2013, profit margins for the four mills have been calculated in Table 16. At the price of 129 €/tonne the margins are between 4.3 – 11.0% with an average of 8.3%. The long term average price of 125 €/tonne CIF ARA results a 5% average with Mill 3 at 1.1%. Based on the FOB price stated in the interviews, the pellet mills have an average profit margin of 14.2%.

Table 16. Profit margins for the pellet mills based CIF ARA spot prices and FOB Latvia price from interviews

Profit margins (%)	Mill 1	Mill 2	Mill 3	Mill 4
Price, December 2013, 129 €/tonne	9.1	8.7	4.3	11.0
Long term average price, 125 €/tonne	5.8	5.3	1.1	7.6
FOB Latvia price, 120 €/tonne	15.2	14.7	9.5	17.4

7 Discussion & Analysis

In this section the results of the study are analyzed with the theoretical framework and discussed based on the objective and research questions of the study.

7.1 Production conditions in Latvia

The Latvian pellet industry has grown steadily over the past 5 years (Fig. 16). While some pellet producers experienced hardship during the financial crisis, others seemed not to have experienced its effect but instead strengthened their position. The pellet producers have also adapted to their local environment by using different strategies, especially concerning raw material. These results suggest that the current Latvian pellet industry consists of resilient firms able to be profitable in the current conditions and capable of handling market fluctuations.

7.1.1 Domestic market

Porter (1990) suggests that a strong domestic market can increase the competitiveness of an industry by creating a closer relationship between producers and consumers. A lack of domestic consumption as well as domestic equipment producers, consultants and experts was raised in literature as production barriers in the Baltic States. With about 90% of the pellet produced being exported the domestic consumption is still small, especially for industrial wood pellets. However the industry has to a great extent developed through foreign investments bringing capital, knowledge, technology and expertise. The fact that Swedish capital is so prominent in the industry, could suggest a close relationship with the main markets in Scandinavia. That relationship could lead to better communicative channels and faster adaptation to changes in demands and requirements from consumers. This might not only have an effect on the competitiveness against North American producers but also be an advantage when competing with other European producers.

The presence of foreign capital could provide another benefit for the wood pellet producers. The foreign demand for Latvian wood and wood products promotes forestry. With a strong forestry sector and export interests mainly for higher priced raw material, lower quality by-products becomes available. These by-products are mostly traded locally, such as low quality round wood and wood wastes and can be utilized by the country's pellet industry. However, the development of effective international supply chains might also lead to increased competition for pellet producers on raw material.

7.1.2 Raw Material

Porter (1990) emphasizes the role of government support and interactions on a nations industry's competitive state. In the case of the Latvian wood pellet industry, the government is clearly present owning about half of the resource base. Meanwhile, the wood products industry in Latvia is the largest manufacturing sector and a major contributor to the national economy. This co-dependency creates an advantage for Latvian pellet producers, which was experienced during the financial crisis. Harvesting on public lands increased to support the wood products industry which also led to the availability of raw material for pellet producers. However government energy market interference also promotes the use of biomass for energy in Latvia which has increased the competition on raw materials.

The price of raw material was seen as the biggest weakness of the Latvian pellet producers. Contracts for wood pellets are made on 1-3 year agreements while some feedstock is purchased on delivery. There is no way to hedge against changes in raw material price. A cost increase in feedstock with 1 € would have at least a 6 € increase on the total production costs. Rising feedstock costs could affect producer profitability until pellet contracts run out and can be renegotiated.

There are signs that increased competition on raw material is going to lead to higher prices. Municipalities' increased use of biomass for heat poses a threat for the pellet industry as well as an increased demand from other energy producers. Resource allocation might become increasingly difficult for pellet producers, especially close to populated areas where the energy is needed. Depending on the development of the raw material markets, producers in unfavorable locations could have a hard time to adjust. This is similar to the situation in 2007-2009 when some pellet producers were unable to survive during harsher conditions as a combination of an unfavorable location and business strategy. However, changes in support schemes, EU ETS or increasing coal price could affect wood pellet demand and in turn lead to wood pellet producers having a higher purchasing power on the domestic raw material markets.

In some areas, there is a possibility of a short term increase of fuel wood availability from increased forest management. A sign of this belief is the new Gulbene pellet mill which will need to acquire feedstock for the production of 155,000 tonnes of pellets annually in a new location. Yet, this mill is said to mark the production cap of wood pellets in Latvia. Managed forests lead to a lower fuel wood content in the long run. Seeing as the supply of fuel wood is thought to decrease in the future, the pellet industry might shrink and revert to mostly using saw milling residue again.

However, Porter (1990) suggests that strong domestic rivalry can lead to the development of an industry. The industry has already evolved once by broadening the feedstock base to include fuel wood. There might be other strategies for wood pellet producers in the future. As suggested in the interviews, using cellulose chips could become an option. The price the pellet mills can pay will ultimately depend on the price they receive for wood pellets. Cost calculations suggests that there is a larger margin for biomass dedicated plants than for coal plants which could result in pellet consumers willing to pay a higher price. However, should the supply from competitors be sufficient for consumers, then the pellet producers of Latvia might not be able to handle a feedstock cost increase.

7.1.3 Transportation

Previous literature stated a lack of an efficient supply chain as a barrier for Latvian pellet producers. However, results show that the pellet mills in interior Latvia has developed good routines both for procuring raw material and transporting to port, keeping efficiency both in production and transportation. In agreement with Porter (1990), the related and supporting industries have played a major role in the development of the Latvian wood pellet industry. The pellet industry has been able to use the infrastructure and equipment of the existing export oriented forest products industry. From this the pellet industry has evolved, using specialized transport equipment continuously improving port infrastructure for greater efficiency and higher product quality.

Shipping rates could be a source of changes in Latvian competitiveness. Current spot freight rates could be an indicator of rising costs at 19 €/tonne. Then the total cost of pellets CIF ARA could increase with 5 €/tonne assuming collected rates apply. However there is likely to be a freight cost correlation between the long distance shipping industry and the Baltic Sea coasters. Both North American pellets and coal could be affected by increased global demand

and in turn higher freight rates. The fact that transportation distances of wood pellets from North America are longer than from Latvia could be an indication that they will be affected the most. However, freight rates are determined by demand and the development of future trade flows will likely have a larger effect.

7.2 Competitive advantage and industry position

7.2.1 Cost advantage

Grant (1991) stated that cost advantage can arise from superior process technology, scale economy or access to low cost inputs. With pellet mills being substantially smaller than in the US, Latvian pellet producers could be at a disadvantage. Spot shipping rates also showed that 45,000 tonne shipments from the US to ARA could compete or even be cheaper than 5,000 tonne shipments from Riga to ARA (Table 10). The cost of resources and process technology could then be a determent of the cost competitiveness of Latvian pellet producers.

Calculations show that on the industrial ARA markets, Latvian wood pellets had a total cost of 117-124 €/tonne. Based on recent reported CIF ARA spot prices ranging from 122-137 €/tonne, all mills would sell at a profit except for mill 3 during October and September (Fig. 15). Based on the long term average price of 125 €/tonne, Latvian profit margins averages on 5%. In line with the response from the interviews, Latvian pellet producers could have problems being cost competitive on the selected industrial markets.

In exporting to Scandinavia, the Latvian pellet producers have a clear advantage against its North American counter parts due to location and ship sizes. The reduced shipping distance leads to a 3 €/tonne overall lower cost while shipments from North America needs to be reloaded to reach most of the end consumers in Scandinavia. With current FOB Latvia prices being 120 €/tonne, the profit margin averages on 14.2% indicating that the Latvian pellet exporters are receiving good prices from their main consumers.

7.2.2 Differentiation advantage

Industrial wood pellets are a fuel commodity and product differentiation seems to be a low point of sale. Operations could be designed to reach acceptable product standards and the certification can also be achieved by North American producers as it was said to be a market entry criteria. However as stated by Grant (1990), a firm's marketing, distribution and service capabilities could lead to a differentiation advantage. According to the interview results, short sea shipping coupled with large port storage could be an advantage for the Latvian pellet producers. Having storage at port, larger than shipment sizes, allows Latvian firms to be flexible and sell during high prices. Having a short transport distance also means that Latvian firms can provide volumes faster than North American firms. Based on previous shipments from Latvia to the UK, the Netherlands and Belgium and the responses from the interviews, Latvian pellet producers have created a niche of flexibility and stability in deliverance which is in demand by some consumers on these selected markets.

7.2.3 Competitive position in the industry environment

The Latvian pellet industry is diversified in markets. The export to the UK has increased in recent years but based on the interview results and export data, the major focus is on the Scandinavian markets, especially Denmark (Table 11). This suggests that the Latvian pellet producers are not dependent on the researched markets. They also have large storage options which allow producers to keep high capacity utilization despite market seasonality and without being overly dependent on continuous sales. In line with Porter (2004), this diversification suggests that they are not subject to a high bargaining power from one buyer or buyer group in the UK, Belgium and the Netherlands. Further market diversification is found amongst Latvian producers with a resource profile heavy in saw dust which enables them to switch between industrial grade and premium grade pellets when the pricing of pellets and raw materials favors one over the other.

North American pellet exporters are instead dependent on one or a group of buyers and are subject to a higher bargaining power from large scale consumers. Both Sweden and Denmark are large importers of wood pellets where the consumers are dislocated from the North American supply due to vessel size and infrastructure. The size of pellet consumers on the selected markets further results in North American pellet producers contracting their entire volumes to a single firm. This puts them in a comparatively weaker position and at higher risk. If something were to happen with the consumer it would leave them without a buyer.

The relatively high diversification of the Latvian pellet industry also suggests that they can handle market fluctuations better than their North American counterparts. However, in regards to the industrial wood pellet markets in Belgium, the Netherlands and the UK, North American wood pellets might be superior to Latvian pellet exports. With utility consumption reaching above millions of tonnes, the buyers are in need of large continuous volumes to keep firing. Due to scale and the difficulty for Latvian pellet producers to compete in price, wood pellets from the US and Canada will continue to be the main source of industrial wood pellets in Belgium, the UK and the Netherlands.

7.2.4 Competitiveness against substitutes

Calculations showed that the wood pellet mills in this study can compete against the coal price even though coal prices are low and emission allowances are cheap. However, the option of co-firing wood pellets with coal seems to be phasing out. The governments have moved on to technology specific banding levels. This reduces the profitability of co-firing pellets or excludes it entirely from the support schemes. In the Netherlands, support schemes are now only awarding new electricity producers that are also producing heat. In Belgium and the UK, the schemes are technology specific with the profitability of co-firing decreasing the share of biomass used.

The development suggests support schemes will change from promoting greener alternatives to the greenest alternatives. In some interviews there was a belief that pellets would not be commodity for large scale energy production in the future. However, contracts to energy producers are awarded for a long period of time and the demand is not considered to change in the near future.

The EU emission allowances will be at a structural surplus throughout phase III which will last until 2020. A price increase in the allowances would raise the profitability of using pellets instead of coal and other non-renewable energy sources. The coal price is also at historic low levels. A higher price would decrease the profitability for energy producers using pellets and result in better incentives for co-firing in the UK and Belgium.

In the end, the demand comprises only of the contracts made between utilities and the governments in their countries through the support schemes. On the governments end, they are working towards a higher renewable energy production. Promoting energy production from biomass is a valid alternative, because coal power plants can be converted at a relatively low cost. For countries lacking in other sources of biomass, importing wood pellets will continue to be a good option to reach the renewable energy targets.

7.3 Methodology

7.3.1 Approach to theory

The approach to theory in this study was only in part successful. This was a result of the wide scope of the study coupled with the difficulty of gathering sensitive corporate data and the limited amount of time. For example, further data on the resources and capabilities would have been needed to properly assess firms' internal sources of competitiveness. However, in an attempt to create results generalizable on the entire domestic industry, the single firm became too small of an entity. This also led to questioning firm specific theories and their use when attempting to conduct research on a national industry level and the validity of the results. How does a single firm's profitability relate to the success of the nation's industry? And how can the operations of single firms be summarized into competitive or comparative advantages on a national level? Competitiveness of firms within a country can differ, but this paper tried to focus on national differences, thus not providing full support to use the firm specific theories.

However, this paper was successful in enhancing the knowledge about the Latvian pellet industry and its competitiveness, which was the motive of the study. As the methodology states, exploratory research is often done as a precursor for further research to raise the knowledge of a phenomenon.

7.3.2 Literature

Preliminary findings revealed that the wood pellet industry, consumer markets and national policies have had a fast development in recent years. Current information from market research about the top industrial pellet consumers, pricing data and development of support schemes was not found in scientific literature. This resulted in weighing the need for current data against finding relevant scientific literature. In many cases this has meant gathering information from reports funded by interest organizations and in some cases corporate data and presentations. After extensive research, the sources deemed most reliable where used.

The downside of using these types of documents is that they are created by organizations with a vested interest in the wood pellet industry. This could lead to bias results as these organizations might be inclined to produce a positive image of the pellet industry and the future use of pellets. However it was deemed necessary to use certain sources to fill some information gaps.

To account for the lack of scientific strength and peer reviews, data from multiple sources have been used to try and verify or screen the material. Another aim in using a wider range of documents was attempting to triangulate the literature study and the interview results to increase the validity. However the literature study and interview results did not overlap in all areas. An example was the lack of literature on the Latvian pellet industry and cost/price data.

7.3.3 Cost calculations

The difference between spot prices and contracted prices was raised in literature and will definitely have an effect on the validity of the calculation results. However, contracts are considered very sensitive information which could not be collected and published in this study due to privacy reasons.

Another weakness of the calculations is that they are mill specific. In the context of this study, they are used as an example of the cost competitiveness of Latvian producers. In concurrence with section 7.3.1., there are issues with trying to generalize between firm specific and industry levels. A wider sample could have given other results as the Latvian pellet industry is quite diversified in pellet producers and mills. However, the calculations added another measurable factor of competitiveness which further could be used to try and triangulate the results.

7.3.4 Interviews

Finding participants willing to share information about their company, especially costs, proved to be very difficult for an industry outsider. Snowball sampling proved to be a good method for breaking this barrier. However, this may have led to some bias in the result as the first individual had a strong impact on the sample. Studying a network rather than sampling a population could also reduce the ability to generalize the results. Predominant views of that network might be skewed from the views in the rest of the population. However after consideration and attempting another method, it was decided that this was the best option.

7.3.5 Ethical considerations

In using the snowball sampling method, the researcher loses control over the sampling process. Because of this I cannot guarantee that participation in this study was voluntary as I was not always the person who initiated first contact. Neither can I ensure that the interviewee's were not influenced or coerced in any way prior to me contacting them.

8 Conclusions

The aim of this study was to investigate the Latvian wood pellet industry and assess the competitiveness of exported Latvian wood pellets on the industrial markets in the UK, Belgium and the Netherlands. The two research questions that derived from the objective are answered with the conclusions below.

- *What are the current production and exporting conditions in Latvia for the industrial wood pellets industry?*

The Latvian wood pellet industry has grown from using only milling residue to include low priced roundwood and are now producing over 1 million tonnes of pellets per year. During this development different strategies have emerged, primarily based on location and raw material availability. Some mills are located close to port because of the proximity to logistic hubs and sawmills, while other are located in the interior relying more on fuel wood as feedstock. However, increased raw material competition was reported in both coastal and interior locations, leading to increased production costs. The availability of fuel wood in Latvia is also thought to decrease in the future due to better managed forests. This suggests that the current size of the Latvian wood pellet industry is not sustainable long term.

While the already export oriented domestic forest industry is a source of raw material it also provides infrastructure for pellet producers. With major seaports located in the Baltic Sea, the Latvian wood pellets industry has a good geographic position to reach the European markets and especially Scandinavia, their main export destination. To offset the effect of seasonality on these main markets and keep capacity utilization all year round, Latvian pellet producers have large storage units at the export terminals. From there, the Baltic shipping industry is used for bulk pellet transports of 2000-12000 tonnes per ship. Currently the Latvian wood pellet industry shows signs of strength, experiencing demand from their main markets and receiving good FOB Latvia prices compared to production and transportation costs. However, rising freight spot prices can be an indicator of increased shipping cost which could affect the industry.

- *Can Latvian wood pellet producers compete with other pellet producers and other energy sources on the selected markets?*

The study shows that the Latvian pellet producers could compete through costs in Belgium, the Netherlands and the UK, but profit margins are lower than with the current FOB price in Latvia. The Latvian pellet producers have a niche against North American pellet producers as they can supply pellets faster and are more flexible due to their location, large storage options and shipment size. However, North American producers seem to have a competitive advantage both through costs and the size of operations. The large utilities in the UK, the Netherlands and Belgium require half a million up to a couple of million tonnes of pellets per year. They are therefore better suited to regularly receive large 45,000 tonne shipments from the US and Canada than smaller shipments from Latvia.

Calculations show that Latvian pellet producers can be profitable selling at a price competitive with the price of coal. Especially to utilities using 100% biomass which have a better spark spread than coal fired power plants under the current market conditions. Wood pellets cost competitiveness in co-firing installations in the UK and Belgium is lower and depends on the share of biomass used by the utilities. In the Netherlands, co-firing coal with pellets no longer receives support. The most recent developments of support schemes further suggest that policy makers are pushing for greener options than burning pellets for electricity. This, coupled with the interviews results is an indicator that support for biomass in electricity production will weaken or disappear in the future.

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Appendices

Appendix A. Overview of documents used in the literature study

Table 17. Overview of the documents used in the literature study shown by type and search engine/method used to acquire the documents

Type	Search engine/method	Documents
Scientific articles	Web of Science Google Scholar	Baxter & Koppejan, 2005; Goh & Junginger, 2013; Lehtikangas, 2001; Olsson, 2012; Pirraglia, Gonzalez, & Saloni, 2012; Resch & Panzer, 2011; Sikkema et al., 2011; Thek & Obernberger, 2004
Books and published papers	Primo (library search) Google Books Ebrary Google Scholar	Grammelis, 2010; Lundmark & Söderholm, 2004; G Thek & Obernberger, 2010; Van Der Linden et al., 2005; Ellerman & Buchner, 2006; Fusai & Ronocoroni, 2008
Statistic databases	FAOSTAT Central Statistics Bureau of Latvia	Eurostat. 2013a; FAOSTAT, 2013a, 2013b; Latvijas Statistica, 2013a, 2013b, 2013c
Reports and other documents	Google Web page searches (Goverments, the EU commission, interest organizations) Personal Communication	AEBIOM, 2012, 2013; Alakangas, 2009, 2010; Barānovs et al., 2013; Bioenergy International, 2012; Biomass Magazine, 2013a, 2013b; Blair, 2013; Carroll, 2012; Céline & Robert, 2013; Ciolkosz, 2009; Cocchi et al., 2011; DECC, 2013; EREC, 2009; Eurelectric, 2011; European Comission, 2012a, 2012b, 2013a, 2013b, 2013c; European Commission, 2013; European Parliament and EU Council, 2009; Eurostat, 2013b; FAO, 1990; Febeliec, 2013; Flach, 2013; Fürsch et al., 2010; Grassi et al. 2009; Greunz, 2011; Hiegl & Janssen, 2009; IEA, 2007; Junginger & Sikkema, 2009; LIAA, 2012; LVM, 2013; McDow & Qian, 2013; Meža nozares informācijas Centrs, 2013; Muiste & Habicht, 2009; Ofgem, 2013a, 2013b, 2013c; Peksa-Blanchard et al., 2007; Sikkema & Steiner, 2009; Vakkilainen & Kuparinen, 2013; VDKi, 2013; Verhoest & Ryckmans, 2012; VREG, 2013a, 2013b

Appendix B. Interview protocol

The interview questions for the semi-structured qualitative interviews derived from the protocol below.

General overview

The Latvian Wood Pellet industry

1. Characteristics of the Latvian wood pellet industry in terms of
    a. Development
    b. Geographical structure (inland vs. coast)
    c. Raw material sourcing
    d. Suppliers
    e. Foreign investments
    f. Size
    g. Type of pellets produced
    h. Price differences
    i. Domestic consumption
    j. Strategies followed by pellet producers
2. Effects of the financial crisis
    a. Demand on pellets and wood products
    b. Russian timber exports
    c. Energy prices
    d. Forest resource
    e. Overall effect?
    f. These factors today
3. Production limits
    a. Where is the limit of pellet production in the Baltic States/Latvia
    b. Which factors deterrence possible volumes
    c. Future growth (How and Where?)
4. Government influence
5. What does the pellet industry in Latvia like in 5, 10, 20 years

Global outlook – industrial wood pellet markets, competitors and policies

1. How wood pellet producers from Latvia are perform on international markets? The UK, Belgium and the Netherlands?
2. Which are the key markets and what makes them important? What are their Characteristics?
3. Characteristics of the industrial markets/consumers in the UK, Belgium and the Netherlands?
4. Main competitors?
    a. Characteristics?
    b. Situation in raw material, production, shipping, main markets?
    c. Weaknesses, Strengths
5. Can Latvian producers be competitive against these? How? Why? Why not?
6. Are there any emerging threats on the international markets?
    a. Increased competition?
    b. Continuity of support Schemes?
7. State of the international markets in 5, 10, 20 years?

Firm specific

Raw material

1. What type of feedstock is being used?
    a. How much is used of what type?
    b. Where is the feed stock sourced? (type of supplier and distance)
    c. What is the price of feedstock?
    d. How much of each type is needed to make one ton pellets?
    e. How is raw material procured? Contracts, spot, in the forest, at roadside, at mill gate?
2. What is the main mode of transportation for getting feedstock to mill? cost? distance?
3. Availability of raw material?
    a. Factors affecting raw material availability
    b. Future outlook, Potential, Risks
4. Competitors
    a. Who are the competitors for the raw material?
    b. How can you compete against these?
5. Top cost for feed stock dependent on margins

Production

1. How many ton pellets are produced every year?
2. Industrial or residential grade,
    a. If a mix how do you determine batch sizes and when to produce what?
3. Plant capacity?
4. Equipment is being used? Cost?
5. Production costs (step by step)? Costs?
6. Energy source for drying? Costs?
7. Storage type, time and costs?
8. Production strategy?

Transportation from mill/Shipping

1. Domestic transportation
    a. Where is it transported and how (in truck, train or by ship? In bulk or bags?)
    b. Capacity of the transportation and the terminals (storage, terminal handling etc)?
    c. Cost for truck/train transportation? Time, distance?
2. Port procedures
    a. How long are pellets in storage at port?
    b. Ship loads?
    c. Loading time?
    d. Renting or owning port facilities?
    e. Costs?
3. Are there any advantages with smaller ships to the importing countries, ports? (Canals, offloading facilities?)
4. Where are the main customer located?
    a. type of user/producer?
    b. price?
5. Currently exporting to the UK or Benelux?
6. Costs for shipping pellets to UK or Benelux?

Appendix C. Interview respondents

Table 18. The interview respondents that participated in the study by category, position, organization and interview medium

Category	Position	Organization	Interview medium
Generalists	CEO	Pellet producing company	Face-to-face
	CEO	Pellet producing company	Face-to-face
	VP	Bioenergy trading company	Face-to-face
	Business Development	Pellet producing company	Telephone
Specialists	Production Manager	Pellet producing company	Face-to-face
	Certification/Development	Pellet producing company	Face-to-face
	Logistics Director	Stevedoring service company	Face-to-face
	Sales Director	Pellet producing company	Telephone
	Resource Specialist	Government	Telephone

Appendix D. Calculations of awarded amount of GCs in Flanders and Wallonia

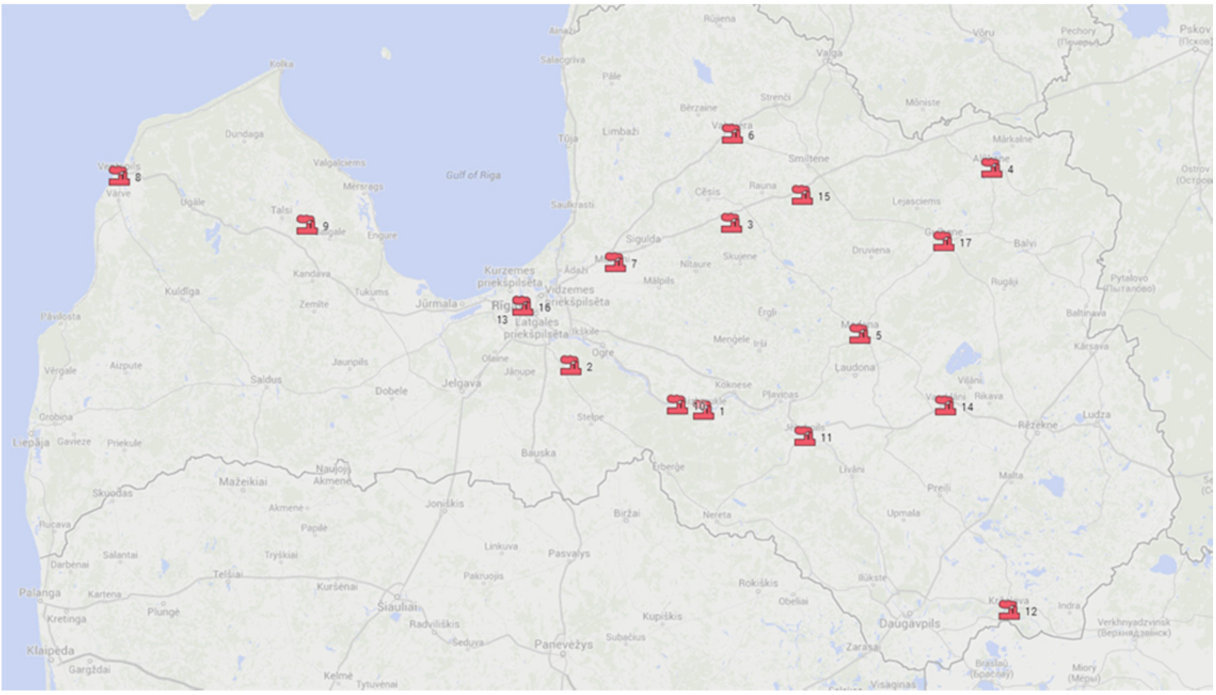
Table 1. The amount of energy produced in Flanders from wood pellets from different regions awarded green certificates. The table also shows size and location in the supply chain of the reductions in the energy balance (Ryckmans 2010)

kWh el. (eq) /tonne	Belgium	Germany	Portugal	Latvia	Canada	S.A.	USA	Australia	Russia
Electricity	160	136	148	130	150	199	230	231	120
Resource handling	35	19	8	24	22	28	73	37	1
Product transport	truck	river	truck sea	truck sea	train sea	sea	sea	sea	train sea
	8	20	49	63	143	115	95	142	310
TOTAL	203	207	205	217	315	342	398	417	431
NET GC	87%	87%	87%	86%	80%	79%	75%	74%	73%

Table 2. The amount of energy produced in Wallonia from wood pellets from different regions awarded green certificates. The table also shows size and location in the supply chain of the reductions in the total CO2 avoidance (Ryckmans 2010)

kg CO_2 (eq) /tonne	Belgium	Germany	Portugal	Latvia	Canada	S.A.	USA	Australia	Russia
Electricity	73	62	68	59	68	91	105	106	55
Resource handling	19	11	4	14	12	17	35	24	0
Product transport	truck	river	truck sea	truck sea	train sea	sea	truck sea	sea	train sea
	5	11	35	35	81	65	53	80	173
TOTAL kg CO2/ tonne	97	84	99	108	165	173	193	210	228
TOTAL kg CO_2/ MWh	22	18	22	24	36	37	44	47	51
NET GC	86%	88%	86%	85%	77%	76%	72%	70%	67%

Appendix E. Map over pellet mills in Latvia



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