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International Biofuel Trade - A Study of the Swedish Import

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Abstract

Following the development of large-scale use of biomass energy in the EU, international biofuel trade is a plausible scenario and something that is already taking place in Northern Europe. This paper focuses on Swedish biofuel imports, both direct and indirect imports, the latter which derive from the fact that part of the imported pulpwood and timber end up as fuel. The objective is to describe the biomass import flows, the actors involved and analyse the fundamental drivers for the trade flows.

The rapid expansion of biomass energy, that has taken place in district heating since the early 1990s in Sweden, has been met partly by imports. The direct biofuel import was estimated to 18 PJ for 2000, which corresponded to 26% of the biofuel supply in district heating. The total indirect biofuel import was estimated to 9 PJ of which 5.5 PJ is consumed in the district heating sector. Sawmill wood chips, decay-damaged stemwood and pellets are imported from Estonia and Latvia, whereas used wood and solid recovered fuels are imported from Germany and the Netherlands. Tall oil and pellets are imported from North America.

Key factors related to the Swedish biofuel import are analysed, both from the view of Swedish demand and from the view of supply in the Baltic countries as well as supply from Germany or the Netherlands. National differences in energy policy are perhaps the most important driving force behind the seemingly strange trade flows. Structures in the different national energy systems are also discussed as well as the transformation process that has taken place in the forest sector in the Baltic countries.

Keywords: biofuel trade, biofuel market, Sweden, energy policy, the Baltic countries, green waste, yellow waste, biomass

1. Introduction

The European Commission has indicated [1, 2, 3] that renewable energy sources, biomass energy in particular, will play an important role in the Union's strategy to mitigate climate change. In the 1996 Green Paper on Renewables [1] the Commission set the target of doubling the share of renewables in the EU gross inland energy consumption to 12% by 2010. The subsequent Community Strategy [2] outlined a ***tripling*** of the use of biomass as a way to achieve the renewable objective.

Traditionally biofuels have been used mainly in the region where they are produced. This pattern changed in Northern Europe during the 1990s with the introduction of biofuels in district heating. Sweden and Denmark are the largest importers of biofuels in Europe. Both countries import biofuels from the Baltic countries, Finland and Canada. Sweden also imports used wood and solid recovered fuels from Germany and the Netherlands.

The large-scale use of biomass energy in the EU would be facilitated by a European market for biofuels. Regions rich in biomass resources could become net exporters of biofuels to regions with fewer opportunities for biofuel production, which would increase the Union's total use of biomass energy. Interregional and international biofuel trade is also a likely consequence of the growing use of

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biomass energy. At the moment there is a mounting interest in biofuel trade in Europe. Several papers and reports have been written on the issue. One study by Vesterinen and Alakangas [4], presents a general overview of the current use of biomass energy in 20 European countries as a means to estimate future biofuel export and import possibilities. The study contains information on biomass resources, users, fuel prices, energy and environmental legislation, and briefly estimates the current biofuel trade. Agterberg [5] analyses costs and macroeconomic effects coupled with biomass imports to the Netherlands, where Sweden has been selected as the hypothetical exporter.

International biofuel trade could also take place on a global scale, which is envisaged by Faaij et al. [6] for instance. International biofuel trade generally implies relatively long transportation distances. The economic feasibility and energy economy of transporting biofuels are greatly influenced by the mode of transport and the order and choice of pre-treatment operations, which is the focus of a report by Suurs [7]. Various studies have indicated that inter-continental trade could be economically feasible and need not lead to discouraging transport energy losses [7].

This paper focuses on the Swedish import of biofuels in a European context. The objective is to describe the biomass import flows, the actors involved and analyse the fundamental drivers for the trade flows. Import data has been gathered, describing both the volumes of wood that are imported as fuel (direct imports) and the volumes that are imported as raw material to the forest industry but end up as fuel (indirect imports). The relevance of the latter is primarily to investigate their magnitude and relate them to the direct imports, something that has not been done before. Previous assessments and analysis of the direct Swedish biofuel imports have been made by [8] and [9]. Neither of these however, analyse the biofuel import flows from the Baltic countries.

As stated earlier, there are grounds to believe that in the future biomass energy will become an important energy source in Europe. In case of such a development, it is also realistic to envisage international biofuel trade of some form taking place. So far most of the international biofuel trade in Europe has been located in the Baltic Sea area. Observations from this market, exemplified by the Swedish import, can provide information about how an international market covering a wider geographical area may develop.

2. The Swedish bioenergy system

Sweden is one of the leading biofuel users in the European Union with biomass accounting for 353 PJ or 16% of primary energy supply. The rest is hydropower 13%, nuclear power* 34%, oil 31%, coal 4% and others 3% [10].

Essentially, all biomass used in Sweden originates from the forests, which makes forestry and the forest industry key sectors for the biofuel market. The forest industry is of great importance to the Swedish economy and accounts for 13% of the total export value [11]. In a typical year 90% of the felled stemwood, including bark, is used in the forest industry, half of it as pulpwood and the other half as timber. The remaining 10% is firewood [12]. However, 40% of the timber and pulpwood end up as process by-products and residues that are used for energy purposes [12]. Most of the residues are used internally in the forest industry, which is the largest biofuel user (figure 1). In pulp mills most of the process energy comes from the spent pulping liquor, black liquor, which is burnt in the chemical recovery cycle. In sawmills half of the input volume ends up as by-products: wood chips, bark and sawdust. Most of the wood chips are used as pulpwood, whereas, much of the bark and sawdust are used internally for heat production. The sawmill's surplus wood fuels are used in other industries including pulp mills, in district heating plants and in the case of pellets also in private dwellings and the service sector. Biofuel trading companies are often the middlemen between wood fuel producers and consumers. They can also be involved in their own biofuel production of pellets and of wood chips from harvesting logging residues, for instance.

The second largest user of biofuels is the district heating sector, which supplies over 40% of the heating in buildings. During the 1990s the share of biofuels in district heating increased rapidly and now accounts for 44% [10]. Biofuels, in this sector, not only includes wood fuels from the forest industry, domestic or foreign, but also used wood.

Small-scale use of biomass for heating of single houses has a long history in Sweden and is particularly common in less densely populated areas and villages. The dominating fuel is firewood, although in the

* total thermal equivalent

past few years a market for small-scale use of wood pellets has rapidly developed, totalling about 1.5 PJ (2000) [11].

Biomass from agricultural land, such as short rotation forests, straw and energy crops, plays a minor role in the Swedish energy system accounting for about 0.4 PJ (2000) [10].

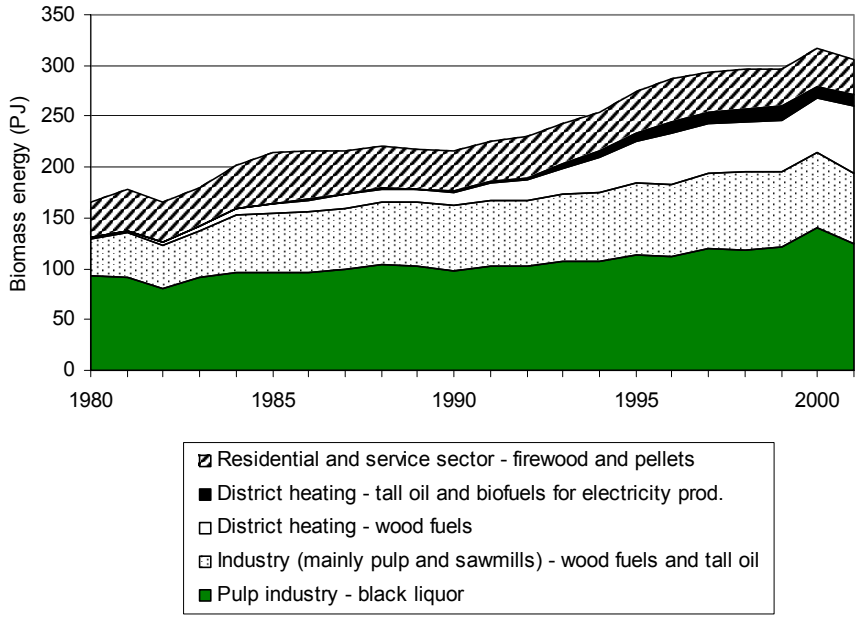

Figure 1. The Swedish use of biomass energy in different sectors during the past 20 years. [10]

3. Method and data

Although biofuels[†] are the target of this study, solid recovered fuels (SRF)[‡] which are usually not categorized as biofuels, have been included in the trade flows due to the difficulty in clearly separating biofuels from waste. SRF are relatively new on the fuel market and since both biofuels and waste are exempt from environmental taxes in Sweden there has been no strong fiscal motive to categorize the fuels in the grey zone. The new Waste Incineration Directive 2000/76/EG [13], however, will change that since after its implementation fuel category will determine the degree of required emission control. Peat is not included in this study.

Biofuels are classified as waste, in terms of trade in the EU, and are regulated according to the waste protocol (EEG 259/93). The Protocol divides waste into three categories: green, yellow and red, where biofuels fall into the two first categories. The Protocol also applies to the EU candidate countries in Central and Eastern Europe since these have signed Association Agreements (Europe Agreements) with the EU.

Green waste is free for trading between countries and includes all biofuels, except chemically treated used wood (treated used wood) and some sorted fractions of solid recovered fuels. The trade volumes are usually somewhat uncertain since customs statistics do not always distinguish wood for material use from wood for fuel use. Trade with yellow waste, on the other hand, must be notified and approved by the Swedish National Environmental Agency, which guarantees a certain reliability of the import data. Yellow waste contains treated wood, mixed SRF and municipal waste. Figure 2 illustrates how different fuels are categorized according to fuel standards and trade classifications.

[†] Biofuels refer to both solid and liquid biofuels. According to CEN/TC 335, solid biofuels include traditional biofuels such as wood chips, wood pellets, bark etc. but also used wood, with the exception of wood that may contain halogenated organic compounds or heavy metals as a result of treatment. Among liquid biofuels only tall oil and black liquor are mentioned here.

[‡] Solid recovered fuels include used wood that may contain halogenated organic compounds or heavy metals. SRF also include plastics, rubber, paper and mixtures of the above including used wood.

Estimations of the direct import flows in section 4.1 have been gathered or derived from several sources, each source contributing data for different biofuels. The sources were: Statistics Sweden [14], the Swedish Wood Fuel Association [15], the Swedish Environmental Protection Agency [16, 17] and Westergård [18]. Data for the estimations of the indirect imports has been collected from the National Board of Forestry [11] and the Swedish Wood Fuel Association [15]. Since the collected data has not been processed at all, the import assessments are presented as single values, although intervals would probably be more appropriate.

Section 5.1 analyses the Swedish biofuel demand, in general and for imported fuels, on the basis of a set of key factors. Only direct import is considered here since indirect imports largely depend on factors unrelated to energy issues.

For the biofuel exporters, in section 5.2 and 5.3, the analysis is narrowed down to the Baltic countries regarding traditional biofuels on the green list and to Germany and the Netherlands regarding used wood. The supply of wood fuels in the Baltic countries is discussed in relation to the supply of timber and pulpwood.

Information about the qualitative aspects of the biofuel imports has been acquired through literature studies and interviews with people in the energy business and at various Swedish authorities.

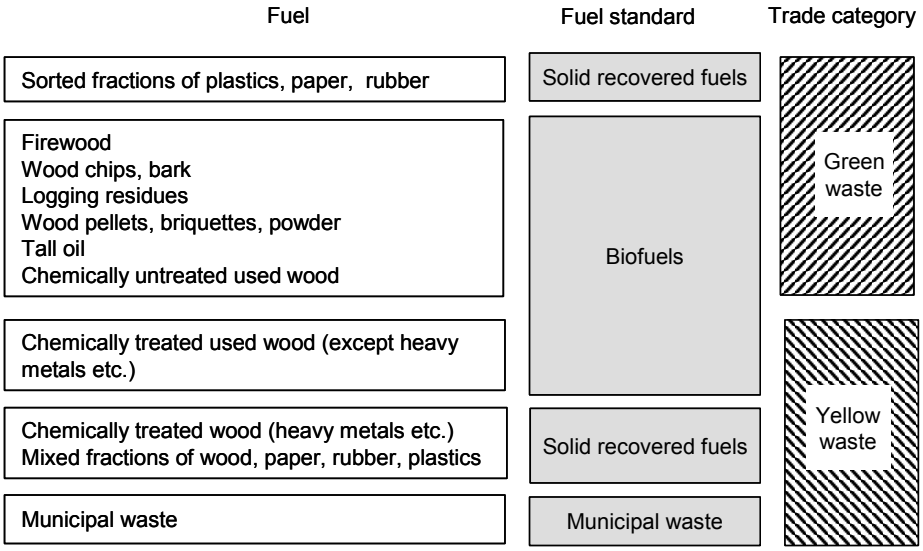

Figure 2. Schematic over how biofuels and some waste fuels are organised in fuel standards and how these relate to the trade categories.

4. Swedish biofuel imports

4.1. Direct imports

The rapid expansion of biomass energy that has taken place in district heating since the early 1990s in Sweden, has been met partly by imports. According to [19] the biofuel imports were less than 2 PJ in 1992. Subsequent surveys by Vinterbäck and Hillring. [8] have estimated the imports to 11-15 PJ in 1995 and 20-32 PJ in 1997.

Table 1 and 2 present the authors' estimations of the biofuel imports in 2000. The biofuel imports, consisting of green and yellow waste, were estimated to be about 18 PJ in 2000. This result is in line with a recent study [20], which estimated the biofuel imports in 2001 to 19-26 PJ (when not including peat).

Sawmill wood chips and firewood/stemwood are imported from the Baltic countries and Russia. Usually the stemwood comes from decay-damaged trees and the wood chips contain bark, which make them unfit as a raw material in the forest industry. Stemwood is primarily imported from Estonia (figure 3) and wood chips from Latvia. Stemwood has better storing properties but requires a chipper at the district heating plant. Since customs statistics do not readily distinguish between pulpwood and fuel wood chips, the import volumes of fuel wood chips, here estimated to 0.8 PJ, are relatively tentative.

Refined solid wood fuels, mainly composed of wood pellets, but also of briquettes and powder, are imported from Canada, the Baltic countries and Finland. In 2000 the imports of refined solid fuels amounted to about 260,000 tonne. This estimate was derived from the total use of refined solid fuels in Sweden [21, 15], the Swedish production [15] and the Swedish export [22]. Canada is one of the largest individual exporters of pellets to Sweden, by 60,000 tonne/year [23], whereas essentially all Swedish pellet export, 40,000 tonne (2000), goes to Denmark [22].

Tall oil, both crude and refined, is mainly imported from the USA and Finland (figure 4). Crude tall oil is a by-product from pulp mills and has similar properties to fuel oil. In order to be treated as a biofuel, i.e. exempt from environmental taxes, the crude tall oil has to be distilled. The distillation leaves 40% refined tall oil to be used as fuel, while the remaining fractions are used in the chemical industry.

The green list also contains untreated used wood and ***separated*** fractions of paper, plastics and rubber. Typical fuels are loading pallets, rubber tyres and scrap-paper. Scrap-paper is usually imported for material recycling but paper of poor quality ends up as fuel. These fuels are chiefly imported from Germany, the Netherlands and Denmark.

Table 1. Estimated imports of fuels on the green list in 2000.

	Quantity tonne	Energy PJ
Refined solid fuels (pellets etc.) [22, 15, 21]	ca. 260,000	4.3
Tall oil (40% of raw and all refined tall oil) [14]	123,000	4.6
Firewood (stemwood) [14]	127,500	1.7
Wood chips	ca. 100,000	0.8
Untreated used wood and separate fractions of paper [18]	100,000	1.4
Plastics [18]	20,000	0.7
Rubber [18]	30,000	0.8
Total	ca. 760,000	14.3

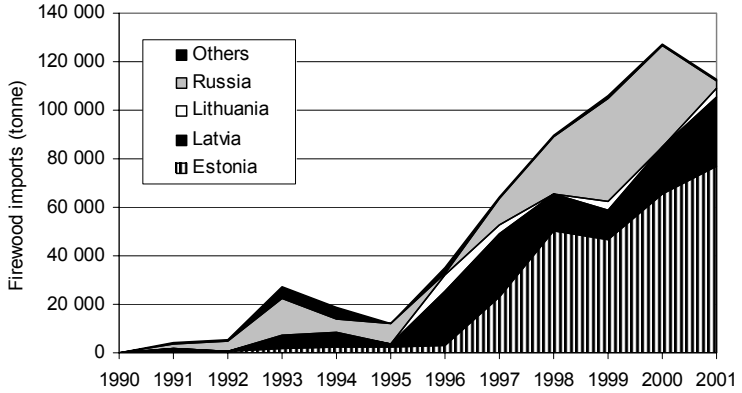

Figure 3. Imports of firewood during the past ten years. [14]

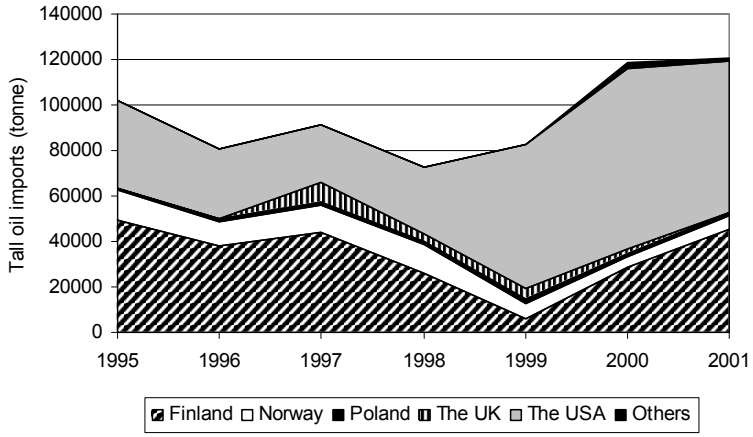

Figure 4. Imports of tall oil, both refined tall oil and 40% of the crude tall oil [14].

In 2000 358,000 tonne of yellow and red waste was imported, of which 269,000 tonne (yellow waste) was used for energy purposes (table 2). This category consisted mainly of treated used wood, for instance demolition wood and railway sleepers, municipal waste, but also of ***mixed*** fractions of paper, wood products and plastics. Apart from municipal waste, these fuels were imported from Germany, the Netherlands and to a lesser degree, Denmark. According to [17], no more than 30,000 tonne of municipal waste was imported, which corresponded to about 2% of the total incineration of municipal waste. Most of the municipal waste came from Norway and some from Finland.

Table 2. Imports of fuels on the yellow list in 2000.

	Quantity tonne	Energy PJ
Treated used wood and mixed solid recovered fuels	ca. 239,000	3.3
Municipal waste [17]	ca 30,000	0.3
Total [16]	269,000	3.6

4.2. Indirect imports

Indirect imports of biofuels derive from the fact that the forest industry imports industrial roundwood (pulpwood and timber) where part of the biomass is eventually used as fuel, either internally or in other sectors.

There has been an increasing trend of roundwood imports over the past decades despite positive annual net growth of the forest resources. Most of the imports originate from Russia, 29%, and the Baltic States, 56 %, of which the imports from Latvia have shown the strongest increase [11].

Swedish pulp mills have imported roundwood since the 1960s, though increasing from modest quantities in the early years (figure 5). Currently 21%[§] of the pulpwood is imported. Sawmills are more sensitive to changes in wood quality and therefore import less. Nonetheless, timber imports, which hardly existed a decade ago, have grown to account for about 8% (2000) of the total use of timber. Sawmills in southern Sweden, where regional sources of wood are scarcer than in the north, import most of these volumes.

A consequence of the roundwood import is that a share of the energy use from internal by-products and a share of the Swedish wood fuel production qualify as indirect imports (table 3). In the forest industry the indirect import makes up about 5.5 PJ of the energy use. Black liquor, which would add another 31 PJ, has been excluded since the burning of black liquor is part of the chemical loop in the pulp mills.

By-products from the sawmills are also used in other sectors, mainly in district heating, but also in private dwellings, industries and the service sector. By utilizing wood fuel statistics from [15], the indirect imports to these sectors were estimated to about 3-4 PJ, of which production of solid refined fuels made up more than 1 PJ.

Table 3. Use of indirectly imported wood fuels in the forest industry (pulp mills, sawmills and wood work industries) and other Swedish sectors in 2000 [11].

Wood fuels used in:	Share of imports	Indirect imports PJ
Forest industry		
Pulp mill by-products (except black liquor)*	ca. 0.12	2.6
Sawmill by-products	0.08	2.9
Other sectors		
Bark and sawdust	0.08	2.5
Refined solid fuels	0.08	1.2
Total		9.2

*Mainly bark. Based on the assumption that half of the imports are pulpwood (no bark) and the other half are roundwood with bark.

[§] For 2000 the total use of pulpwood was 43 800 m^3 solid excluding bark. 24 700 m^3 was harvested in Swedish forests, 8600 m^3 was imported and 10 500 m^3 came from Swedish sawmills. The supply from Swedish sawmills include about 690 m^3 of foreign origin. Source: [11]

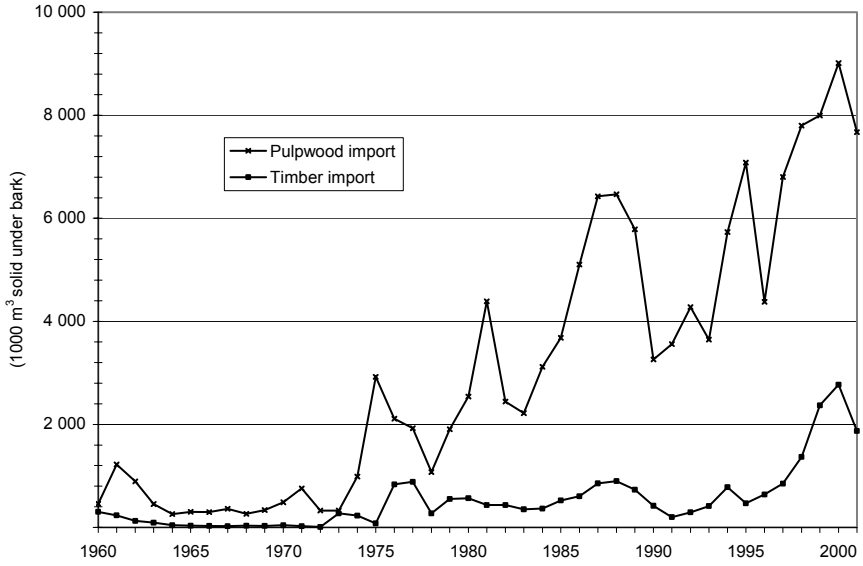

Figure 5. Timber and pulpwood imports to Sweden. The distinction between pulpwood and timber during 1994-2001 are estimates from the National Board of Forestry. During that period statistics covered them collectively under the definition industrial roundwood. [11]

4.3. Total biofuel imports

Our estimates point to a direct biofuel import of about 18 PJ in 2000. Assuming that all (directly) imported biofuels were used in the district heating sector, the direct imports would have represented 26% of the biofuel supply, municipal waste excluded. Adding the indirect biofuel imports used outside the forest industry would have raised the import share in district heating to 31%.

In total, the indirect biofuel import was half the size of the direct import.

Table 4. Swedish direct and indirect imports of biofuels in 2000. Compilation of table 1, 2 and 3.

Biofuels used in:	Imports		
	Direct PJ	Indirect PJ	Total PJ
District heating/CHP			
Refined solid fuels*	4.3	1.2	5.5
Tall oil	4.6	-	4.6
Firewood/stemwood*	1.7	-	1.7
Wood chips, bark and sawdust*	0.8	2.5	3.3
Untreated used wood and paper	1.4	-	1.4
Plastics and rubber	1.5	-	1.5
Treated used wood and mixed solid recovered fuels	3.3	-	3.3
Municipal solid waste	0.3	-	0.3
Forest industry			
Pulp mill by-products	-	2.6	2.6
Sawmill by-products	-	2.9	2.9
Total	17.9	9.2	27.1

*Also used in households, the service sector or industries other than the forest industry.

4.4. Key actors

4.4.1 Timber and pulpwood importers

The actors involved in importing roundwood for material use can be divided into three categories: forest industry corporations, import agents and forest owner associations (figure 6).

Forest industry corporations are large companies that own forest land, processing industries (pulp, paper and sawmills) and sometimes smaller independent sawmills. Several of the large forest corporations, as well as forest owner associations, have established themselves on the ground in the Baltic countries where they procure roundwood through own logging companies or subsidiary companies. A significant part of the Baltic countries' pulpwood is exported by Nordic subsidiary companies. In the 1990s many of the corporations tried to set up business in Russia, but most of the projects failed. Instead, import agents handle the imports of roundwood from Russia [24].

There are five large independent agents that import industrial roundwood to Sweden. Lemo Agency AB, the largest one, accounts for 49% of the volume and Thomesto Sverige AB, the second largest for 26%. Lemo Agencies AB mainly imports from Russia and Thomesto Sverige AB from the Baltic countries. The import agents are the major suppliers of imported timber to independent sawmills and also supply the forest owner associations with imported roundwood [24].

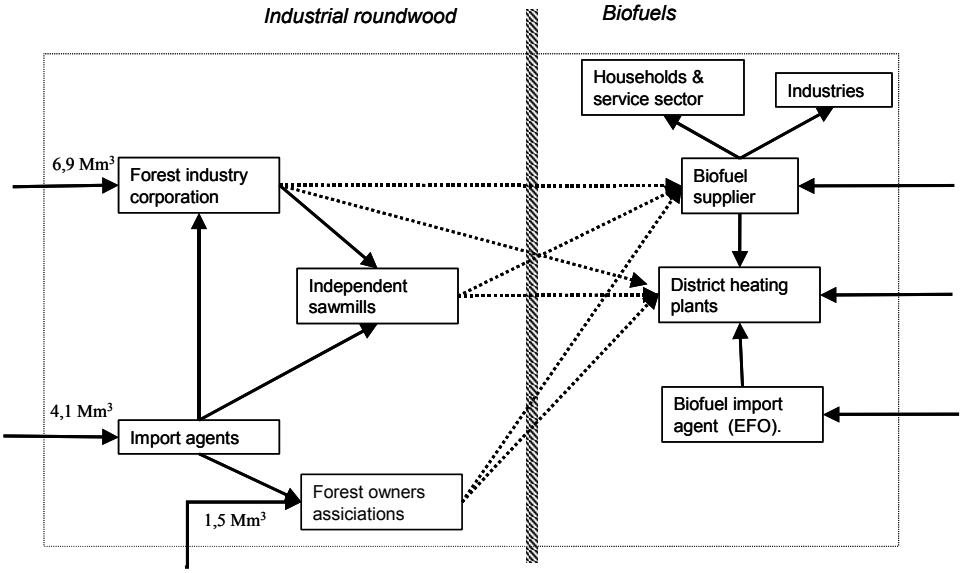

Figure 6. Actors involved in the imports of industrial roundwood [24] and biofuels and the chains of supply. The broken lines indicate by-products, i.e. wood fuels.

4.4.2 Biofuel importers

The commercial market for biofuels is dominated by district heating companies. The most common organisational type producing and selling district heating in Sweden is the municipal limited company. There is, however, an ongoing trend of large private electricity companies and one state-owned company buying municipal companies. It is possible that this trend has contributed to the growing biofuel imports, since these larger companies have experience from international fuel trade. The bulk of the total importing is either handled by the energy company itself, or by an import agent. Small amounts of imported biofuels also reach district heating plants through biofuel trading companies, which also supply industries and small-scale users with biofuels (figure 6).

There is one import agent in Sweden, EFO AB, which is owned by 11 district heating utilities[**]. Most of these are geographically situated on the east coast or east inland in the Stockholm region by Lake Mälaren. This import agent acts only on behalf of these 11 companies (which belong to the group of

[**] ENA Kraft (Enköping), Eskilstuna Miljö- och Energi, Gävle Energi, Göteborg Energi, Tekniska verken i Linköping, Mälarenergi (Västerås), Fortum Värme (Stockholm), Sundsvall Energi, Söderenergi (Södertälje), Södertörns Fjärrvärmeaktiebolag (Norsborg), Vattenfall Värme Uppsala,

large district heating producers) and handles all their imports, whether it is fossil fuels or biofuels. The agent imports wood fuels from Estonia and Latvia and used wood from Germany and the Netherlands. [25]

According to [26] there were 44 biofuel trading companies active in Sweden in 2001. These have a number of different owner structures; some of them are subsidiary companies to forest industry corporations or forest owner associations whilst others are owned by municipalities, sawmills or private interests. The subsidiary companies acquire most of their biofuels from by-products within the corporation, but some of the larger subsidiary companies also import biofuels, for instance Södra Skogsenergi. There is one biofuel trading company with a subsidiary company (SBE Latvia) on the ground in Latvia, which annually produces approximately 60,000 tonne pellets (2000) for export to Sweden [27].

5. Analysis of Swedish biofuel imports

5.1. Key factors for the Swedish biofuel demand

5.1.1 Swedish energy policy

Biomass energy has been given priority in Swedish energy policy since the early 1970s, first as a means to achieve oil substitution and more recently to mitigate climate change. Oil has been heavily taxed since the first oil crisis in 1973. The rapid expansion of biomass in production of district heat, however, took off after the energy tax reform in 1991. In addition to the previously established energy tax, the reform introduced a carbon dioxide tax (now 630 SEK/tonne CO_2, approx. 70 €/tonne CO_2) and a sulphur tax on fossil fuel. Consequently biomass, which was exempt from these taxes, became the most competitive fuel in the production of district heat. Biomass-based district heating has also been promoted through investment grants. To maintain the competitiveness of Swedish industry, they have been given reduced environmental taxes in heat production. Furthermore, no energy or carbon tax is levied on fuels used for electricity production, which is taxed at the consumer level instead. Industry is exempt from this electricity tax.

5.1.2 Existing structures

The ability to adapt to the bioenergy incentives created by government policy has been facilitated by existing structures in Sweden. The first is the extensive forest industry, which supplies relatively inexpensive wood fuels to the biofuel market. Due to this industry there is also a well-developed forestry infrastructure that enables harvest of logging residues coupled to roundwood felling. The second structure is the district heating systems that were introduced in Sweden in the 1940s and have, since then, expanded considerably, mainly because of their favourable position in energy policy. Today district heating supplies over 40% of the heating in buildings. The introduction of biomass energy in district heating was facilitated by fuel flexibility in existing heat plants. This resulted partly from the Solid Fuel Act between 1982 and 1994 [28], which required new plants producing more than 50 GWh thermal per year to be designed so that they could be fired with solid fuels.

5.1.3 Biofuel prices

In production of district heat wood fuels compete on the fuel market with other biofuels rather than highly taxed fossil fuels. Since the potential physical supply of wood fuels in Sweden vastly exceeds current demand, production and transportation costs are the dominating price factors. The nominal prices for biofuels in Sweden have been stable during the past two decades, which implies a decline in real prices. Most likely this is a combined effect from learning processes and from price pressure exerted by imported biofuels. Figure 7 shows the average purchasing prices for district heating plants, where refined fuels are the most expensive (4.5-5.5 €/GJ) and used wood the least expensive (approx. 2 €/GJ). Note that the average purchasing prices include imported volumes of biofuels and that biofuel prices always include transport to the heating plant.

Fuel prices paid by individual plants, or for imported biofuels on the other hand, are difficult to obtain since the district heating companies act on a competitive market. According to [29], the Latvian export prices were 2.6, 3.7 and 3.5 €/GJ in 1998 for wood chips, pellets and briquettes respectively, which is far below the average wood fuel prices in Sweden (figure 7).

Fuel price, however, does not solely determine the fuel's competitiveness. Associated investment costs, fuel flexibility, operation and maintenance costs are other important aspects to take into account. For instance, the viability to use relatively expensive pellets on a large-scale can be explained by the option to burn pulverised pellets in old coal powder fired boilers. Treated used wood, on the other hand, is cheap but requires sophisticated cleaning and boiler equipment in order to comply with emission levels regulated by the plant concession. It has been speculated that district heating companies prefer SRF from Germany and the Netherlands to that from Sweden. The reason would be better fuel quality due to more thorough waste fractioning [9].

For district heating companies, security of supply may be equally important to price when choosing a supplier, especially for large users of pellets, since the possibility to switch to another biofuel is limited. From their point of view, biofuel imports can be a means to diversify the fuel supply or the result of foreign biofuel trading companies offering better guarantees in terms of supply. In Sweden, the pressure has been particularly strong on the domestic pellet market due to the growing demand for pellets in several sectors. During the winter of 2001-2002 there was a shortage in some regions.

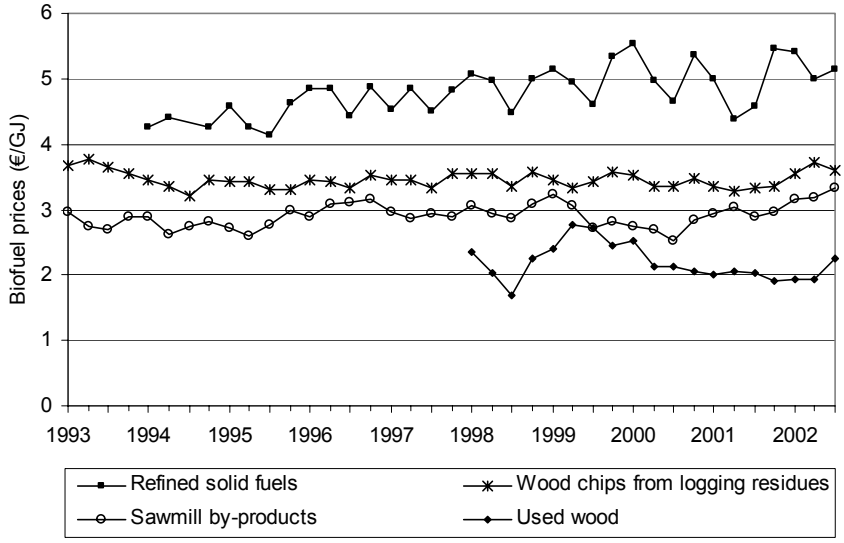

Figure 7. Nominal wood fuel prices excluding VAT (the only tax on biofuels). Prices are average quarterly purchase prices for district heating plants [30]. The exchange rate, 1 €=9 SEK has been used. (During the period 1993-2002 the exchange rate varied between 8.2-9.8 SEK/€.)

5.1.4 Transportation

Sweden is a long country (figure 8), with some regional imbalances in supply and demand of wood fuels. Studies [31, 32] have shown that the regions most likely to have a future shortage in supply of inexpensive wood fuels are counties on the east coast surrounding Stockholm and Lake Mälaren and the most southern county. In effect, these regions account for most of the current biofuel imports.

For short distances, up to 150 km, trucks are the most competitive mode of transport and for longer distances boats are the most competitive [32]. All biofuels from the Baltic States, North America, Germany and the Netherlands are transported to Sweden by sea. Only SRF and municipal waste from Norway and Denmark are transported by truck.

The transportation distance between the Baltic States and Stockholm, for instance, is no longer than the distance between northern Sweden and Stockholm. The Swedish Environmental Protection Agency [31] has estimated the transportation cost for wood chips and pellets from a Baltic Sea harbour to a Swedish harbour on the east coast to be 0.62 €/GJ and 0.31 €/GJ respectively, loading and discharge excluded (table 5). Pellets are cheaper to transport than wood chips due to higher energy density. The shipping is usually done by conventional bulk vessels or vessels transporting wood products. Since wood fuels have a lower density than other traditional bulk goods, such as coal and cereals, all loading capacity cannot be used. Therefore, only refined fuels are traded over very long distances, best exemplified by the pellet imports from Halifax in Nova Scotia on the Canadian east coast to a combined heat and power (CHP) plant in Helsingborg in the southwest of Sweden.

In addition to shipping, the transportation cost includes costs coupled with loading and discharge. Added together, loading and discharging make up 30-50% of the transportation cost across the Baltic Sea, which illustrates the importance of avoiding reloading (table 5). Another way to economise is to coordinate the biofuel shipping with that of another product. There are, for example, district heating plants that import biofuels by boats that export Swedish goods in the other direction.

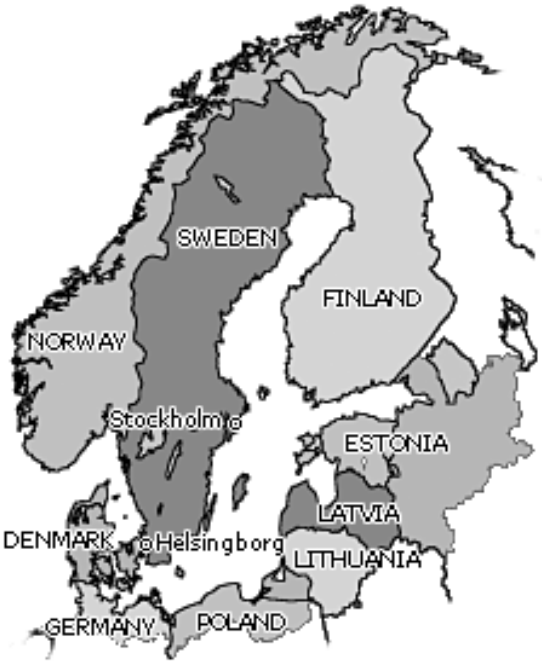

Figure 8. Geography of the Baltic Sea area.

Table 5. Transport from a Baltic Sea port to a Swedish port on the east coast [31]
1 € = 9 SEK.

	Sea freight		Load/discharge	
	€/tonne	€/GJ	€/tonne	€/GJ
Wood chips	7.8	0.62	3.3	0.28
Pellets	5.6	0.31	4.4	0.25
Coal	4.4	0.15	2.8	0.092

5.2. Key factors for the supply of biofuels from the Baltic countries

5.2.1 Forest sectors in transition

The Baltic States are comparatively rich in forest resources (table 6), which provide the basis for a supply of wood fuels. The growing supply of biofuels for export that has emerged during the past decade, however, is the outcome of increasing removals and structural changes within the forest sector.

The forest sectors in the three Baltic States have undergone major changes since the countries became independent in 1991. During the period of Soviet rule following World War II the Baltic States were fully integrated into the economic and political system of the USSR. The forced integration made the Baltic States highly dependent on raw material and energy sources from other parts of the Soviet Union. While these inputs were delivered at subsidised prices, the Soviet market was virtually the single market available for exports. When the economic union of centrally planned countries collapsed, the import prices of raw material and energy increased significantly for the Baltic countries and their previous export market was lost. Accordingly, the industrial output dropped dramatically in the early 1990s and the economies went into a severe recession.

Table 6. Data on forest land, ownership structure (1999), annual increment and felling in the Baltic countries in 2000. Sweden has been included for comparison. (2000).

	Estonia	Latvia	Lithuania	Sweden
Forest land [36]				
in 1000 ha	2060	2923	1994	27134
as % of total land area	48.7	47.1	31.9	65.9
as ha per capita	1.5	1.2	0.54	3.0
Ownership [35], [35], [37] and [11]				
State %	45	53	77*	3
Private %	27.5	40	23	90
Others %	27.5	7		7
Annual increment (Mm^3 solid over bark)	11.9 [35]	16.5 [35]	11.7 [37]	101.3 [11]
Annual felling (Mm^3s.ob.)	6.44 [38]	14.5 [34]	5.3 [37]	76.2 [11]

* 560,000 ha of the state forest (27% of total forest land) is reserved for privatisation.

Table 7. Production of different forest products during the past 30 years. Estonia: [38], Latvia [34] and Lithuania: [37]. All data on wood-based panels has been collected from [34].

Product (Unit)	Country	Year 1970	1980	1985	1990	1992	1994	1996	1998	2000
Sawnwood	Estonia	n.a	637	668	500	300	310	511.4	923.7	1200.2
(1000 m^3)	Latvia	n.a.	n.a.	n.a.	n.a.	740	950	1614	3200	4030
	Lithuania	1313	855	n.a.	776	n.a	840	1450	1150	1300
Pulp	Estonia	n.a	86.5	104.1	68.4	35	0	20.7	44.1	54.4
(1000	Latvia	n.a.	n.a.	n.a.	n.a.	36.9	2	2	0	0
tonne)	Lithuania	62.1	94	n.a	77.8	n.a	0.8	2.6	1.3	0
Paper and	Estonia	n.a.	98	94.5	82.1	34.5	0.3	20.9	43.2	54.3
paperboard	Latvia	n.a.	n.a.	n.a.	n.a.	45.4	4	8.3	18	16
(1000	Lithuania	152.9	235.4	n.a	217.6	n.a	21.1	30.7	32.6	53.3
tonne)										
Wood-based	Estonia	n.a.	n.a.	n.a.	n.a.	110.9	180	312	391	411.3
panels*	Latvia	n.a.	n.a.	n.a.	n.a.	195.1	238	281	343	291
(1000 m^3)	Lithuania	n.a.	n.a.	n.a.	n.a.	233	154.8	197.3	270.4	270.3

*Wood-based panels is a congregation of plywood, particle board, fibreboard and veneer sheets. n.a. indicates not available

Like any other sector in the Soviet Union's economy, the forest sector was primarily state-owned and heavily centralized. Immediately after regained independence, re-establishment of private ownership within the forest sector was initiated in the Baltic countries. Privatisation of the forest industry, which was reasonably straight-forward, was completed in the mid 1990s in all three countries. Private companies now represent the lion's share of total production [33]. Privatisation and restitution of forest land have been slower and is still not completed in any of the Baltic countries, (table 6). Most of the privatisation is taking place on collective farm forests that were introduced during the Soviet era. Eventually private ownership is expected to represent approximately 50% of the forest land in the Baltic countries [33].

The forest industry was also hit by the recession in the early 1990s, but as a whole recovered faster than other industrial sectors [33]. There are, however, large differences between different sub-groups in the forest sector regarding how well they survived the transformation process. In general, the labour-intensive sawmilling, wood working and furniture sectors managed well and even entered into an expansion phase that is still continuing, while the capital-intensive pulp and paper industry faced set-backs. In Estonia and Latvia, the sawmilling sector has expanded significantly since the bottom of the recession in 1994-1995, supported by high growth of exports (table 7). Most pulp and paper mills, on the other hand, have been forced to close down. Obsolete technology, poor management and

difficulties to meet quality and ecological requirements are reported to have caused this set-back [33]. Currently, pulp is only produced in Estonia and in modest volumes [34]. Some paper machines are still operating in all three countries, mainly using recycled fibre as raw material, and at the moment the production is growing (table 7). Private ownership of the pulp and paper mills is, to a relatively large degree, in foreign hands, for instance in Lithuania 29% is foreign capital and 67% domestic and in Latvia the numbers are 50% and 35% respectively [33]. Generally, the most competitive companies in the forest sector are those that have been able to attract foreign investments for new technology [33].

The annual fellings have increased continuously in the Baltic countries since the reform, generally growing faster on private forest land than on state-owned. Rising timber prices, due to opening of the raw material market towards the outside world, has provided incentives for newly established forest owners to increase harvesting. In Latvia the removals have more than tripled (period 1990-2000), however, not exceeding the net growth [34, 35]. A considerable share of the removals (approx. 1/3 in Estonia and Latvia) is exported without adding value; the good quality wood as industrial roundwood and the rest as firewood. The roundwood that is not exported is used notably in production of sawn and planed wood. This current structure of the forest sector fails to ensure a full utilization of the harvested wood in the area due to the undersized pulp production. Instead, much of the sawmill's by-products are exported as pulpwood and fuel wood chips.

The transformation taking place in the Baltic countries has required a renewal and revision of the forestry policy and legal framework. During the years of Soviet administration forest management deteriorated; the central planning system was based upon targets for exploitation and silvicultural works were neglected [33]. The newly adopted legal framework[††] in the Baltic countries affects management and utilization both in state and private ownerships. Sustainability is also targeted, not only in order to sustain production, but also in an ecological sense. Illegal fellings have, however, been reported to take place in all three countries [35]. In Estonia they were estimated to 300,000 m^3 in 1999.

5.2.2 Energy system and policy

The energy systems of the Baltic countries carry many traits that are typical for Central and Eastern Europe, such as high fossil fuel intensity (except Latvia), high shares of district heating and generally low energy efficiencies in housing and industry. National characteristics, however, include the dominance of shale oil in Estonian electricity production and nuclear power in Lithuania (figure 9). Until the early 1990s Russian oil and gas were imported at subsidized prices, which offered modest incentives to exploit other energy sources. Since regained independence, oil and gas import prices in the Baltic countries have increased dramatically and are now roughly equal to import prices paid by Western European countries.

Domestic energy resources apart from shale oil in Estonia are primarily biomass, peat and hydropower. The shares of biomass in the total energy supplies are 11, 22 and 8% in Estonia, Latvia and Lithuania respectively. Biomass is used in heat production in single houses, sawmills, and to a minor degree district heating. There is no electricity production from biomass due to the difficulty to compete with the inherited production capacity from the Soviet time based on oil shale and nuclear [39].

The district heating systems (DHS) provide good opportunities for the Baltic countries to use energy sources efficiently and to increase the use of biomass energy. For the time being, however, the DHS suffer high energy losses and are in acute need of restoration. An element, that can hinder a fuel switch to biomass in district heating, is the high share of non-solid fuels (oil and gas) in existing boiler capacity.

Currently, higher wood fuel prices in neighbouring countries stimulate wood fuel producers in the Baltic countries to export. In 1998 the Latvian export prices for wood chips, pellets and briquettes were 2.6, 3.7 and 3.5 €/GJ while prices for the same products on the domestic market were 1.6, 3.4 and 3.15 €/GJ [29]. Possible explanations for the lower production costs of wood fuels in the Baltic countries are lower wages and the fact that so far only the most easily accessible raw materials are used, such as sawmill by-products and felled damaged trees that have been discarded by the forest industry.

Generally speaking, the fiscal incentives for promoting renewable energy in the Baltic States are weak. Air pollution charges have been developed and implemented for major pollutants, such as SO_2, NO_x

[††] New Forest Act (approved by Parliament in Dec. 1998) in Estonia, Law on Forest Management and Utilization (1994) in Lativa and Forestry Law (1994) in Lithuania.

and solid particles, but the charge rates are too low[‡‡] to create a pronounced incentive effect. Similar to most other countries Latvia and Lithuania lack charges/taxes based on carbon content. Estonia, however, introduced a CO_2 emission charge on fossil fuels in 1999, which is levied on combustion plants where the power capacity exceeds 50 MW. The charge is 0.48 €/tonne CO_2 (100 times lower than the Swedish tax) [40].

The three Baltic countries have ratified the Kyoto protocol. The obligation to reduce the CO_2 emissions by 8% until 2008-2010 compared to 1990, however, does not present any short-term incentive to promote biomass energy since they will meet this target without difficulty.

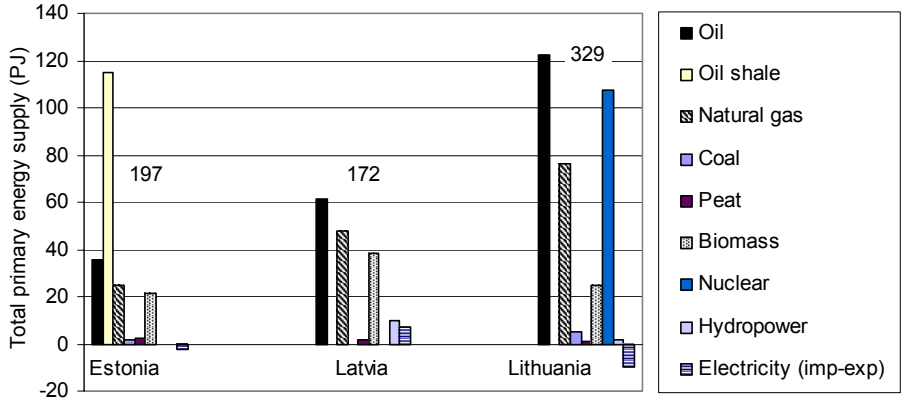

Figure 9. Total primary energy consumption, specified per energy source, in the Baltic countries in 1999 [41, 42 and 43].

5.3. Key factors for the supply of used wood and solid recovered fuels from neighbouring countries

5.3.1 Waste legislation and policy

On a European level the Netherlands have had the most progressive waste legislation, as a ban on land filling combustible waste and organic waste was in place in 1996. Since then several other European countries have adopted, or are in the process of adopting similar legal provisions. In Sweden, for instance, there has been a ban on land filling combustible waste since January 2002, which will expand to apply to organic waste in 2005. Germany will introduce a similar ban on organic waste in 2005. In Denmark, Norway and the Netherlands there is a tax on burning waste (In the Netherlands the tax has been introduced administratively but the tax rate is still zero). This tax, however, only applies to mixed SRF and municipal waste, which are imported to a minor degree, but nevertheless the tax may have bearing on the imports from Norway.

While waste legislation in Germany and the Netherlands brings understanding to the supply (availability) of used wood and SRF to the fuel market in general, it does not explain the export. Motives for the export to Sweden are rather to be found in the lack of demand for these fuels in the domestic energy sectors, which is related to energy policy and structural factors.

5.3.2 Energy policy

Sweden, Denmark, Finland and Norway are four of the few countries with carbon dioxide taxes on fossil fuels. High environmental taxes on fossil fuels in Sweden have increased the cost of producing district heat and made biofuels and waste the most competitive fuels. In Germany and the Netherlands, where the environmental taxes are much lower, biofuels and waste have difficulty in competing with fossil fuels.

5.3.3 Structural factors

The major driving force behind the export of used wood and SRF from Germany and the Netherlands to Sweden is related to the different conditions that exist for utilizing the energy in fuel. One

[‡‡] Emission charges in 2000 presented as EUR/tonne NO_x and EUR/tonne SO_2: (Estonia:8.05 and 3.52, Latvia: 17.9 and 17.9, Lithuania:105.5 and 56.3) [40]

explanation of the low domestic demand for these fuels can be found in the structure of the energy systems of these countries. In Germany district heat makes up about 12% of the heat market and in the Netherlands only 4% [44]. Moreover, there are few boilers designed to burn biofuels in Germany and the Netherlands. Instead used wood and SRF are most suitably used as co-fuel in coal plants or in cement furnaces. In order to do so however, the plant usually requires some reconstruction. On average the energy recovery from incineration of waste is only 39% of the waste's total energy content in Germany, whereas, the share is 90% in Sweden. This clearly demonstrates the better economy of burning used wood and SRF in Sweden. [9]

The same argument holds for the Norwegian export of municipal waste. Since only 3% [44] of the heat market is made up of district heating, several Norwegian regions lack waste incineration capacity.

5.4. Consequences

It has been argued that the biofuel imports have increased the competition on the Swedish biofuel market and has most likely acted as a price stabilizer over time and between regions [45]. Possibly, the option of import has provided confidence to the biofuel market and thereby, played a supportive role for investments in biomass technology in the energy sector.

While most of the imported biofuels have added to the biofuel market, some have won market shares on behalf of logging residues. The previous yearly increase in harvest of logging residues was broken in the second half of the 1990s and has since then been declining. Sawmill by-products, on the other hand, are close to completely exploited in Sweden.

5.5. Prospects

The Swedish biofuel imports seem to have stabilized during the past few years. There are several factors which suggest that the Swedish biofuel imports will not grow in the near future. Regarding biofuels on the green list, most of these factors relate to tougher competition for the biofuels, which will increase the prices of the biofuels that Sweden is currently importing. Domestic logging residues would then have a chance to gain competitiveness again.

If the European Commission's ambitions on renewable energy are translated into national policies, biofuel demand will grow in several European countries. Swedish biofuel importers will then face stronger competition from countries, such as Denmark, the UK, the Netherlands and Germany. There are also reasons to believe that local demand in the Baltic countries for roundwood and sawmill by-products will increase in the future, both for fuel and material use, resulting in less material available for export. Currently, the production of wood-based panels and paper is growing (table 7). Producing more value-added products such as pulp, paper and wood-based panels, instead of exporting roundwood, would substantially increase the economic return for the forest sector in the Baltic countries. So far the major obstacle to setting up a pulp mill has been financing the investment. The newly started company Baltic Pulp[§§], however, is currently investigating the conditions to set up a pulp mill in Latvia.

Although the Baltic countries have experienced rapid economic growth during the past ten years, they still lag behind Western Europe in terms of GDP. As the economic situation ameliorates, environmental issues will be given higher priority, which will stimulate domestic use of biomass energy. Moreover, accession to the EU requires adoption of EU's environmental and energy policies. Promoting biomass energy in the Baltic countries also goes hand in hand with the outspoken ambition of decreasing the dependence of oil and gas imports from Russia. It should be noted that the current biofuel export is a valuable alternative to the domestic market for wood fuel producers and thus could facilitate future growing use of biofuels in the Baltic countries.

The prospects for biofuels in Europe do not only depend on future energy policy but also on agricultural policy. Accession of countries in Central and Eastern Europe will further accentuate the issue of how to deal with the surplus of agricultural land. In some areas, energy crops and short-rotation forestry could serve as alternatives to food production. Countries with relatively high shares of agricultural land, such as Poland and Lithuania, could thereby also become large exporters of biomass

[§§] Baltic Pulp is co-jointly owned by the Nordic forest companies Södra (Sweden), Metsällitto (Finland) and the Latvian State.

in the future. However, there are several possible options available to increase the overall use of biomass energy in Europe. Biofuel trade is one alternative, whereas trade with electricity produced from biomass is another viable option.

Standardisation of biofuels is recognised as an important element for the development of an international biofuel market. There is ongoing standardisation work of solid biofuels and SRF within CEN/TC 335 and CEN/TC 343 respectively (European Committee for Standardization).

With respect to imports of used wood and SRF, one study highlights a number of factors that will influence future trade flows [9]. They are: (1) future volumes of these fuel materials and (lack of) treatment capacity in Sweden and the exporting countries, (2) the technical and economical viability to co-fire used wood and SRF with other solid fuels, such as coal, in conventional solid fuel boilers, (3) the renewable status of SRF, which will determine their attractiveness on the domestic fuel markets and (4) the Waste Incineration Directive 2000/76/EG [13], which contains new conditions for the operation of incineration plants including more stringent regulations of emissions. The Directive, however, only concerns mixed SRF, municipal waste and certain treated wood, and it was to be implemented in national law no later than December 2002. It is likely that these factors will work in the direction of stabilised or reduced Swedish imports of used wood and SRF due to growing domestic use in Germany and the Netherlands. Future public perception of SRF in Sweden and other countries may however, also affect the situation.

6. Conclusions

The Swedish imports of biofuels illustrates a situation which has evolved on the basis of a set of different driving forces that have worked in parallel both in Sweden and the exporting countries. Among these, incongruity of energy policy between Sweden and the neighbouring countries stands out as the most crucial driving force. When Swedish energy policy in the early 1990s made biofuels the most competitive fuel in the production of district heat, this stimulated biofuel import flows, not foreseen or intended by Swedish policy makers. Gradually, a common market for biofuels around the Baltic Sea emerged with most of the trade flows directed towards Sweden. Several factors suggest that the Swedish biofuel imports, here estimated to about 18 PJ for 2000, will not grow in the near future. Meanwhile, other countries are entering the international biofuel market, such as the Netherlands and the UK.

The international biofuel market is still at an early and very dynamic stage. Future conditions for an international biofuel market in Europe will largely be decided by EU policies on renewable energy and their interplay with national energy policies. So far the Commission has indicated that biomass will play an important role in the future. In that context, biofuel trade seems to be a plausible scenario for Europe. It is likely that seemingly strange trade flows will appear and disappear as this new fuel market evolves.

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