RAW WOOD

Pilot Case for IWW Transport

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Content

1 GENERAL

This report takes a closer look at the Finnish pilot. It is important to understand the wider framework of bio-based products as energy source. According to the EU, biomass – in its widest sense – stands for biodegradable fraction of products, wastes and residues from biological origin from agriculture (including vegetable and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste. Basically, this means that any material of organic origin can be considered as biomass. In energy production this usually relates to wood, straw, vegetable oil, manure, and agricultural-industrial and organic waste.

In this report the focus is on biomass products derived from forests. Forest and wood-based industries produce wood, which in turn is the largest resource of solid biomass. Biomass can be used to produce biomass fuels such as wood logs and chips, bark, sawdust and pellets. The second chapter of the report begins with a more strategic review of bioenergy strategies in EMMA partner countries and especially in Finland. Regional level strategies are also considered since they reflect the willingness in the pilot regions to bring environmentally friendly energy production and transportation closer together.

The third chapter describes a pilot case from Päijät-Häme region linking the opportunity to store raw wood and use it as energy source. The changes for similar activities are even better in North Karelia region. This relates to Finland's long history in forestry. Log floating through inland waterways (mainly rivers) used to be a common sight in the country at the beginning of the 20th century. A closer look at this and other potential of inland waterway transport is studied in chapter 4. The report is summarised in the concluding chapter 5.

2 BIOENERGY IN EMMA PARTNER COUNTRIES

2.1 Finland - strategic level

The latest Government Programme ”Finland of Solutions” (Ratkaisujen Suomi in Finnish) consists of several strategic objectives – one of them being bio economy and clean solutions. This objective is divided into five spearhead projects, out of which ”cost efficient, coal free, clean and renewable energy” contains Government’s environmental and climate alignments:

- Usage of emission free, renewable energy will be increased sustainably – its share will rise above 50 per cent in 2020s
- Coal is no longer used in energy production and use of imported oil for domestic market is halved during 2020s.
- The share of renewable energy use in transport will increase to 40 per cent by 2030.

The Government Programme pays attention to wood and wood products: the use of wood is diversified and increased by 15 million cubic meters per year and its processing value is increased. The size of forest farms is increased with the aim of entrepreneurial forestry and good maintenance of forests. To achieve this:

- A national forestry strategy will be implemented
- Building regulations that prevent the use of wood will be demolished
- Public investments will be targeted in basic roads, railways and terminals

A recent Government report on the National Energy and Climate Strategy for 2030 sets out actions that are aligned with the Government Programme. These actions target an 80−95 per cent reduction in greenhouse gas emissions by 2050. There are also other numeric objectives in the programme:

- The share of transport biofuels will be increased to 30 per cent
- The minimum aim is to have 250 000 electric and 50 000 gas-powered vehicles on the roads
- The share of renewable energy in the end consumption will increase to approx. 50 per cent

Additionally, it is stated in the programme that the share of renewable energy use in transport will clearly exceed the Government Programme target (increasing the share of renewable energy use in transport to 40 per cent by 2030).

In addition to the aforementioned strategic documents, the National Forestry Strategy 2025 prioritises the objectives and more detailed measures to achieve the strategic goals set in the Forestry Policy Report of Prime Minister’s Office (2014). One of the key objectives of forest policy is to **safeguard the prerequisites for the profitability of the entire value chain in forestry**. **Good conditions of road and other transport networks** are among the key prerequisites. The strategy calls for public investments in transport infrastructure in order to support the anticipated increase in logging as well as enhance harvesting and logistics. The strategy also points out that use of wood as energy contributes to the need for harvesting, transport and infrastructure. In terms of logistics, the strategy mainly considers road and rail transportation, and makes no reference to inland waterways. The strategy will be implemented through projects of strategic importance. One interesting example is forest sector

supportive traffic infrastructure. This stands for preparing and implementing a development programme to target public investment especially in road networks, railways and terminals serving the forest sector.

2.1.1 Regional level strategies in North Karelia and Päijät-Häme

Regional development programmes are tools used for implementing more long-term development plans of Finnish regions. New regional development programmes are currently being drafted. The regional development programme 2014-2017 of Päijät-Häme points out that the strengthened role of bio-economy supports the vitality of countryside in the region. Furthermore, there are good transport connections to an international airport as well as to ports, while there are still opportunities to develop rail connections locally and towards Russia. One of the spearheads in the programme is promoting the transport system and accessibility.

Various strategies and plans in the region pay very little attention to waterways, and the focus is more on road and rail transport.

The regional development programme 2018-2021 of North Karelia contains three focus areas, one of which is oil free region. This stands for increased attention to bio-economy and climate change which gives good grounds for intelligent use of resources in the region. The programme states that an oil free region is an ambitious, yet realistic objective.

From the economy's point of view **North Karelia relies on forests and wood**. Forestry employs thousands of people in wood processing, wood harvesting, transportation, production of machinery as well as wood energy production.

Wood represents renewable source of energy and forests grow fast in the region. Annual growth of the region's forests has already risen to 8 million cubic meters. According to the National Forest Research Institute's inventory, North Karelia has a sustainable wood harvesting level of 5.8 million cubic meters, or about one million more than the current use. In the recent years, around 4.8 million cubic meters of forest has been sold to the markets.

In addition to the development programme, another important document aligning forestry and energy sectors is the climate and energy programme of North Karelia 2020, which is a tool for climate change mitigation and adaptation in North Karelia. The visions and targets of the programme aim beyond year 2020. The region already exceeds the EU and national climate targets – hence more ambitious objectives are in place. This is done by strengthening the existing resources in the area and making full use of the potential the region has to offer. Renewable energy for instance accounts for 63 percent of the total energy consumption in the region, and the majority of this comes from wood energy.

In the future there is a need to invest in railway and waterway transportation in Finland (90 % of all emissions in transport sector come from road transport); **a top target for the Finnish transport sector is efficient cargo transport logistics - transferred to rail and water transport routes where appropriate**. Another national target is to increase utilisation of year-round waterway transportation for bioenergy, recycling materials and aggregates. Transport is also increased due to increase in production. Goals for production by 2020 include (Table 2.1):

- The production of wood chips will be 1 mil. m³ (2 000 GWh). The aim is to enhance the supply chain and infrastructure related to wood chips (incl. waterways)
- The production of wood pellets and torrefied wood will be doubled by 2020 (700 GWh). The usage of wood pellets will be tripled (150 GWh) in the region by 2020

Table 2.1. Current production and usage situation (2008) vs objectives (2020) in Finland

	Current situation (GWh)			Goal (GWh)		
Energy (GWh)	Production 2008	Usage 2008	Export 2008	Production 2020	Usage 2020	Export 2020
Black liquor	2 400	2 400	-	2 500	2 500	-
Fuel wood	700	700	-	800	720	80
Wood chips	550	550	-	1500	1500	-
Wood pellets and torrefied wood	280	50	230	700	150	550

2.2 Germany – strategic level

According to the German Federal Government, biomass is the most important renewable energy source in Germany. Both biogas and solid biomass (such as wood residues, foliage or straw) are considered easily storable and thus well suited to compensate for fluctuating electricity generation from wind and sun. Currently bioenergy constitutes the largest share of energy from renewable sources and is expected to play an even more important role in the future. Such development is, however, slowed down by the limited potential of domestic bioenergy. **Thus, the Government anticipates that Germany will depend on the import of sustainable bioenergy carriers**. It is furthermore pointed out that there must be no competition between the production of food for humans and animals alike and energy production.

The National Research Strategy Bio-economy 2030 represents a vision of a sustainable bio-based economy. The strategy, published by the Federal Ministry of Education and Research in 2010, also calls for **continuing the structural change from a petroleum- to bio-based economy** and contains a range of topics research can tap into. One of the objectives is to enable an internationally competitive and sustainable use of biomass in Germany. From sustainability point of view the potential of residual mass as well as wood and straw containing plant materials is high and long-term use should be exploited to greater extent than is currently the case.

Federal Ministry of Education and Research and Federal Ministry of Food and Agriculture are jointly responsible for a report on bio-economy in Germany (2015). The document is titled “Opportunities for a bio-based and sustainable future” and it demonstrates how bio-economy has already become a part of everyday life in several sectors in Germany. In terms of energy, **bioenergy is considered as a key pillar in the future energy mix**. Wood fuels such as wood chips, shavings and wood pellets are mentioned as typical for solid bioenergy carriers whereas liquid bioenergy carriers include biofuels such as plant oil, biodiesel fuel and bioethanol.

The report makes a reference to data from the Working Group on Renewable Energy Statistics which shows that in 2013 Germany covered 12.3 % of its total energy consumption with renewable energy. Within renewable energy sources bioenergy constituted 62 %. These figures should still increase if Germany intends to reach the objectives set for the energy transformation (away from nuclear power and fossil fuels). Germany should cover 55-60 % of electric power by renewable energy sources by 2035 and 80 % by 2050. The report states that bioenergy represents an important building block – alongside wind, water and sun – toward this objective in this energy mix.

2.3 Lithuania – strategic level

Bio-economy plays an important role in Lithuania. According to the Lithuanian Bio-economy Development Feasibility Study the forest bio-based sector (forestry and logging, production of wood, paper and furniture) is the second largest sector of Lithuanian bio-economy. Wood resources are prioritised in the utilisation of forests. This prioritisation is determined by the strategic principle of combining food security with sustainable use of renewable energy sources for industrial (including energy) purposes and the assurance of environmental protection. On the one hand, the total volume of wood has constantly increased in Lithuania and consequently farmed forests make up 71.4 percent. On the other hand, the use of forest biomass is limited by environmental goals prohibiting or limiting economic activities. The forest area has – however – potential to expand by afforestation of abandoned agricultural land and other land unsuitable for agriculture.

The study also shows that the contribution of wood waste for firewood and fuel to the production of primary energy of Lithuania accounted for almost two thirds in recent years. Also, low value-added chips intended for the domestic market have been produced. To increase the contribution of forest bio-based sector to Lithuanian bio-economy and enhance its competitiveness, promoting sustainable use of forest in the production of higher value added industrial products is considered necessary. Furthermore, to reach the EU climate and energy goals, the production of first generation biofuels from grape and cereal grain should be replaced by **the production of advanced second and third generation biofuels made of** agricultural and **wood waste**.

2.4 Poland – strategic level

Poland used to be more in line with other EU Member States in its energy policy. The Polish government for instance adopted in 2009 energy policy which indicated support for the sustainable use of renewable energy. The policy contained a 15 % renewable energy target for final energy consumption by 2020, which included a 10 % share of biofuels in the transport sector. These targets have since then received less attention due to changes in the political climate in Poland. The country still relies on coal and has

in several occasions objected deeper carbon cuts at the EU level. For instance, in 2012 Poland was the only country opposing a resolution calling on the European Commission to propose a new policy framework for low-carbon energy up to 2030. According to the Polish member of European Biomass Association **renewable energy production has been in a crisis** in Poland, and consequently the biomass market has almost disappeared.

This is not likely to change quickly. The government has stated that **coal will remain the cornerstone of the energy system in Poland** for the long term. According to the International Energy Agency (IEA) Poland's energy policy and its relation to coal and renewables shall be addressed in an update to Poland's long-term energy strategy, which is expected in 2017. Based on IEA's 2016 review of Poland, 79 % of country's energy production and 51 % of total primary energy supply (TPES) consists of coal. Electricity generation is also dominated by coal (81 %), but with increasing renewable capacity from biomass and waste alongside wind power. Renewable energy sources provide 10 % of TPES and 13% of electricity generation. Biofuels and waste constitute the largest renewable energy source. The biggest part (82 %) consists of primary solid biofuels, mainly used in heat and power plants or consumed directly in the residential or industrial sectors.

Poland's positive progress in the deployment of renewable sources should not be disregarded. During 2005-2015 the share of renewables in total primary energy supply has risen from five to ten percent. More progress, however, is still needed. The EU Renewable Energy Directive mandate Poland to increase its overall renewable energy consumption to 15 % by 2020.

2.5 Sweden – strategic level

In 2012 Sweden adopted a Research and Innovation Strategy for a Bio-based Economy. The strategy contains a range of research and development needs such as intensified production of bio-based raw materials, further refinement of biomass products as well as **more efficient transport, distribution and storage.** Furthermore, the strategy initiated several processes and gave rise to the innovation programme "Bio-Innovation", with the overall aim of **transforming Sweden to a bio-economy in 2050**.

In Sweden, there is a broad agreement on climate policy as well as on energy issues. Due to the climate agreement, Sweden will be climate neutral or even have net zero bio-gas emissions by 2045, which makes the Swedish approach more radical than that of the EU.

As more recent development, the Swedish government has announced that it will invest 850 million SEK (appr. 87.5 million Euros) in more renewable energy, more efficient energy use and more energy and climate advisory services in 2018, with additional funding in 2019 and 2020. The investments are linked to the 2016 energy agreement between the Government, the Moderate Party, the Centre Party and the Christian Democrats which sets the target of 50 per cent more efficient energy use by 2030, and **100 per cent renewable energy production for electricity by 2040**. The investments will support especially the expansion of wind power and solar energy. However, the role of solar energy will be limited and wind power as well as bio electricity will be the most relevant ones.

2.5.1 Strategic level summary

Majority of the countries included in the study have a positive approach towards bio-economy. Finland is strongly encouraging the use of forest based biomaterials as a replacement of fossil fuels. Germany has already years ago decided to promote renewable energy. This stands especially for solar and wind energy, although bioenergy is regarded as important ingredient in the future energy mix. There is also a lot of on-going research both in Germany and in Sweden regarding the ways to increase the use of bioenergy across sectors. Sweden has also recently announced significant investments in renewable energy, focusing on wind and solar energy. There are less strategic documents available from Lithuania. It can, however, be stated that bio-economy also plays a role in Lithuanian energy mix and the attitude seems somewhat positive. Poland, on the other hand, is on a different path. The country still relies on coal. Despite less proactive approach to bio-economy, Poland has made progress in the deployment of renewable sources, demonstrated by increase from 5 to 10 per cent during 2005-2015.

2.6 Description of the Markets

2.6.1 Europe

According to European Biomass Association total consumption of bioenergy reached its highest point in the EU-28 in 2015. Between 2014 and 2015 the whole sector grew by 6.53 %, resulting in 112.374 thousand tonnes of oil equivalent (ktoe) consumption. This increase was also higher than the average annual growth rate recorded in the period 2000-2015 (4.83 %). In terms of volumes, bioenergy consumption has more than doubled since 2000 (from 55.4 million tonnes of oil equivalent [mtoe] to 112.3 mtoe). There are also high hopes for future growth. It has been assessed that bioenergy should account for 139 mtoe by 2020 in Europe and play a major role to reach its 2020 renewable energy target.

At the European level, majority of bioenergy is consumed in heating (74 %), followed by electricity (14 %) and transport biofuels (13 %). At the national level five Member States are responsible for more than half of the total EU bioenergy consumption. Germany leads the pack with 17 %. France is the runner-up with 12 %, followed by Italy (9 %), Sweden (8 %) and Finland (7 %). In relative terms, however, bioenergy is far more important in the two Nordic countries where the share of bioenergy in the total energy consumption amounts respectively to 33.9 % (Finland) and 32.6 % (Sweden).

Eurostat allows examining how primary production of solid biofuels (excluding charcoal) has developed during 2006-2015. Germany is the largest contributors in terms of volumes, followed by Sweden and Finland. Statistics demonstrate that production levels have increased in all nations except for Finland (Table 2.2).

Table 2.2. Production (thousand tonnes of oil equivalent) of solid biofuels[1] (Eurostat)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FIN	7 629	7 316	7 435	6 441	7 792	7 656	7 949	8 082	8 117	7 901
GER	8 613	8 795	8 702	9 606	11 010	10 629	10 931	10 902	11 425	12 062
LIE	902	884	936	1 003	1 002	983	992	1 041	1 117	1 205
POL	4 326	4 417	4 739	5 190	5 866	6 351	6 988	6 837	6 179	6 268
SWE	8 332	8 441	8 306	8 621	9 500	8 712	9 563	9 211	8 923	9 129

2.6.2 Finland

Finland is still a home to significant paper and pulp industry which traditionally has been using raw wood as a source of energy. The volume of bioenergy as fuel is on the rise. Consequently, wood or bio-based fuels constitute the largest share (25 %) in total energy consumption. At the same time water transport of raw wood has been decreasing (Figure 1).

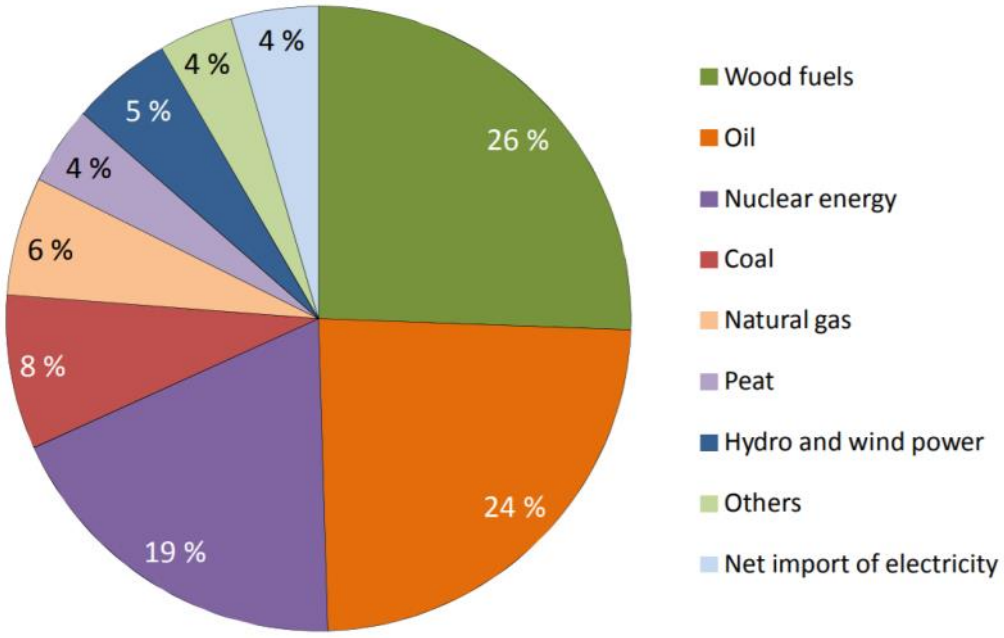

Figure 1. Primary energy consumption 2015 (362 TWh)

[1] According to Eurostat solid biofuels cover organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. They are the sum of fuelwood, wood residues and by-products, bagasse, black liquor, other vegetal materials and residues and animal waste.

The future demand is anticipated in Finland's energy and climate strategy 2030. The figure below demonstrates that wood-based energy sources can play an important role in the Finnish energy production (Figure 2).

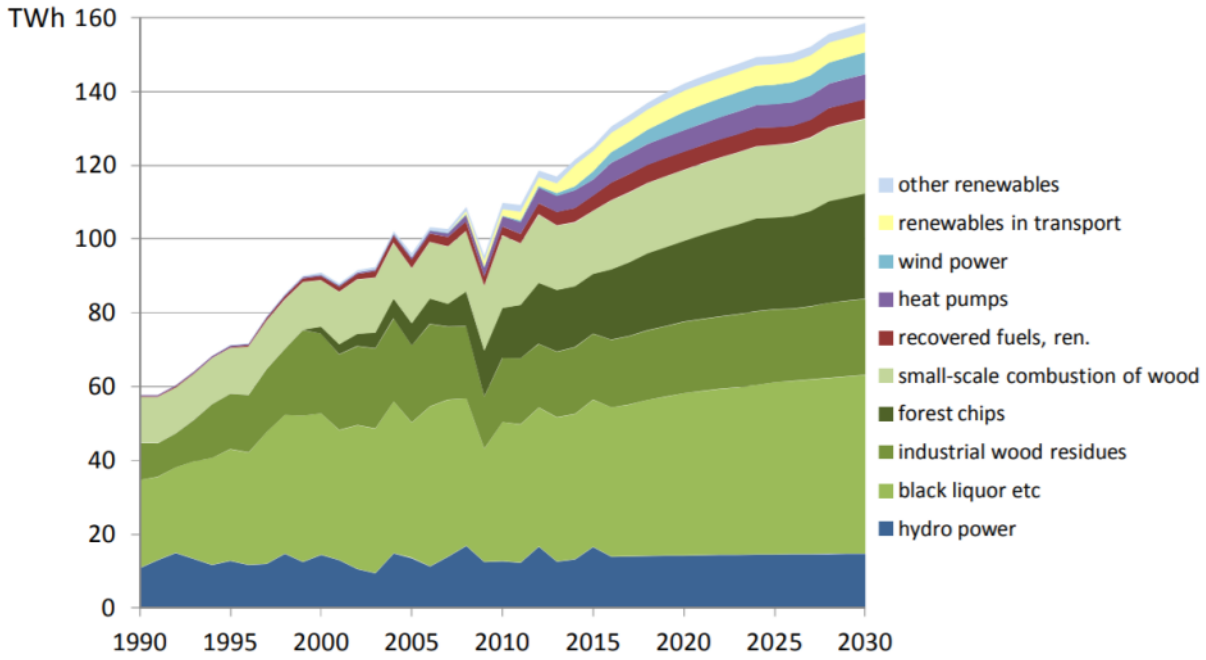

Figure 2. Statistics and forecast for wood based energy sources

Finnish Forest Institute (Metla) and VTT Technical Research Centre of Finland have shown that the use of wood chips and related products has increased in Finland between 1999 and 2009 (Figure 3). This growth can be seen in the areas in the vicinity of inland waterways. Furthermore, there is a more recent report[2] which illustrates that growth in the use of wood chips has also continued since 2009. In 2016, the overall consumption of wood chips was 8.1 million m^3 or 16.1 TWh. According to the report this corresponds to 4.3 per cent of total energy consumption in Finland. Wood pellet factories are shown in Figure 4.

[2] Wood Ship Production in Finland 2016. Slideset 6/2017. Metsäteho Oy

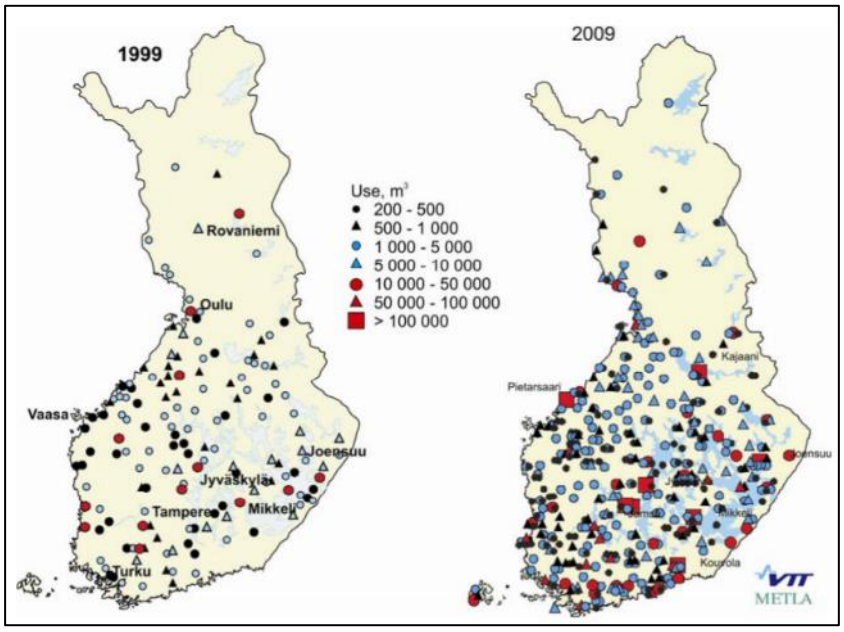

Figure 3. Wood pellet users in Finland 1999 and 2009.

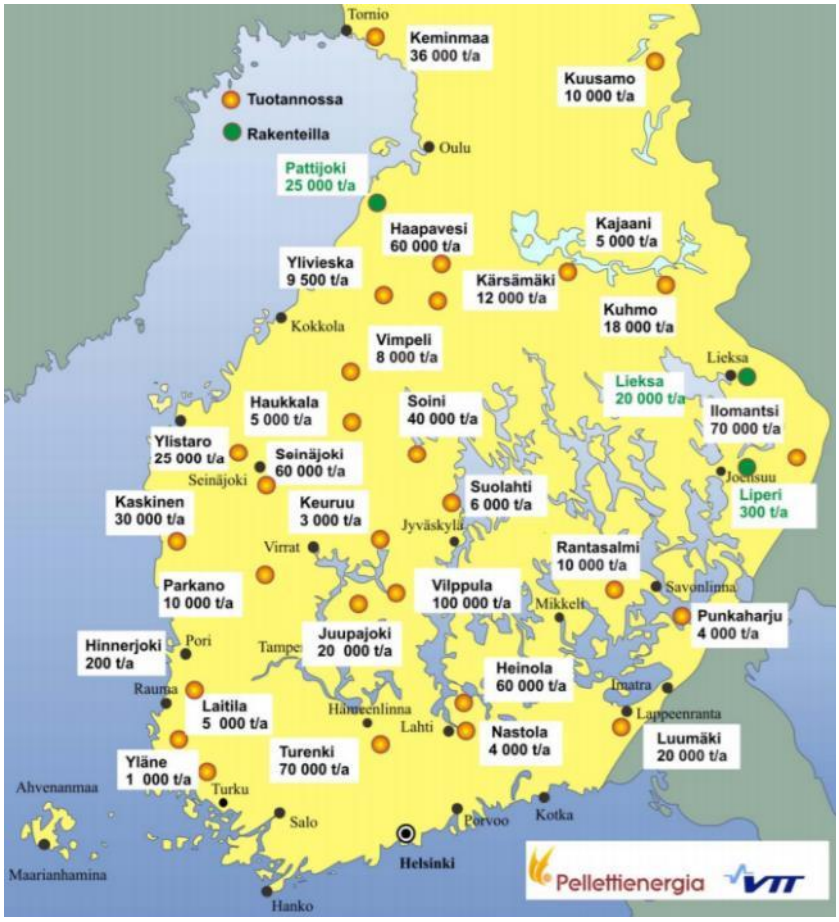

Figure 4. Wood pellet factories in Finland

2.6.3 Germany

According to the documents (cf. Bio-economy in Germany) described earlier in this report, wood is of great importance as fuel in Germany. Approximately 60 million tonnes of wood – mainly split logs in the ovens and boilers of private households – is burned annually. Furthermore, due to the government Market Incentive Programme (MAP), the number of automatically fed and low-emission wood-pellet and wood-chip heating systems has increased. Consequently, approximately 2.3 million tonnes of pellets and 6 million tonnes of wood chips as regionally available biofuels are sustainably produced annually in Germany. Forest wood and wood waste is considered to hold untapped potentials for production of heat.

It has been reported that Germany did not perform as well as expected in pellet production in 2016. The objective was to increase pellet production and the amount of stove and boilers in the country. However, pellet production decreased to about 1.95 million tonnes, compared with 2.0 million tonnes in 2015. According to the German energy wood and pellet association (DEPV) this was due to insolvency of a major producer German Pellet. Consequently, Russia became the largest pellet producer in Europe with a capacity of 2.1 million tonnes a year, just ahead of Germany. There are high hopes in the country to regain the top position in 2017. The DEPV chairman argues that the raw material situation in Germany remains excellent. Furthermore, weather-related demand is expected to increase pellet production.

2.6.4 Lithuania

The biomass from wood and waste is the key in Lithuania's bioenergy portfolio. Practically all the cities, towns and bigger villages in Lithuania utilise biomass district heating, capable of covering base load and supply heat and hot water. Very often biomass energy covers 100 % of necessary heat (in smaller towns). Only in Vilnius this type of transition is still in progress. A new biomass powered combined heat and power plant (CHP), with Waste to Energy (WtE) block built in addition, will finish this switch from gas to biomass in Lithuania in 2017. This large energy unit will also be able to produce 400 GWh of electricity (3.7 % consumption of Lithuania), will supply to district heating grid in Vilnius 1.240 GWh of heat (delivering up to 50 % of Vilnius need), and will reduce the emission of CO2 by 230.000 tonnes annually. Together with the existing capacities in Vilnius of biomass boiler houses and CHP it will be enough to cover even more than the base load, and some assistance from gas generators will be required only during very cold days. After this is done, biomass heat in Lithuanian district heating will reach at least 80% of market share.

The biomass pellets are widely produced in Lithuania, mostly at the small-scale fabrication and are exported to the EU household market. The export represents approximately 25 % of annual biomass output worth 100 million euros.

2.6.5 Poland

As pointed out in chapter 2.4, the Polish renewable energy market is undergoing difficult times. For some renewables this means severe limitations. This is the case with wind energy. In 2016, a bill was passed in Poland to restrict wind power development. Consequently, it is currently illegal to build turbines within 2 kilometres of other buildings or forests - in practice ruling out 99 % of land. Furthermore, the bill quadruples the rate of tax payable on existing turbines.

The situation with biomass is different, because biomass can be burned together with coal in a coal-fired plant and there are also financial incentives (e.g. Green Certificate System) to do this. There are also a few actors using biomass in CHPs. For instance, PGE (Polish Energy Group) has had a biomass boiler operating in Szczecin since 2012. The plant is located on the Oder river. Therefore, inland waterway transportation could in principle be used. However, due to low bridges and too shallow embankment, IWW transport is not considered a viable option.

A foreign energy company, Fortum, has three CHP plants in Poland. The network covers the cities of Płock, Wrocław, Częstochowa, Zabrze and Bytom. The overall power generation capacity is about 200 MW and heat generation capacity is over 1,100 MW, serving around 360,000 households in Poland. Fortum continues to invest in Poland. The company is building a multi-fuel CHP in Zabrze. The plant is expected to start commercial operation by the end of 2018, providing district heating to some 70,000 households in Zabrze and Bytom. The facility replaces old plants in both cities. Częstochowa CHP, built in 2010, utilizes up to 35% biomass in its production.[3]

There is also some pellet production in Poland. Since 2008 Polenenergia Group has provided the energy sector with pellet made from agricultural biomass. The company has three pellet factories which are located in Sępólno Krajeńskie, Ząbkowice Śląskie and Zamość.[4]

2.6.6 Sweden

In Sweden, 50 % of the energy used in all energy sectors is derived from biomass due to large volumes of country's forest industry. One relevant question for the future is how to develop the forest industry more focused into bio refineries. This means that the production will be expanded with e.g. textiles, chemicals and other new kinds of wood products and bio fuels. This strategic development is currently run by large forest companies in Sweden. Overall the industry is focusing more and more on bio components and bio refineries.

The role of raw wood (wood pellet and chips etc.) is central and will increase in the Swedish bioenergy field. This relates e.g. to heating and biofuels production. In Sweden, 54 % of total energy used is currently renewable energy. In order to meet the target of 100 %, one alternative for Sweden is to increase the export of bio-based chemicals and bio-based fuels.

According to Svebio, production of pellets increased from 1.6 million tonnes in 2015 to 1 738 580 tonnes in 2016. The production level is equivalent to approximately 8.3 TWh of energy. The trend seems to

[3] https://www.fortum.com/en/corporation/fortumworldwide/poland/pages/default.aspx
[4] http://www.polenergia.pl/pol/en/page/pellet-factories

continue in 2017 towards 1.92 million tonnes of pellets (approximately 9.2 TWh of energy). Some of the largest pellet producers are illustrated in the figure below as red dots: Scandbio in Vaggeryd (no 2), Norberg (no 3), Ulricehamn (no 5) and Malmbäck (no 7) as well as Stora Enso Timber in Grums (no 4). The demand for pellets in the Swedish market has stabilised and the Swedish pellet manufacturers have increased their share of the market by reducing imports.

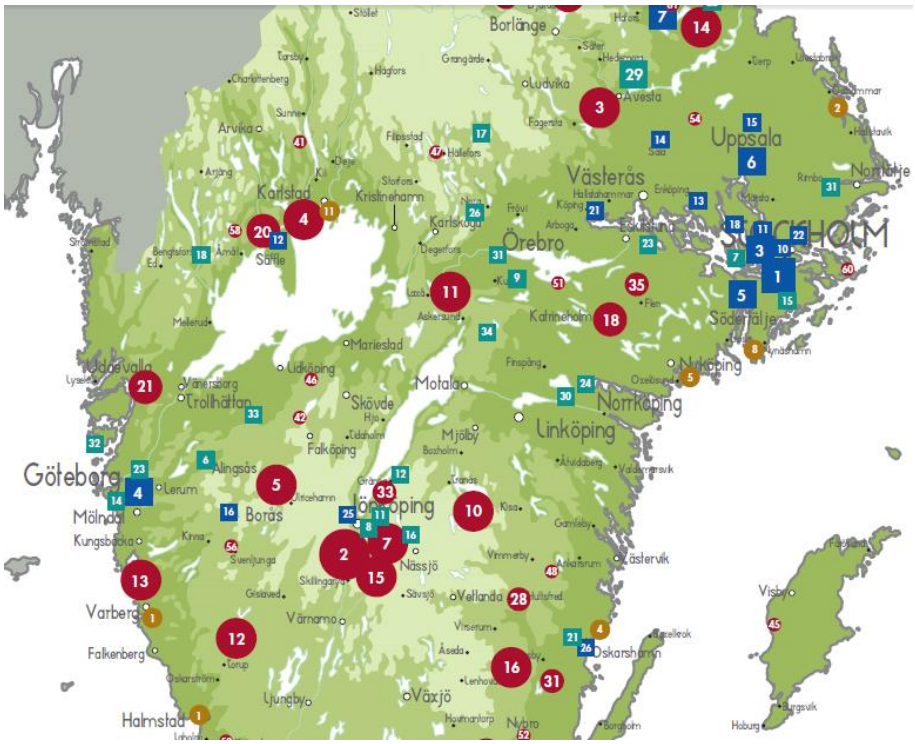

Figure 5. Largest pellet producers in Sweden (source: Svebio)

The ports that handle biofuels in Sweden include Halmstad, Varberg and Landskrona in the west coast, Karlshamn and Sölvesborg in the south as well as Oskarshamn, Oxelösund, Stockholm and Harg in the east.

Waterway transport of raw wood

Wood based bioenergy production facilities in Sweden are situated all over the country. Only few facilities are near inland waterways, i.e. near the big lakes of Vänern and Vättern. Based on the interview of Kjell Andersson, Communications and Policy Director from Swedish Bioenergy Association, the inland waterway transport of raw wood is not expected to increase in Sweden in the future. The possibilities available are already utilised.

Mainly bio fuels, e.g. wood chips, are sourced locally. Biomasses are transported mainly by trucks and most of fuel is used within 70-100 kilometres or even closer, from the source. The rail and water transportation are clearly having lower volumes. Water transport is carried out both along the coast and around the lake side, but the volume varies from time to time depending on e.g. handling costs, fuel prices, and demand. Storages are not located in the big cities due to limited space and high stocking

costs. This might, however, change in 5-10 years, when more and more raw materials will be transported within longer distance and the network of terminals will increase in the country.

It is estimated that the water transport will increase only offshore, not inland. For example, Fortum has a new biomass-fired combined heat and power plant (CHP) in Värtan, Stockholm (established in 2016) which uses forest residues and wood waste to produce district heating. This plant, as well as other plants in the Swedish coast line, utilises water transport. In the case of Fortum, fuels are imported from the Baltic countries and from Russia.

2.7 Trends in Usage of Wood Pellet and Chips

Europe has set ambitious targets to fight climate change. This requires increase in the use of renewable energy. Biofuels such as wood pellets and chips represent a viable option especially for Member States located in the Central and Northern Europe. These countries have vast forest resources and forests grow faster than they are harvested.

This is also reflected in the previous chapters. The total consumption of bioenergy has consistently increased between 2005 and 2015. Bioenergy plays a major role in case Europe intends to reach its 2020 renewable energy target. At the national level Finnish paper and pulp industry continues to use raw wood as a source of energy. Combined heat and power plants (CHP) are using more wood-based fuels to fulfil environmental requirements. This is related to emissions trading and taxation which is a driving force set by the Finnish Government (Figure 6).

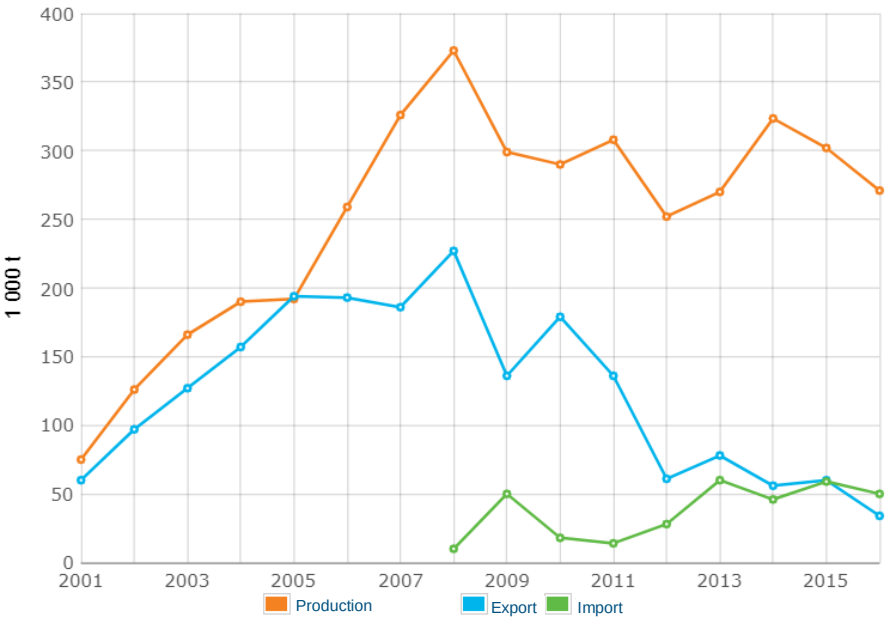

Figure 6. Wood pellet production in Finland (http://stat.luke.fi/puupelletit-2016_fi).

Germany is also considering pellets as one alternative for fossil fuels due to its energy change policy. The country is also a significant producer of pellets. Lithuania on the other hand is already using biomass for district heating and the new CHP plant will finish the switch from gas to biomass this year. Lithuanian

pellet production currently exceeds the domestic demand. Thus, pellets are also exported to the EU household market.

In a similar way as Germany, Sweden has set ambitious goals for its climate policy. The country intends to become a bio-based economy. The intention is backed by large investments from the public sector, although focus of the investments is on wind power and solar energy. Regarding wood-based bio fuels and especially pellets, the Swedish production levels are already quite high. However, there is still some untapped capacity in the production units.

3 PILOT: RAW WOOD TERMINAL SUPPORTING POWER PLANT IN LAHTI

Possible locations for bio-terminal have been studied during project EMMA by using geographical information analysis. The work done was linked to the objective to connect road transport with Europe and its markets via waterways. Therefore, the so-called dry ports are needed in inland locations that have no direct waterway connections. Lahti region in Päijät-Häme is such a location. There is also a need for bio-terminals in the immediate vicinity of dry ports.

The study is linked to targets set in the strategy of Lahti. The objective is to cut greenhouse gas emissions by half by 2025 from the level they were in 1990. The key element in achieving this goal is Lahti Energia's 200 MW multi-fuel power plant, which mainly uses wood-based fuel. The power plant is expected to start heat production by 2019. To secure fuel for the power plant, preparations must be made in Lahti region for a terminal area or areas, where fuels of biological origin can be stored and processed (Figure 7).

It was concluded that there is only a theoretical potential for inland waterway transport. Päijänne waterway does not have connection to other waterways. New traffic would be local and requires new vessels designed for the special conditions (e.g. 2.4 metres draft) (Figure 8).

Figure 7: Example of accessibility analyses.

4 POTENTIAL OF WATERWAY TRANSPORT

The image below illustrates the most important Finnish inland waterway systems. It also shows that Kymijoki watercourse and Kokemäkijoki watercourse are not connected to other inland waterways and can thus be described as internal. Vuoksi watercourse instead has internal transport as well as transport to sea ports mostly in the Baltic Sea.

Kymijoki watercourse and Kokemäkijoki watercourse have limited depth (2.4 m) for large scale commercial transport. Some of the locks are also too small for commercial vessels.

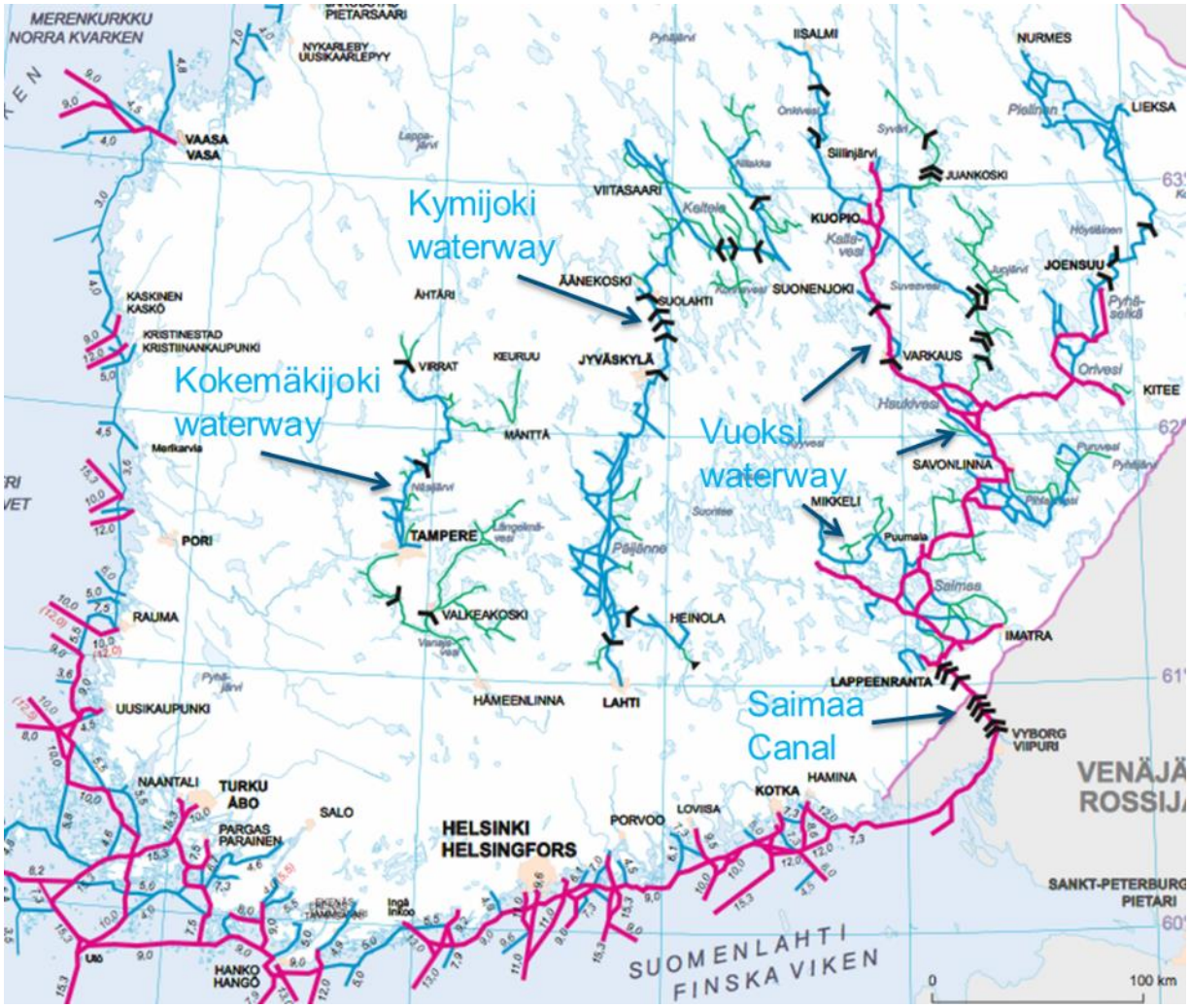

Figure 8. Major Inland Waterways in Finland

4.1 Raw Wood Producers and Users in the Vuoksi IWW

During this study both raw wood producers (such as pulp, paper and saw mills) as well as users (for instance bioenergy factories) have been identified. According to another study, approximately 15 million m^3 of raw wood is transported annually from Eastern Finland (basically the three regions of South Savonia, North Karelia and North Savonia). Demand is likely to increase following the inauguration of country's largest bioproduct mill in October 2017 in Äänekoski. The annual pulp production capacity of the mill is 1.3 million tonnes. Additionally, a broad range of bioproducts such as tall oil, turpentine, bioelectricity and wood fuel are produced in the mill.

4.2 Planned Plants increase IWW Traffic in Finland?

4.2.1 Production Plants planned near Inland Waterways

Green Fuel Nordic Ltd is planning to build a bio oil plant in Lieksa. The plant will for instance make use of by-products from saw mills. Green fuel Nordic anticipates that annually around 90 000 m^3 of raw materials will be turned into 24 000 tonnes of bio oil.

Finnpulp Ltd is also planning a large investment in Kuopio. Total investment is approximately 1.4 billion euros. The factory designed by Finnpulp would be the world's largest single-line softwood plant. As a producer of renewable and versatile chemical raw material - crude tall oil - it would also be the largest in the world. The new plant is planned to use 6.7 million cubic meters of raw wood material per year. The annual production capacity of the plant will be 1.2 million tonnes of pulp. In addition, the plant produces 60,000 tonnes of tall oil and 1 TWh of biomass electricity to the national grid. Production at the plant is expected to begin in 2019.

It has been estimated that the Finnpulp pulp plant will increase wood transportation in the Vuoksi watercource. It can even create a need for importing wood from the sea using the Saimaa Canal. This would be very good in order to get inbound cargo to reduce ship's time for sailing empty.

These are only a few examples of planned production plants in Finland. Figure below demonstrates that there are similar projects across the country. Numbers 2, 5, 9, 10, 13, 14 and 15 represent existing production units which are being redeveloped. Decisions on actual investments have not yet been made regarding numbers 1, 3, 4, 6, 7, 8, 11 and 12.

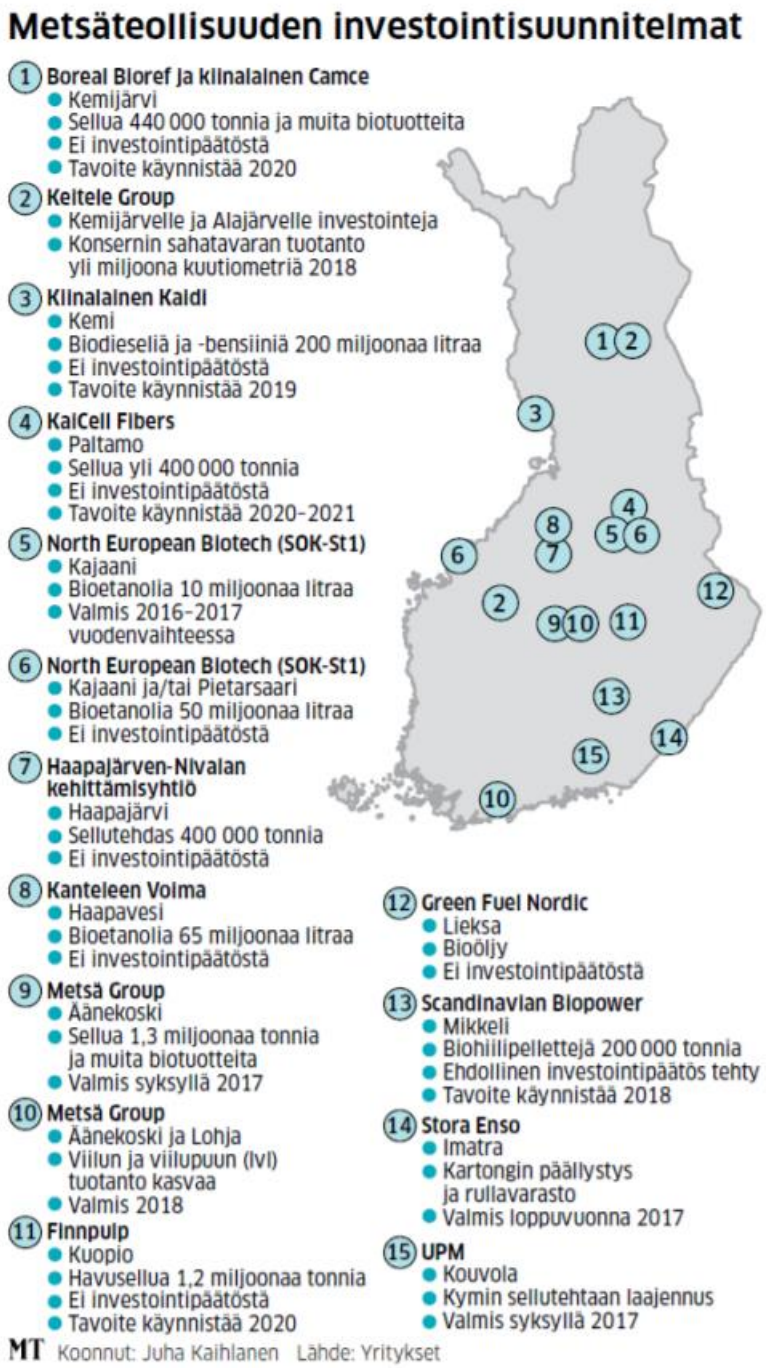

Figure 9. Planned forest industry investments in Finland (Source: Maaseudun Tulevaisuus 30.12.2016)

4.2.2 Power Plants planned in the Finnish Coast

There are several Combined Heat and Power (CHP) plants in Finland. Some of these, especially on the Baltic coast, use coal as fuel. The share of renewable energy should be increased due to the environmental improvements and EU's decisions. As an example, the city of Helsinki's energy policy goal is to increase the renewable energy share to 20 % of the Helsinki Energy's electricity and heat production by the year 2020. To reach the goal Helsinki Energy's developing program contains an alternative that co-firing wood pellets with coal at 40 % share of the annual mixture in Hanasaari and Salmisaari power plants. (http://urn.fi/URN:NBN:fi:aalto-201408292519)

It is recognized that wood pellet is a potential product to transport from Vuoksi to the power plants located in the southern coast of Finland:

- Salmisaari and Hanasaari CHP plants in Helsinki
- Kivenlahti CHP plant in Espoo
- Naantali CHP plant in Naantali

Winter is naturally a period when wood pellet is needed the most. The Saimaa canal, however, is closed for a while during the winter due to ice. Therefore, transportation must be done by other means during that period.

4.2.3 Cost Comparison

A rough cost comparison concerning transport of wood pellets by ship using inland waterways and by truck was conducted as part of this report. IWW transport was calculated according to Saimax -vessel carrying 2500 tonnes of wood pellets from central Vuoksi lake area to Helsinki. Truck transportation was calculated from the same location for the same volume of pellets transported directly from the factory to the powerplant in Helsinki. The road transport distance is 320 km whereas distance using IWW transport is 500 km. It was acknowledged that transporting goods from Vuoksi watercourse requires moving an empty ship or truck to the location where loading occurs. Ship's pre-transport - the cargo needs be transported from the factory to the port - was also considered in the calculation.

Table 4.1: Comparison of Ship and Truck Transport Costs (one transport two-ways).

SHIP/INLAND WATERWAYS

Explanation	Sum €
Pre-Transport	8 454 €
Vessel costs	30 751 €
Port and fairway etc. costs	31 644 €
Cargo charges	2 500 €
TOTAL	73 349 €
Euros per tonne	29,3 €/tonne
Euros per cbm	18,3 €/cbm

TRUCK/ROADS

Explanation	Sum €
Pre-Transport	0 €
Cost per kilometre (two ways)	1 811 €
Waiting etc.	60 €
Cargo handling	80 €
TOTAL	1 951 €
Euros per tonne	48,8 €/tonne
Euros per cbm	31,7 €/cbm

Following summary of costs and difference was resulted:

IWW Transport costs (2500 tonnes)	73 349 €	
Truck Transport costs (2500 tonnes)	120 002 €	
Truck vs. IWW transport	1,7	Times more expensive with truck
Truck trips vs. one IWW trip	62	Times more trips needed by truck
Fuel burn by IWW vessel	20 016	Litres per 2500 tonnes cargo
Fuel burn by truck	25 600	Litres per 2500 tonnes cargo

It can be concluded that inland waterway transport is considerably cost efficient and more environmentally friendly means of transport. However, cost calculation as well as conclusions change significantly if a ship or truck has cargo on both journeys (from Helsinki to Vuoksi and from Vuoksi to Helsinki). Furthermore, the challenges such as closure of the canal due to ice and availability of ships should not be disregarded.

4.3 Log Floating and Ship Transport within Vuoksi watercourse

As mentioned in the first chapter, it used to be common practice to float logs through rivers and canals in Finland. At its hay day log floating routes extended to thousands of kilometres. Due to development of rail and road transport the importance of inland waterways for transportation has diminished. Nowadays for instance log floating only occurs in Vuoksi region and volumes represent a minor share of what they once were. At best approximately 1.2 million cubic meters of logs were transported in Vuoksi. In 2016 the figure has decreased to 0.3 million m^3 (Figure 11, Figure 12 and Figure 13).

However, the new pulp factories in Vuoksi area (e.g. Kuopio and Lieksa) could change transport flows in Vuoksi inland waterways. A typical pulp factory purchases wood in the range of 150 kilometres from the factory. New factories may have such an impact that wood could be transported from locations that are further away due to capacity issues. It has for instance been argued that the new Äänekoski plant will need raw materials from North Ostrobothnia. This means that the distance of transporting wood may clearly exceed the range of 150 kilometres from the factory (Figure 11).

Figure 10. Example of 150 km range for supplying pulp factory in Kuopio.

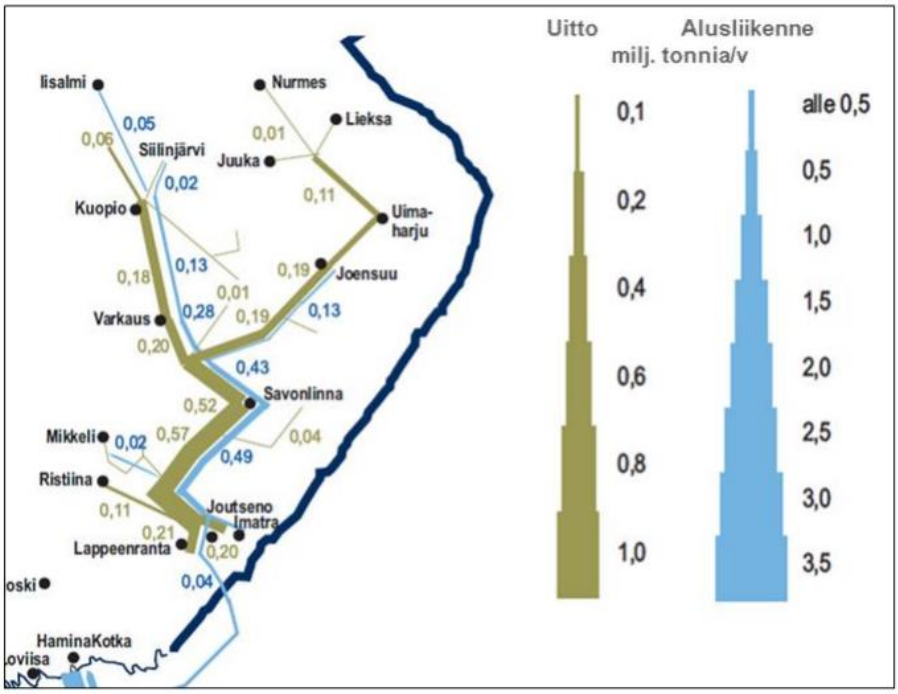

Figure 11. Comparison of volumes transported by log floating and ships.

Figure 12. Log floating in a lock.

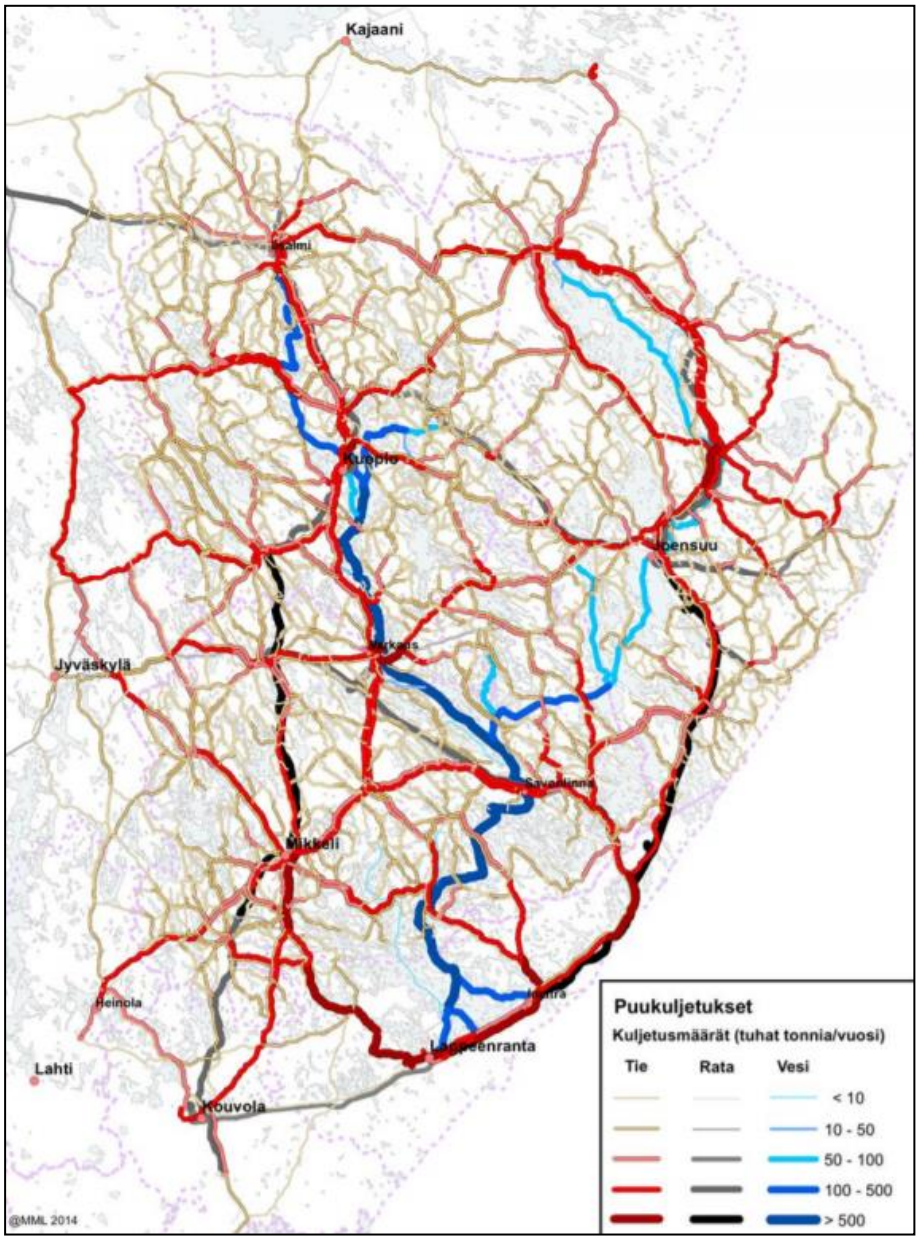

Figure 13. Comparison of volumes transported by different transport modes.

5 CONCLUSIONS

Biomass is the most important renewable energy source in Germany. Germany lacks potential for domestic bioenergy and thus Germany needs to import bioenergy. Germany is also the second largest wood pellet producer in Europe after Russia. Due to a vast network of inland waterways and long tradition in IWW transport it can be argued that Germany holds untapped potential for transporting bioenergy through rivers.

Poland has a long history of using its own coal resources. It is expected that it will take some time to increase the usage of renewable energy. The country has potential to increase both production and usage of biomass, in case the political climate towards renewable energy changes and inland waterway transport infrastructure is enhanced.

Lithuania has recognised the importance of renewable energy sources. However, the usage is currently small-scale, but positive changes are expected.

Sweden has a strong commitment towards renewable energy. It is recognised that more efficient transport, distribution and storage solutions should be developed. However, only a few production facilities are located close to inland waterways and thus inland waterway transport is unlikely to improve in the future.

In Finland, Saimaa deep fairway and Saimaa Canal are still potential transport routes for raw wood. Raw wood transportation as well as usage of bioenergy is expected to increase in the future. Planned new factories e.g. in Kuopio could have a positive impact on internal transport in Vuoksi. The increased usage of wood pellets in CHP plants will provide opportunities for transporting wood pellets from Vuoksi to CHP plants in the southern coast of Finland. Calculations demonstrate that inland waterway transport is more cost efficient and environmentally friendly means for transport.

Ships are getting bigger and the availability of suitable ships for the Saimaa Canal in the Northern Baltic is limited. Therefore, an extension of locks would allow larger ships to be operated in the Saimaa deep fairway and canal. This is considered to be an important factor for keeping inland waterway transport in Finland as commercially feasible mode of transport.

6 LIST OF TABLES AND FIGURES

7 ABBREVIATION LIST

AEBIOM	The European Biomass Association
CHP	Combined Heat and Power
CO2	Carbon dioxide
DEPV	German Energy Wood and Pellet Association
EU	European Union
GWh	Gigawatt hours
IEA	International Energy Agency
ktoe	thousand tonnes of oil equivalent
mtoe	million tonnes of oil equivalent
MAP	Market Incentive Program (Germany)
SEK	Swedish Krona
TPES	Total Primary Energy Supply
TWh	Terawatt hours
WtE	Waste to Energy

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