Wood pellets in the Baltic countries

Cecilia Salin

Helsingin Energia

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1 Global pellet market overview

The global pellet market has evolved considerably during the past years and is expected to further expand in the future. Wood pellets have been traded for over 20 years and the supply chain is considered to be mature. Between different biofuels, like torrefied pellets and pyrolysis oil, wood pellets are most actively traded globally. (Lamers et al. 2013.) Wood pellets have low moisture content and a higher energy density than unprocessed material. The high volumetric density of the pellets facilitates the logistics and the storage of the raw material. (Takko, 2006)

In 2010 the global wood pellet *production* was between 14.3 million and 16.4 million tons, whereas it was between 22.4 million and 24.5 million tons in 2012. The European Union is the largest pellet producer, with a production capacity of approximately 10.5 million tons in 2012. (Calderon et al. 2013.)

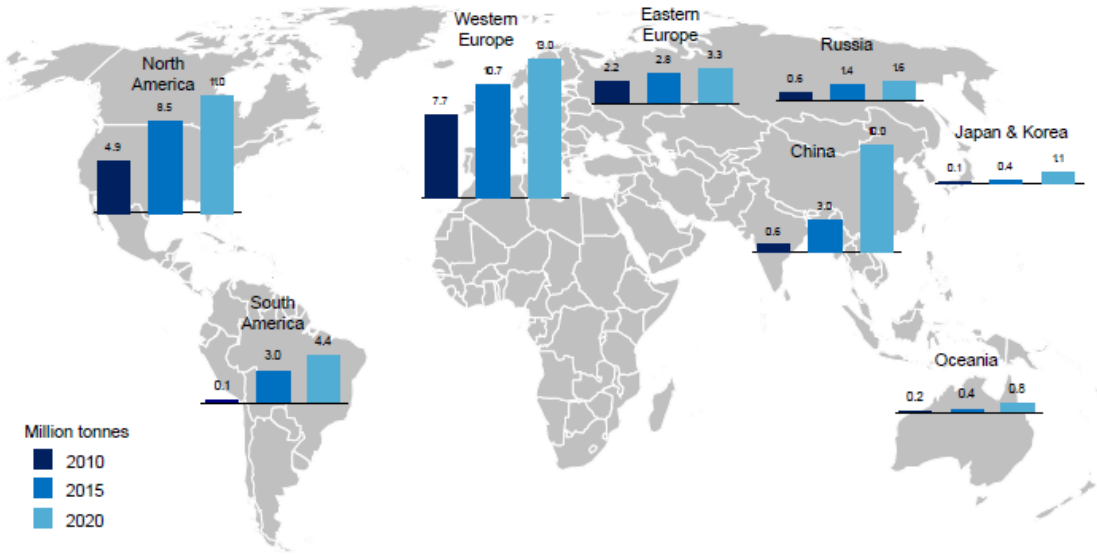


Figure 1: Global pellet production (Pöyry, 2010)

In the end of 2012 there were approximately 760 pellet plants operating globally, having a total production capacity of 42 million tons. The largest pellet producers are primarily located in North America and Russia, whereas the European Union pellet sector is comprised of medium and small scale pellet producers. Of the 760 pellet plants operating globally, only 150 are located in North America, whereas 497 are located in the EU. The largest plant operating in the EU is located in Germany and has a production capacity of 256 000 tons pellets annually. In North America on the contrary, there are several pellet producers with a production capacity ranging from 360 000 to 800 000 tons annually. (Calderon et al. 2013.) The world's largest pellet plant

is, however, located in Russia with a production capacity of 900 000 tons of pellets annually (Pellcert, 2012).

The global wood pellet *consumption* was between 13.5 million to 15.5 million tons in 2010, whereas the consumption ranged from 22.4 million tons to 24.5 million tons in 2012. The pellet consumption is growing rapidly and recent studies show that the global pellet consumption will continue to expand in the future. The European Union is by far the biggest pellet consumer with an average pellet consumption of 15.1 million tons in 2012. (Calderon et al. 2013.)

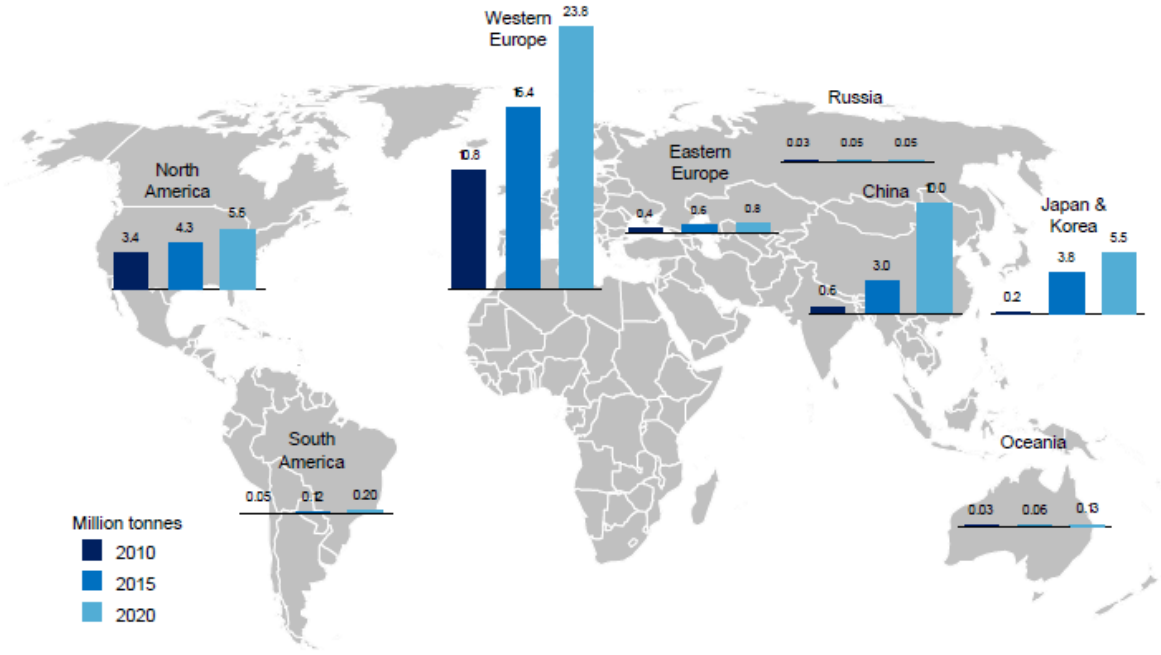


Figure 2: Global pellet consumption (Pöyry, 2010)

The pellet market is however, becoming more globalized and the demand for pellets is also increasing globally. It is estimated that the European Union will continue to be the main pellet consumer in the future, but the pellet demand is expected to increase significantly also in China, Japan and South Korea. (Calderon et al. 2013.)

According to Pöyry, much of the increased pellet demand in Europe is expected to come from further use of pellets in electricity production in the UK and the Benelux countries. Additionally, the use of pellets in heat production is expected to increase in Europe, mostly in Scandinavia. In north America, the use of pellets is expected to increase in residential heating, due to increasing oil prices. (Pöyry, 2010).

1.1 Situation in the European Union

It is expected that the utilization of biomass in heat and power production is going to play an important role for the European Union in reducing its CO2 emissions and meeting the renewable energy targets. In 2012, the European Union consumed approximately 15.1 million tons wood pellets and the demand is expected to increase to 17 million tons in 2014. (Flach et al. 2013.) The biomass market is still dependent on a range of market and policy factors and in many cases, solid biofuels rely on policy supports and incentives (Cocci, 2011). The figure below shows the production and consumption in the EU over the past years.

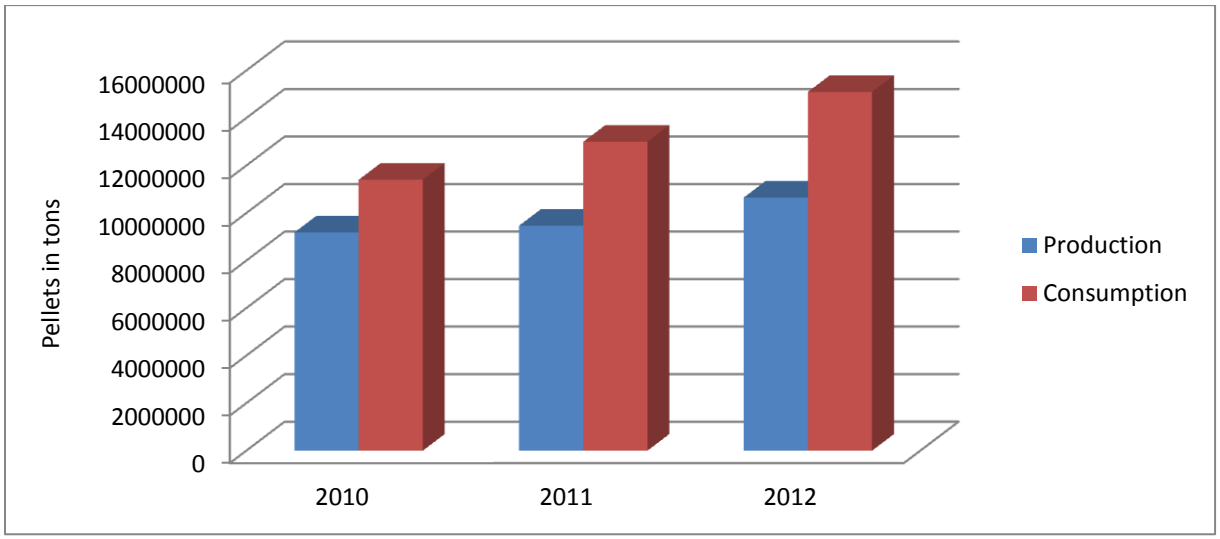


Figure 3: Wood pellet production and consumption in the EU (Calderon et al. and Flach et al. 2013)

As the pellet market is evolving, the competition is becoming more intense, which has intensified international trade. Sawdust is generally used as raw material for pellet production and therefore the raw material availability is dependetnt on the feedstock suppliers. The competition for sawdust has limited the resource availability, making new raw material options like forest residues, wood waste and agricultural residues essential. (Flach et al. 2013.)

Germany, Sweden, Latvia and Austria are the biggest wood pellet producers in the European Union. The wood pellet production is expected to stay stagnant or increase marginally for the largest pellet producers in the EU, as the limited feedstock availability is restricting the production. Some countries have reached their maximal production capacity, whereas other countries are still expanding their pellet production. In Central Europe some expansion is expected, but the the capacity growth will not be sufficient for supplying the growing demand in

northwestern Europe. Overall, as the pellet demand is growing in the EU, the pellet production will not be able to keep up. (Flach et al. 2013.)

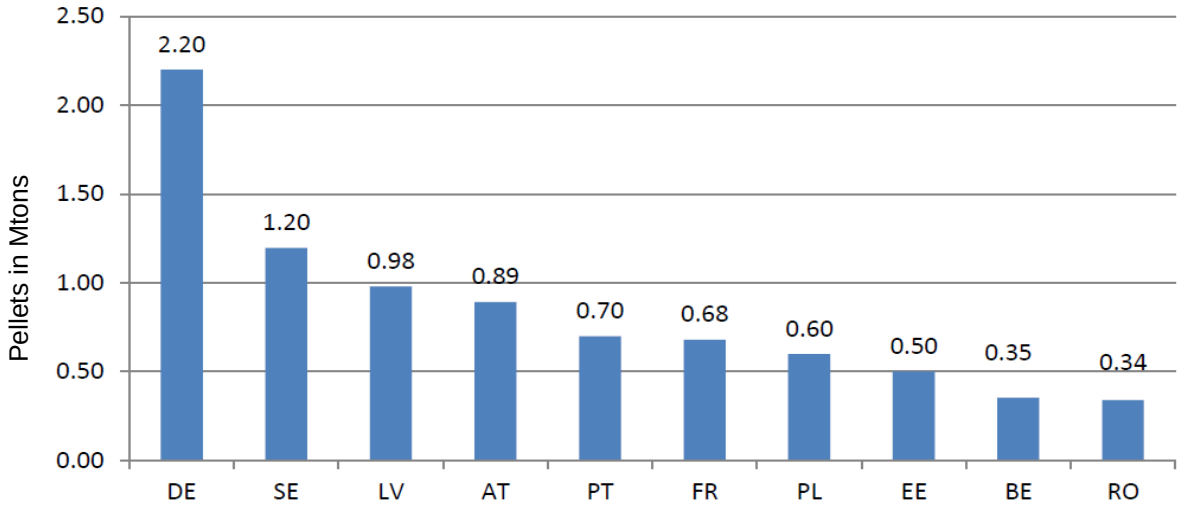


Figure 4: Largest pellet producers in EU (Calderon et al. 2013)

The wood pellet consumption in the EU can be divided into three categories; the pellet power market, the pellet heat market and a combination of the two markets. In the United Kingdom, the Netherlands and Belgium wood pellets are mostly used in large-scale power plants, whereas in Italy, Austria and Germany wood pellets are mostly used in industrial boilers for heating and in small-scale residential heating. In Scandinavia, mostly Denmark and Sweden, wood pellets are used in district heating as well as by large-scale power plants. (Flach et al. 2013.)

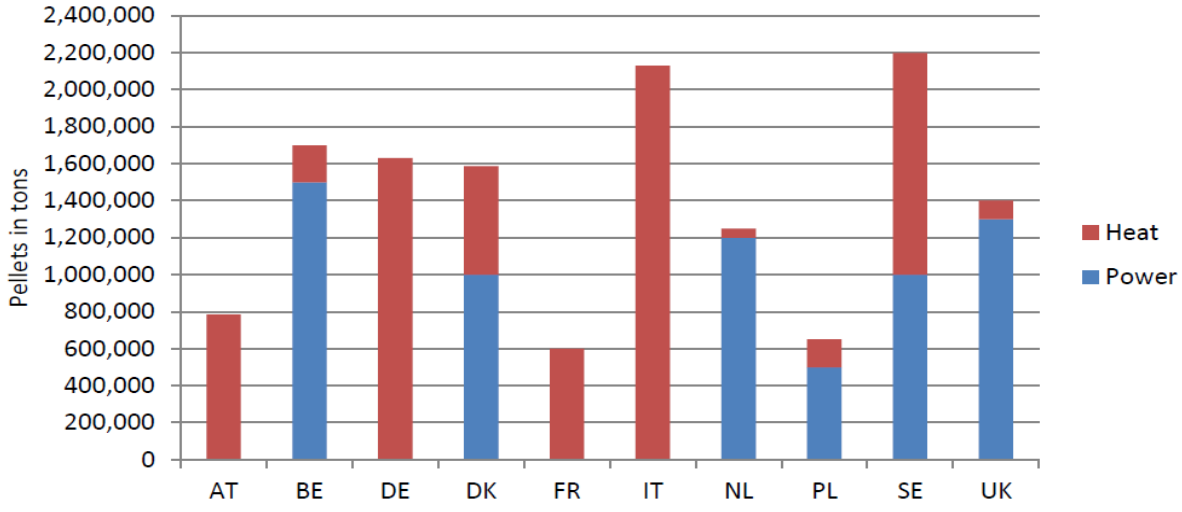


Figure 5: Largest pellet consumers in EU (Calderon et al. 2013.)

The heating sector is growing rapidly, with a share of more than 50 % of the total pellet consumption in the EU nowadays. The use of pellets in heat production is expected to further increase in Europe, with most focus on Scandinavia. (Calderon et al. 2013.) The main growth market for wood pellets in the EU is, however, predicted to be in the power market in the UK and the Benelux countries. The increased pellet use is essential for the countries to meet their renewable energy targets till 2020. (Flach et al. 2013.)

As the European Union consumes more wood pellets than it produces, large amounts are also imported from non-European countries. Since 2008, the European demand has outpaced the domestic production, which has led to large global imports. Most of the transcontinental trade flows are between North America and the EU. Also Russia exports significant amounts of pellets to the EU, whereas minor pellet quantities are imported from Australia, New Zealand and South Africa. (Calderon et al. 2013.)

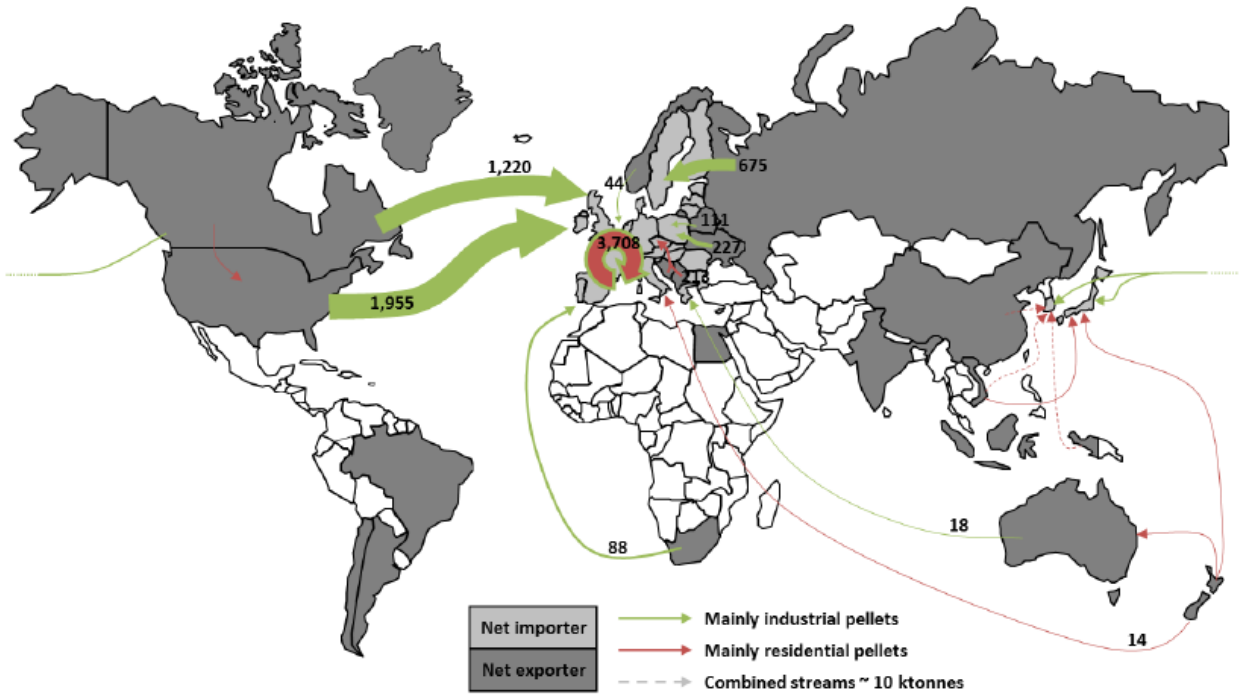


Figure 6: World trade flows (Lamers et al., 2013)

In 2012, the overall wood pellet import to the European Union was approximately 4.5 million tons. The imports are excpected to further increase and reach amounts ranging from 6 to 7 million tons in the following years. In 2012, the imports from the United States grew with 70 percent, reaching nearly 2 million tons. If the trade patterns stay somewhat consistent, the US has the potential to supply the EU with half of the import demand. (Flach et al. 2013.) Denmark

is the biggest wood pellet importer in Europe, following the UK, Italy and the Benelux countries. (Eurostat, 2012.)

Main wood pellet importing countries (EU)	Quantity, tons
Denmark	1 976 506
United Kingdom	1 453 161
Italy	1 090 054
Belgium	969 954
Netherlands	965 213
Sweden	463 328
Germany	304 400
Austria	267 628
Slovenia	29 852
Finland	28 270

Table 1: Largest wood pellet importing countries in EU (Calderon et al. 2013)

Following the three consumer categories for wood pellet use, also three trade flows can be determined. The UK and the Benelux countries mainly import wood pellets from Canada and the US, whereas the Scandinavian countries mainly import from Russia and the Baltic countries. The Central European countries, for example Germany, Austria and Italy, mainly focus on trade and imports from the nearby countries. The table below shows the largest wood pellet exporting countries and their quantities. (Calderon et al. 2013.)

Main wood pellet exporting countries	Quantity, tons
United States	1 955 000
Canada	1 220 000
Latvia	909 684
Germany	815 189
Russia	675 000
Portugal	581 061
Austria	472 949
Estonia	425 403
Romania	276 497
Lithuania	264 831

Table 2: Largest wood pellet exporting countries (Calderon et al. 2013)

As can be seen from the above table, the Baltic countries play a significant role in exporting wood pellets. In 2012, the Baltic countries exported nearly 1.6 million tons wood pellets, mostly to Scandinavia and the UK. (Calderon et al. 2013.)

2 Wood pellets in the Baltic countries

The bioenergy market is considered to be quite unique in the Baltic countries. All three countries have a high share of renewable energy sources in their energy mix, which is considered to be higher than the European Union average. Estonia, Latvia and Lithuania are all significant producers of industrial wood pellets and in all countries, the majority of the pellets produced are exported. A significant driver for the wood pellet market and its development, is the constantly growing demand for bioenergy, both on a regional and global level. The wood pellet market is extremely vivid in the Baltics and the countries are considered to be the source of trade for industrial wood pellets in the European Union. (Cocci, 2011.)

The pellet production in the Baltic countries started in the beginning of the 21 century and has been growing ever since. The growing demand for wood pellets in the Batic sea region and the good production conditions has made the pellet industry interesting and profitable. Cocci (2011) has listed the main drivers for pellet production and trade in the Baltic countries as following:

- Good raw material availability
- Relatively low production costs
- Good logistics. Large ports in all three countries; Sillamae and Paldiski in Estonia, Liepaya and Vetspils in Latvia and Klaipeda in Lithuania

The Baltic countries, especially Estonia and Latvia, are covered with forest land, which ensures good raw material avilability and low transportation costs. The wood industry had been growing during the past years, which has made the sawdust availability better and cheaper. Other factors that make the production profitable are the low labor costs, the low taxes and low energy costs. The low production costs has put the Baltic wood pellets in a good position at the Nordic market, which has led to a significant development of the pellet market. For example in 2010, Sweden decreased their wood pellet production and increased their wood pellet imports from the Baltic states, due to more favourable prices. Also increasing fossil fuel prices has made bioenergy more enticing, which has further encouraged the development of the wood pellet market in the Baltic countries. (Cocci, 2011.)

Latvia is by far the largest pellet producer of the Baltic countries. In 2012, Latvia's wood pellet production reached 980 000 tons, making Latvia EUs third largest wood pellet producer after Germany and Sweden. Estonia's wood pellet production was estimated to 500 000 tons, whereas Lithuania's was 275 000 tons. (Calderon et al. 2013.)

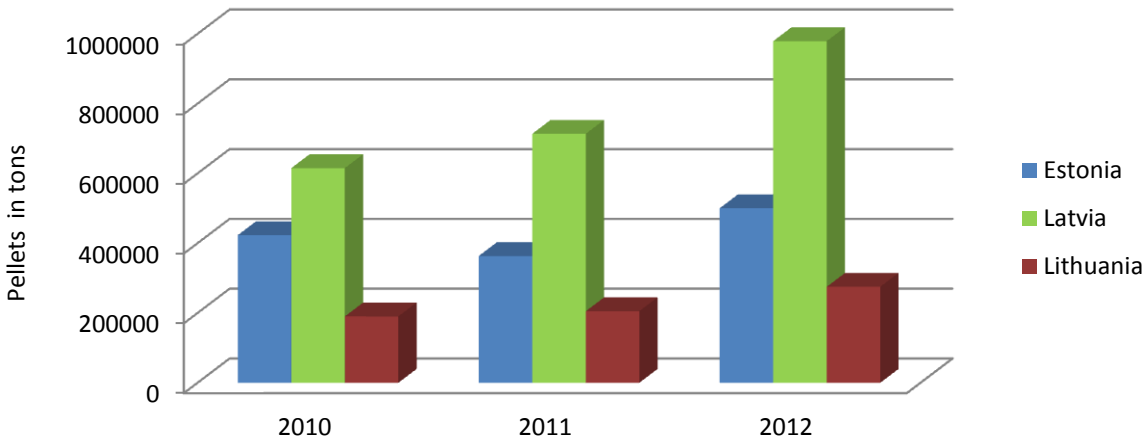


Figure 7: The Baltic countries wood pellet production (Calderon et al. 2013)

According to Cocci (2011) the main barriers for pellet production and trade in the Baltic countries are the following:

- Lack of domestic equipment producers and expertise
- Lack of good quality supply chains
- Lack of big domestic consumers (Cocci, 2011.)

Because the lack of big domestic consumers and the competitive wood pellet price, over 85% of the Baltic wood pellets are exported. Latvia is not only the largest wood pellet exporter of the Baltic countries but the largest pellet exporter in the European Union. In 2012, Latvia exported nearly 910 000 tons wood pellets, whereas Estonia's export reached approximately 425 000 tons and Lithuania's approximately 265 000 tons. (Calderon et al. 2013.)

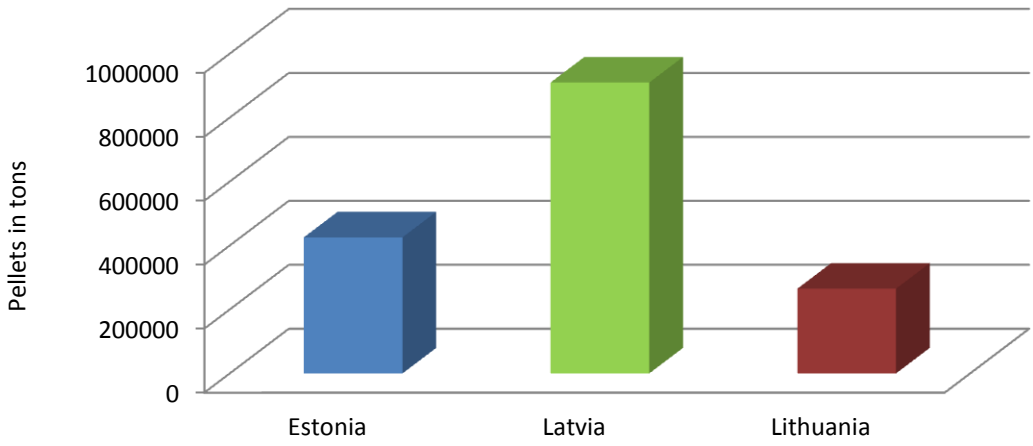
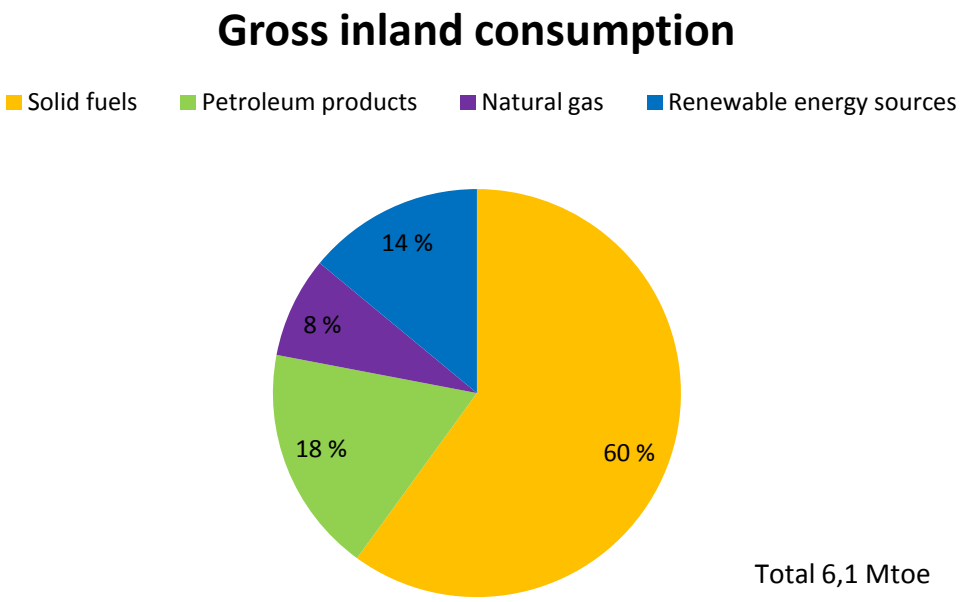


Figure 8: The Baltic countries wood pellet export (Calderon et al. 2013)

2.1 Estonia

Estonia is the smallest of the Baltic countries, both in size and in population. The country's energy production has mostly been based on a small number of large fossil-fuel power plants and the Estonian economy is highly dependent on fossil fuels. The country imports oil and natural gas, but is considered to be less dependent on energy imports than other EU countries. (EREC Estonia, 2009.) In 2012, the country's gross inland consumption was approximately 6 100 ktoe, whereas the final energy consumption amounted to approximately 2 900 ktoe. (Eurostat, 2012). The figure below shows the country's gross inland consumption in 2012 and the energy resource allocation. The figure is drawn based on information from Eurostat.



Source: Eurostat, 2012

The domestic fuels play a significant role in Estonia's total energy resources and the country produces significant amounts of oil shale. Approximately 80 % of the world's oil shale is produced in Estonia and in 2012 the country produced over 18.7 million tons. Besides oil shale, the country uses oil shale gas, shale oil, petroleum products and wood residues as energy fuel. (Estonia Statistics,2012)

The combustion of oil shale puts high pressure on the environment. Since 2009, a range of bio-energy projects were initiated to increase the country's renewable energy sources and cut down on the atmospheric pollution. Combined heat and power plants has been put into operation,

which has increased the utilization of bioenergy. The utilization of oil shale and natural gas in heat production has decreased somewhat, as the utilization of wood fuels in heat production has grown. In 2012, the utilization of power plants for heat production increased by 7% compared to 2011 and over 40% of the heat was produced by power plants. (Estonia Statistics, 2012.)

Estonia's RES target for 2020 is set at 25% and the country's share of renewable in gross final energy consumption amounted to 25,2% in 2012, making Estonia the first country in the European Union to meet its renewable energy target. The share of renewable energy sources used in electricity production amounted to 15,8%, whereas the amount of renewable energy sources used in heating and cooling amounted to 42,1%.

Share of renewable energy sources (%)	Estonia	
	2020 Target	2012
in gross final energy consumption	25 %	25,2 %
in heating and cooling	17,6 %	42,1 %
in electricity	4,8 %	15,8 %
in transport	2,7 %	0,3 %

Table 2: Share of renewable energy sources used in different sectors (Eurostat, 2012)

2.1.1 Renewable energy production

In 2012 Estonia's total primary energy production amounted to 5 091 ktoe, whereof 1056 ktoe was produced from renewable energy sources. Bioenergy plays a significant role in the country and the solid biomass and biofuels are by far the dominant sources of renewable energy. The country has a small number of small-scale hydropower plants operating as well as a growing number of wind turbines. In 2012 the production of hydro and wind energy increased by 20% compared to the previous year, 2011. The largest growth potential for renewable energy in Estonia is expected to be within the biomass and wind power sector. (Estonia Statistics, 2012.)

ktoe	Solar energy	Solid biofuels	Geothermal energy	Hydropower energy	Wind energy	Biofuels	Biogas
Estonia	0	1012,5	0	3,6	37,3	0	2,9

Table 3: Primary production of renewable energy in 2012 (Eurostat, 2012)

According to Estonia's statistical bureau, the solid biofuels consisted of 1 690 000 m^3 firewood, 1 642 000 m^3 wood chips, 1 300 000 m^3 wood waste and 521 000 tons wood briquettes and pellets. (Estonia Statistics, 2012). The majority of wood chips, and about half of the wood waste were used domestically for conversion to other forms of energy. Of the remaining wood waste, approximately 48 000 m^3 was exported and the rest used in residential heating and by other sectors. Most of the firewood was used domestically in residential heating and by other sectors. Only a small part, 45 000 m^3, was use for conversion to other forms of energy and 139 000 m^3 was exported. (Estonia Statistics, 2012.)

In 2012, Estonia also produced approximately 500 000 tons wood pellets and 21 000 tons wood briquettes. The majority of the briquettes were used domestically, mainly in residential heating. Wood briquettes are normally preferred over pellets as the briquettes can be combusted in normal firewood stoves and no reconstruction is necessary. Of the pellets produced on the contrary, only 11 000 tons was consumed domestically as over 90% of the pellets were exported. (Estonia Statistics, 2012.) Based on Estonia statistics figures, Estonia utilizes significant amounts of its bioenergy domestically, with the exception that the majority of the pellets are exported.

2.1.2 Wood pellets

During the last years wood pellets have become an important export product for Estonia. In 2012 Estonia produced approximately 500 000 tons wood pellets, meaning the wood pellet production was over 28% higher than in the previous year. According to the statistic center of Estonia, the country's wood pellet production was 1.5 times higher in 2012 than in 2008. (Estonia Statistics, 2012.)

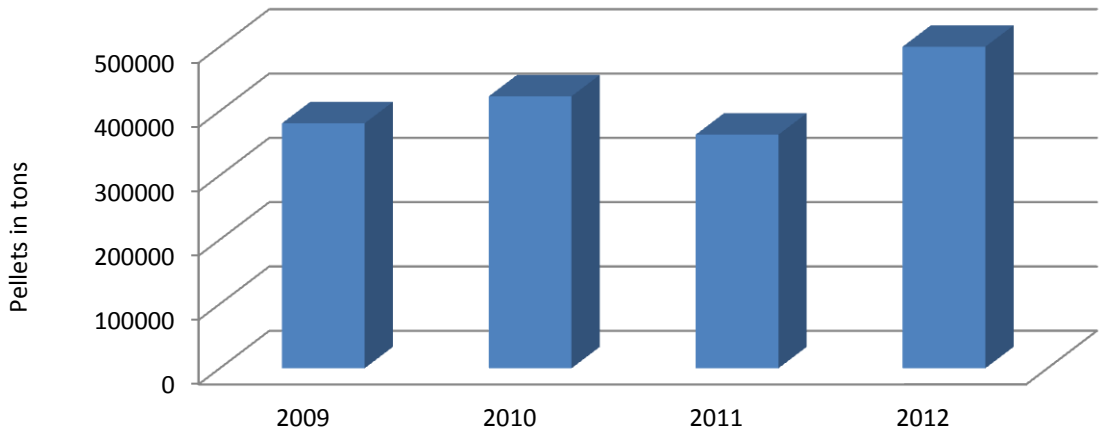


Figure 9: Estonian wood pellet production (Calderon et al. 2013)

The largest wood pellet producer in Estonia is Graanul Invest. The company operates in all three Baltic countries and has an annual production capacity of 820 000 tons wood pellets. The company is the largest wood pellet producer in the Baltic countries and the second largest producer in Europe. Graanul Invest has 6 pellet plants operating, whereof three are located in Estonia, two in Latvia and one in Lithuania. The total production capacity of Graanul Invest pellet plants operating in Estonia is approximately 395 000 tons annually. OÜ Helme Graanul is the largest of the pellet plants with an annual production capacity of 180 000 tons wood pellets. (GraanulInvest,2014.)

Company	Capacity/ton
AS Graanul Invest	105 000
OÜ Helme Graanul	180 000
OÜ Ebavere Graanul	110 000
Purutuli OÜ	120 000

In the beginning of 2014, Graanul Invests subsidiary, OÜ Osula Graanul, begun the construction of a new pellet plant in Estonia Vorumaa, Somerpalu county. The new plant is the largest wood pellet plant in the Baltic countries, with a production capacity of 250 000 tons wood pellets annually. The plant is expected to start operating in the end of 2014, increasing the Graanul Groups production capacity to over one million tons annually. (Graanul Invest, 2014.) Another significant pellet producer in Estonia is Purutuli OÜ, with a production capacity of 120 000 tons wood pellets annually (Purutuli, 2014). The other pellet producers in Estonia are considered to be much smaller.

The gross inland consumption of wood pellets was approximately 11 000 tons in 2012, which is the same as the previous year. Of the amount, approximately 6 000 tons were used for conversion to other forms of energy, whereas 5 000 tons were used in households for heating. (Estonia Statistics, 2012.) Of the pellets produced as much as 425 403 tons were exported, which is over 90% of the total pellet production. Nearly two thirds, 264 729 tons wood pellets, were exported to Denmark and somewhat under one third, 122 465 tons wood pellets, to Sweden. Exports to the UK amounted to 20 011 tons, whereas the remaining 18 200 tons wood pellets were exported to other European countries. (Calderon et al. 2013.)

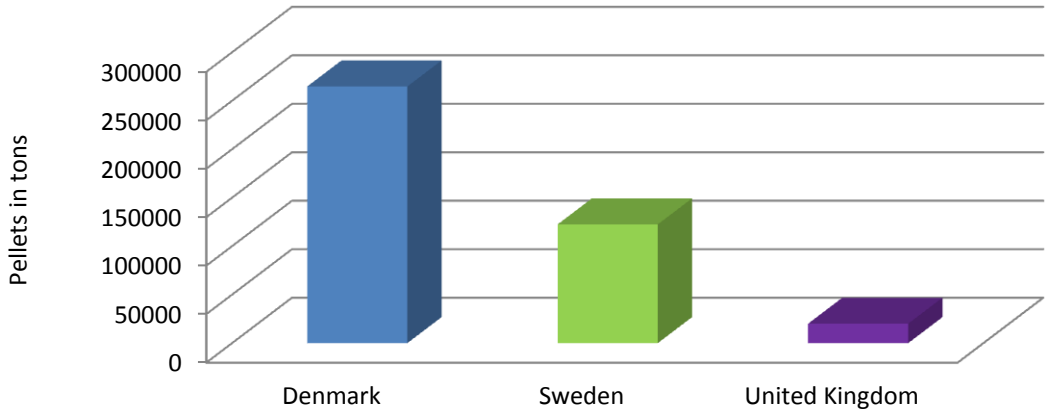


Figure 10: Estonian wood pellet export (Calderon et al. 2013)

2.1.3 Energy support

In Estonia, subsidies are granted to increase the usage of renewable energy sources, secure the internal energy supply and make the energy sector more efficient. The subsidy might be paid as a *feed-in tariff* or as an *investment support*. The feed in-tariff is generally paid for electricity produced from renewable energy sources, whereas the investment support is normally paid for specific renewable energy production technologies and to encourage the use of renewable energy sources in heat production. It is normally the consumers that stand for the cost of financing the subsidies through the electricity transmission costs and network service costs. (Elering, 2014.) Moreover, the purchasing of electric cars that use energy generated from renewable energy sources is encouraged through a specific support scheme (RES-Legal Estonia, 2014).

The subsidies are paid to promote the usage of renewable energy sources by making investments more profitable and renewable resources more competitive. In Estonia wind, water, solar, biomass, geothermal, wave, tidal, landfill gas and biogas are all considered to be renewable energy sources. The biomass covers agricultural biomasses (plant and animal matter) and biomass from forestry. Also residues and by-products from the related industries are considered to be renewable energy sources, as is biodegradable waste. (Elering, 2014.)

The *feed-in tariff* is generally granted to all electricity generation technologies based on renewable energy sources. The producer is entitled to sell the energy generated on the free market and receive a surplus on top of the market price. It is the transmission grid operator that is obligated to pay the surplus on top of the market price to the electricity producer. In Estonia, all renewable energy generation technologies are entitled the feed-in tariff. The surplus amounts

to 0,054 € per kilowatt hour and is the same for all technologies. Notable is however, that small combined heat and power plants, below 10 MWh, using peat, oil-shale retorting gas or waste as fuel are eligible a much smaller surplus amounting to 0,032 € per kilowatt hours. The surplus may be granted for a maximum of 12 years from the date of commissioning. (RES-Legal Estonia, 2014.)

However, electricity produced for the power plants own use is not entitled support and for some technologies specific requirements have been defined. For electricity generated by a wind power plant the following exceptions are relevant:

- If a wind power plant has already been granted other investment support from the state, then the electricity generated by the plant is not eligible for support.
- "The tariff scheme will be suspended for the current calendar year as soon as a total of 600 GWh of electricity from wind energy has already been supported. The amount of support available for calendar year is 76,694 000 Euros." (RES-Legal Estonia, 2014.)

Also for biomass to be entitled the feed-in tariff the following condition must be met:

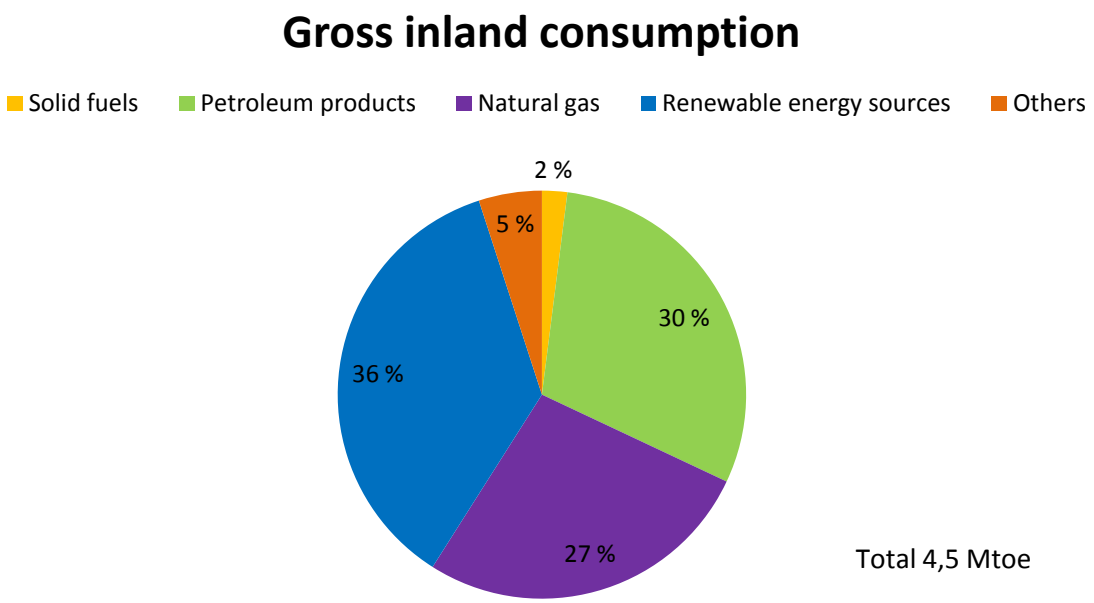
- "The electricity must be generated by high-efficiency CHP plants. Electricity generated by conventional thermal power stations is not eligible." (RES-Legal Estonia, 2014.)

Additionally, *Investment supports* are granted to encourage the development of infrastructure and new technologies necessary for the production of renewable energy. There are a number of different investment supports schemes aimed to encourage different investments in renewable energy projects. The investment supports are granted to promote the development and installations of renewable energy sources. In Estonia, investment supports are granted for the following investments:

- wind energy production development
- development of the technology necessary to process and produce energy from biomass
- construction or reconstruction of combined heat and power plants and the infrastructure related to it. (RES-Legal Estonia, 2014.)

2.2 Latvia

Latvia's energy production is mostly based on large-scale hydropower and combined heat and power plants. (Cocci, 2011). The main primary energy resources are natural gas, biomass and oil. The country imports the majority of the fossil fuels and the energy import dependency is considered high. The supply of natural gas is considered at risk level, as Russia is the only supplier at the moment. Also the majority of the oil is imported from Russia. (EREC Latvia, 2009.) Latvia's gross inland consumption amounted to 4 537 ktoe, whereas the final energy consumption was 4 027 ktoe (Eurostat, 2012). The figure below shows the country's gross inland consumption in 2012 and the energy resource allocation. The figure is drawn based on information from Eurostat.



Source: Eurostat, 2012

Latvia's share of renewable energy in their energy mix is amongst the highest in EU. In 2012, the country's share of renewable energy sources in their energy mix was over one third. Latvia's main primary energy production consists of renewable energy sources and peat. During the past years small-scale hydro and onshore wind power has been growing, as has the utilization of biomass in CHP-plants. (Cocci, 2011.) Biomass is mostly used for district heating (both local and centralized) and for heating individual buildings. Hydropower is on the contrary used for generating electricity. (EREC Latvia, 2009.)

Latvia's share of renewable energy sources in their gross final energy consumption was 35,8% in 2012, whereas their target is set at 40% to 2020. Latvia's RES target is the second most ambitious in the EU after Sweden (49%), and at the moment Latvia has the second highest share of renewable energy sources used in their energy mix in the EU. Approximately 47,3% renewable energy sources is used in the heating and cooling sector, whereas the RES-share is 44,9% in the electricity sector. (Eurostat, 2012.)

Share of renewable energy sources (%)	Latvia	
	2020 Target	2012
in gross final energy consumption	40 %	35,8 %
in heating and cooling	53,4 %	47,3 %
in electricity	59,8 %	44,9 %
in transport	10 %	3,3 %

Table 4: Share of renewable energy sources used in different sectors (Eurostat, 2012)

2.2.1 Renewable energy production

In 2012, Latvia's total primary energy production amounted to 2 336 ktoe, whereof the primary production of renewable energy sources was 2 331 ktoe. This means that practically all primary energy produced in Latvia derived from renewable energy sources. Bioenergy is by far the most significant source of renewable energy, followed up by hydropower. Approximately 1 870 ktoe of the primary energy produced, derived from solid biomass. (Eurostat, 2012.)

ktoe	Solar energy	Solid biofuels	Geothermal energy	Hydropower energy	Wind energy	Biofuels	Biogas
Latvia	0	1869,5	0	318,7	9,8	81,4	51,9

Table 5: Primary production of renewable energy in 2012 (Eurostat, 2012)

In 2012, solid biomass covered over 80% of the total volume of energy resources produced in Latvia. Latvia's solid biofuels consisted of approximately 5 222 000 solid cubic meters of firewood, 3 490 000 loose m^3 wood waste, 3 952 000 loose m^3 wood chips and 1 141 000 tons wood briquettes and pellets. (Central Statistical Bureau of Latvia, 2012.)

Most of the firewood produced in 2012, was used within the country's borders. Approximately 4726 000 m^3 was used domestically, whereas 297 000 m^3 was exported. Of the domestic use, over 80 % was used by households, whereas the remaining amount was mostly used by large

industries and the construction sector. The difference between the production and the utilization of the fuel was because of stock changes. (Central Statistical Bureau of Latvia, 2012.)

Wood chips are strongly used domestically in the energy transformation sector. In 2012, approximately 1 910 000 m^3 was used in the energy transformation sector, whereas 1 003 000 m^3 was used by other large industries, mainly the wood and chemical industry. Of the wood chips produced, approximately 1 227 000 m^3 was exported. (Central Statistical Bureau of Latvia, 2012.) According to Lamers et al., Latvia is amongst the largest exporters of wood chips in the EU. Sweden and Denmark are the main wood chips importers sourcing primarily from Latvia and Russia. (Lamers et al. 2012.)

The majority, 2 956 000 m3, of the wood waste was used domestically, whereas 286 thousand m^3 was exported. Of the domestic use, 77 000 m^3 was consumed in the energy transformation sector and 2879 000 m^3 was used in other sectors, mostly the industry and construction sector. (Central Statistical Bureau of Latvia, 2012.)

Latvia also produced 93 000 tons wood briquettes and nearly one million tons wood pellets. Of the wood briquettes, about two thirds were exported and one third was used domestically, mainly by households. Of the wood pellets on the contrary, solely 136 000 tons was used domestically, whereas over 902 000 was exported. (Central Statistical Bureau of Latvia, 2012.)

2.2.2 Wood pellets

In Latvia, the wood pellet production has evolved alongside the sawmill industry (Blumberga et al. 2009). During the past years, the development of the Latvian pellet market has been significant and in 2012 the wood pellets production reached nearly 1 million tons. In 2009 the pellet production was approximately half a million tons, which means that the production has almost doubled during the past three years. (Central Statistical Bureau of Latvia, 2012.) The figure below shows Latvia's wood pellet production during the past years.

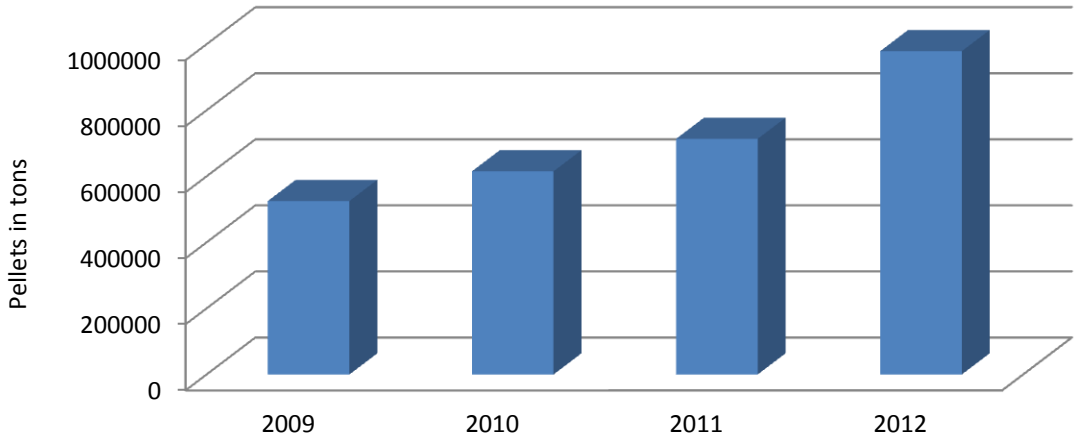


Figure 11: Latvian wood pellet production (Calderon et al. 2013)

The largest pellet producers in Latvia are Graanul Invest and Latgran. Latgran is the largest pellet producer in Latvia, with an annual production capacity of 400 000 tons wood pellets. The company has three pellet plants operating. The newest unit, Kraslav, was put into operation in 2011, increasing the company's production capacity with 160 000 tons annually. (Latgran, 2014.)

Graanul Invest has two large pellet plants operating in Latvia, producing over 360 000 tons wood pellets annually. In 2012, the company started a new pellet plant in Incukalns, SIA Graanul Pellets, with a production capacity of 180 000 tons wood pellets annually. Also the same year the company reconstructed the SIA Graanul Invest plant, increasing its production capacity from 110 000 tons to 180 000 tons wood pellets annually. (Graanul Invest, 2014.) Together the two companies, Latgran and Graanul Invest, stand for more than 760 000 of the wood pellet production in Latvia. Latvia's other wood pellet producers are considered to be much smaller, with production capacities ranging from 10 000 to 70 000 tons annually. (Bioenergy International, 2012.)

Company	Capacity/ton
SIA Graanul Invest	180 000
SIA Graanul Pellets	180 000
Latgran, Kraslava	160 000
Latgran, Jekabpils	160 000
Latgran, Jaunjelgava	80 000
SBE Latvia (Lantmännen Agroenergi)	70 000
Kurzemes Granulas	70 000

According to Latvia's statistical center, the share of pellets used in the country's gross energy consumption in 2012 was about 136 000 tons pellets. The pellets are mostly used by households and by the public sector. The amount used in the energy transformation sector is nearly insignificant, less than 10 000 tons. On the contrary, over 902 000 tons wood pellets were exported, which is over 90% of the country's wood pellet production. (Central Statistical Bureau of Latvia, 2012.) Latvia exported nearly 436 993 tons wood pellets to Denmark, 131 659 tons to Estonia and 103 899 tons to Sweden. The amount exported to other countries was estimated to 237 134. (Calderon et al. 2013.)

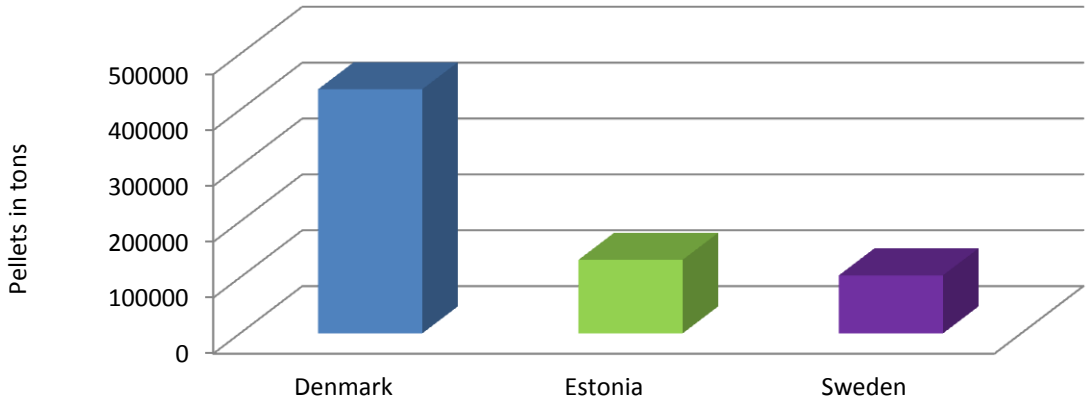


Figure 12: Latvian wood pellet export (Calderon et al. 2013)

As can be seen from the above figure, Latvia exports significant amounts of wood pellets to Estonia. However, Estonia's wood pellet consumption is quite insignificant and according to Estonia's statistical center only 15 000 tons wood pellets were imported for energy production to the country. Therefore, it is most likely that most of the pellets exported to Estonia from Latvia are further exported. According to Eurostat, the UK imports more than 100 000 tons wood pellets from Latvia, and thus we can assume that most of the pellets exported to Estonia are further shipped to the UK.

2.2.3 Energy support

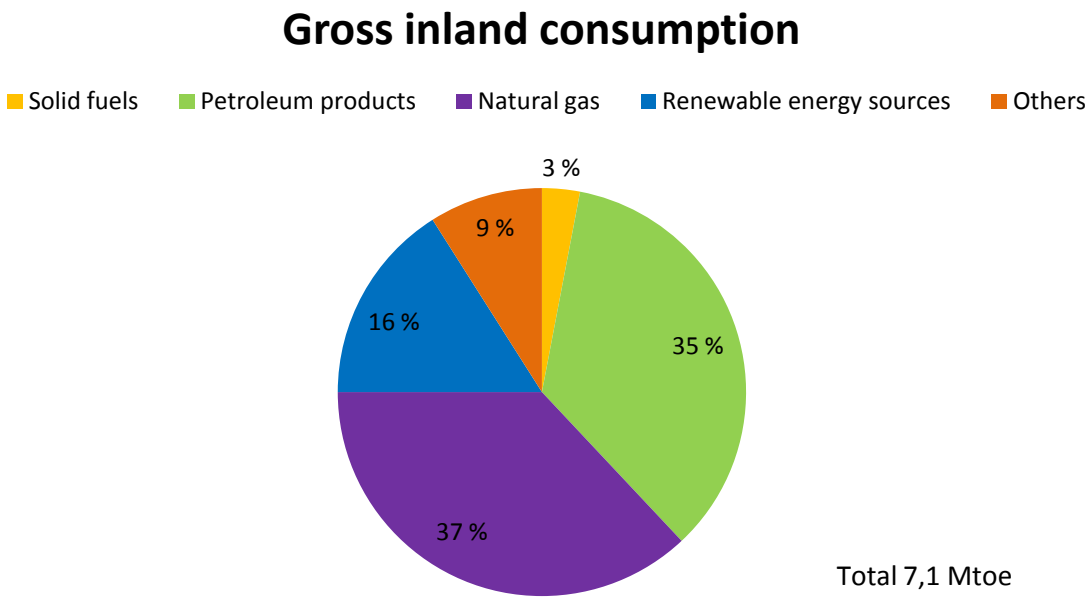
In Latvia, *electricity* generated from renewable energy sources is prompted through a feed-in tariff, whereas heat generated from renewable energy sources is stimulated through different tax benefits. The Latvian government has decided that a certain percentage of the final energy consumption has to derive from renewable energy sources. The percentage varies for every source of energy and the specific amounts were primarily set in 2010. For a electricity producer to attain his right to sell the electricity produced from a certain form of renewable energy source

to a guaranteed price, he is obligated to participate in tenders until a cap, set by the government, is reached. The tariff was carried out in 2007 and is eligible for all renewable energy sources except for geothermal generation. Notable is however, that due to concern of corruption and lack of transparency concerning the feed-in tariff, the subsidy is currently on hold and closed for new submissions until the beginning of 2016. The existing support mechanism for renewable energy production is at the moment being revised. (RES-Legal Latvia, 2014.)

Heat produced from renewable energy sources is on the contrary promoted through two different tax benefits; a value added tax reduction and an excise tax reduction. By the excise tax reduction is meant that if biogas is used for heating then the tax rate is reduced. With the value added tax reduction is on the contrary meant, that companies producing biomass and biogas pay a reduced tax rate. Notable is also that neither electricity nor heat produced from renewable energy sources are prioritized when it comes to connecting the RES-devices to the electricity grid or the heat transmission network. (RES-Legal Latvia, 2014.)

2.3 Lithuania

Lithuania is the largest of the Baltic countries both in area and in population. The country's energy production is mostly based on large fossil-fuel power plants and CHP-plants, using natural gas and oil as fuel. (EREC Lithuania, 2009). According to Eurostat, the gross inland energy consumption in 2012 consisted mostly of natural gas, petroleum products and renewable energy sources. As Lithuania is the largest of the Baltic country, the energy consumption is also notably larger. In 2012, Lithuania had a gross energy consumption of 7 084 ktoe and a final energy consumption of 4 800 ktoe. (Eurostat, 2012.) The figure below shows the country's gross inland consumption in 2012 and the energy resource allocation. The figure is drawn based on information from Eurostat.



Source: Eurostat, 2012

Up till 2009 Lithuania's energy production was, however, mostly based on nuclear energy. The Ignalina nuclear power plant played an important role for the country, as the plant accounted for 80% of the national electricity production. At the end of year 2009, the nuclear power plant was shut down, making Lithuania exceptionally dependent on energy imports. (EREC Lithuania, 2009.) Nowadays Lithuania's primary energy production consists mainly of renewable energy sources and to a small extent also of crude oil and peat (Eurostat, 2012). The country imports approximately 78% of its energy and is considered to be the most dependent EU member state on electricity supply from abroad. (Statistics Lithuania, 2012.)

In order to reduce the energy dependency the country has increased its usage of renewable energy sources in the energy production. Compared to the previous year, 2011, the imports decreased slightly, as the use of renewable energy sources increased. A wider use of renewable energy sources has also been considered important to reduce the impact of fossil fuels on the environment. (Statistics Lithuania, 2012.)

Lithuania has set a target of 23% renewable energy resources in its gross final energy consumption by 2020. In 2012, the share of renewable energy sources in the gross final energy consumption amounted to 21,7%. The country has actively installed combine heat and power plants and the share of renewable energy sources used in heating and cooling amounted to 35,5% in 2012. The amount of renewable resources used in electricity production was much smaller and amounted to 10,9%. (Eurostat, 2012.)

Share of renewable energy sources (%)	Lithuania	
	2020 Target	2012
in gross final energy consumption	23 %	21,7 %
in heating and cooling	39 %	35,5 %
in electricity	21 %	10,9 %
in transport	10 %	4,8 %

Table 6: Share of renewable energy sources used in different sectors (Eurostat, 2012)

Lithuania's bioenergy market differs somewhat from the other two Baltic countries. The biggest difference is that bioenergy products are less traded internationally. (Cocci, 2011.) According to Lithuania's statistical center, the country's gross inland consumption of biofuels was 1 003 ktoe in 2012. A bit under one third was used in the energy transformation sector for heat production, whereas over two thirds of the solid biofuels were used in the final energy consumption, mostly by households. The country imported approximately 110 ktoe solid biofuels, whereas the export was 116 ktoe. (Statistics Lithuania, 2012.)

2.3.1 Renewable energy production

Of Lithuania's primary energy production, approximately 1 198 ktoe derived from renewable energy sources. The main domestic primary energy resource in Lithuania is solid biomass. According to Eurostat, the country produced over 992 ktoe solid biomass in 2012, which is over 75% of the country's total primary energy production. Lithuania also produces biogas and liquid

biofuels, but solid biofuels are however, expected to have the greatest growth potential of renewable energy sources in the country. (Eurostat, 2012.)

The main installations for *heat production* from renewable energy sources are solid biofuels (EREC Lithuania, 2009). Lithuania has also increased the wind energy and hydropower production constantly. Wind power and hydropower are the main renewable energy sources for *power production* and in 2012 the wind power production reached 46.4 ktoe, whereas the hydropower production reached 36.4 ktoe. (Eurostat, 2012.)

ktoe	Solar energy	Solid biofuels	Geothermal energy	Hydropower energy	Wind energy	Biofuels	Biogas
Lithuania	0	992	3,8	36,4	46,4	107,6	11,6

Table 7: Primary production of renewable energy in 2012 (Eurostat, 2012)

Accurate information concerning Lithuania's solid biofuels allocation turned out to be difficult to find. In Lithuania's statistics, the solid biofuels are divided into three categories; wood fuels, wood waste and agricultural waste. In 2012, approximately 5.8 ktoe of the solid biofuels was agricultural waste, which means that most of the solid biofuels consisted of wood fuels and wood waste. (Statistics Lithuania, 2012.) The information of what resources the wood fuels consisted of (firewood, wood chips, wood briquettes or wood pellets) was however lacking.

According to Calderon et al. (2013) Lithuania produced approximately 275 000 tons wood pellets, whereof 264 831 tons were exported. As the country's biofuel export was nearly 1,35 TW and the wood pellet export reached approximately 1,26 TW, the majority of the biofuels exported consisted of wood pellets. Also according to Erlickyt-Marčiukaitien et al. (2009) Lithuania's bioenergy export flow is mostly based on wood pellets.

2.3.2 Wood pellets

Lithuania's wood pellet production is considerably smaller than the other two Baltic countries. The country's wood pellet production has however, been constantly growing and in 2012 the production reached 275 000 tons. (Calderon et al. 2013.) According to Erlickyt-Marčiukaitien et al. (2009) the demand for wood pellets is quite small in Lithuania and only 5% of the wood pellet production is used domestically. Compared to other wood fuels wood pellets are considered quite expensive and only a small part of the households have installed pellet boilers. Wood briquettes are normally preferred over pellets as the briquettes can be combusted in normal firewood stoves and no reconstruction is necessary. Lithuania is also lacking large industrial pellet consumers. (Erlickyt-Marčiukaitien and Marčiukaitis, 2009.)

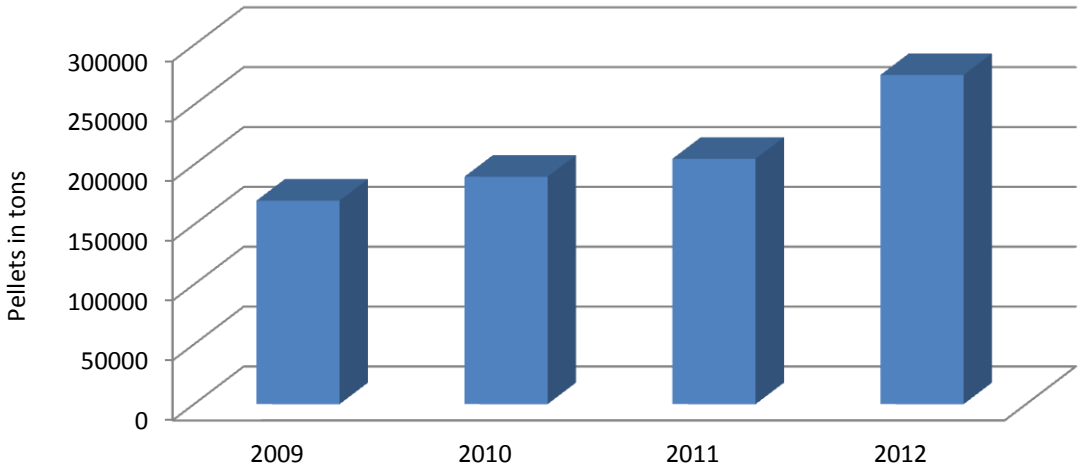


Figure 13: Lithuanian wood pellet production (Calderon et al. 2013)

The pellet producers in Lithuania are significantly smaller than the pellet producers in Estonia and Latvia. The largest pellet plant in Lithuania is Graanul Invests pellet plant in Alytus. The plant has been operating since 2005 and has a production capacity of 70 000 tons wood pellets annually. The second largest plant in the country is Granulita, which has a production capacity of 50 000 tons wood pellets annually. Otherwise the pellet plants operating in Lithuania are much smaller. (Bioenergy International, 2012.)

Company	Capacity/ton
UAB Graanul Invest	70 000
Granulita	50 000
Baltwood	15 000
BioFuelz	14 400
Gairelita	12 000
Biodela	10 000

Lithuania is mainly a wood pellet exporter and according to both Calderon et al. (2013) and Erlickyt-Marčiukaitien et al. (2009) the country exports approximately 95% of the wood pellets produced. The majority of the pellets are exported to Italy, Denmark and Germany. Approximately 130 070 tons wood pellets were exported to Italy, which mainly use wood pellets in industrial boilers for heating and in small-scale residential heating. The amount wood pellets exported to Denmark reached 94 581 tons and the amount to Germany 18 281 tons. In Denmark, wood pellets are mainly used in district heating as well as by large-scale power plants. Germany on the contrary, mainly use wood pellets in industrial boilers for heating and in small-scale residential heating. (Calderon et al. 2013.)

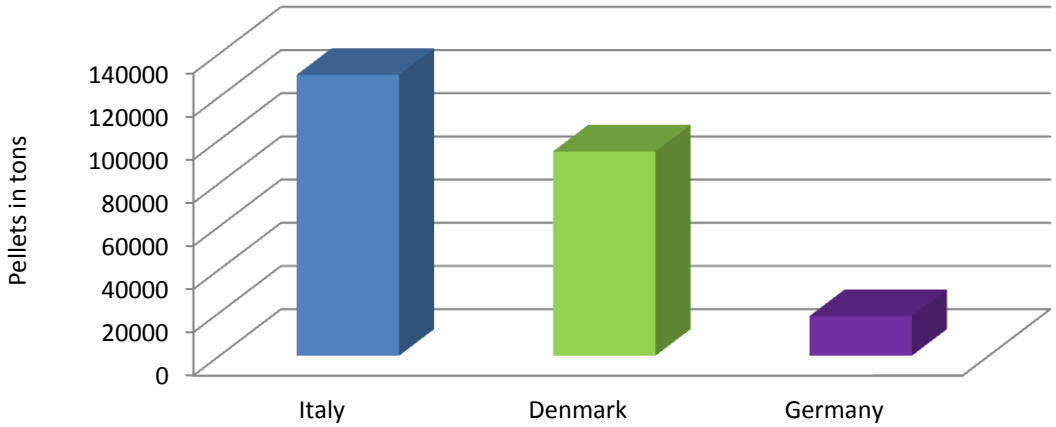


Figure 14: Lithuanian wood pellet export (Calderon et al. 2013)

2.3.3 Energy support

In Lithuania, *electricity* produced from renewable energy sources is encouraged through investment supports and a feed-in tariff. The *feed in-tariff* is generally paid for electricity produced from renewable energy sources, whereas the *investment supports* are normally paid for specific renewable energy production technologies. The operators of renewable energy power plants are prioritized when it comes to connecting the power plant to the grid and the electricity produced from renewable energy sources is prioritized in the distribution and transmission network. (RES-Legal Lithuania, 2014.)

Renewable energy sources used for *heating or cooling* are on the contrary promoted through grants and by an environmental pollution tax relief. Heat produced from renewables is also further promoted, as heat suppliers are obligated to buy all heat produced from renewable energy sources. (RES-Legal Lithuania, 2014.)

The subsidies are paid to promote the usage of renewable energy sources and make renewable energy more competitive. In Lithuania, all renewable *electricity* technologies are eligible a *feed-in tariff,* except for electricity generated from geothermal power technologies. The amount of the feed-in tariff is dependent on the electricity production technology and on the size of the power plant. The feed-in tariff is different for all technologies; wind energy, solar energy, hydro energy and electricity produced from biomass and biogas, and may vary from 0,08 € per kilowatt hour to 0,21 € per kilowatt hour. (RES-Legal Lithuania, 2014.)

Electricity generated by plants using renewable energy sources and whose capacity is up to10 kW is entitled a feed-in tariff set by the National Control Commission for Prices and Energy

(NCC). The feed-in tariff contracts for RES power plant operators with a larger installed capacity than 10 kW are settled through tenders. The tariff is paid for a maximum of 12 year from the commissioning, or from the moment an agreement is sign with the grid operator, which connects the power plant to the grid. (RES-Legal Lithuania, 2014.) The varying feed-in tariffs for the different RES technologies and for the different power plant sizes can be found in appendix 1.

Investment supports are also granted in Lithuania for both electricity production and heat production. The Lithuanian Environmental Investment Fund (LEIF) and The Fund for the Special Programme for Climate Change Mitigation are the main organs that permits investment supports. The Lithuanian Environmental Investment Fund strives to decrease environmental damage in the long run. The organ may grant investment support or loans to projects that promote electricity produced from renewable energy, as well as to projects that promote the conversion of heating plants from fossil fuels to use biomass and geothermal resources. (RES-Legal Lithuania, 2014.)

The Fund for the Special Programme for Climate Change Mitigation supports projects, which strive to decrease greenhouse gas emissions. All technologies that promote the utilization of renewable energy sources in electricity production are eligible support. The support may be granted as a direct financial surplus or as a loan.

Different tax relieves are also valid for renewable energy in the country. For example electricity produced from renewable energy sources is exempt from excise tax. Also the utilization of biogas and biomass for heating purpose is exempt from the environmental pollution tax. (RES-Legal Lithuania, 2014.)

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APPENDIX 1. LITHUANIAN FEED-IN TARIFF

Wind energy	Feed-in tariff (Item 1.3. Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.33 per kWh (approx. EUR 0.10 per kWh) Maximum feed-in tariff rates for wind power plants (Item 1.3. Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 350 kW: LTL 0.32 per kWh (approx. EUR 0.09 per kWh) ▪ Installed capacity exceeding 350 kW: LTL 0.26 per kWh (approx. EUR 0.08 per kWh)
Solar energy	Feed-in tariffs for building-integrated solar power installations (Item 1.1. Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.73 per kWh (approx. EUR 0.21 per kWh) Maximum feed-in tariff for building-integrated solar power installations (Item 1.1. Resolution No. O3-335/2013) ▪ Installed capacity exceeding 10 kW up to 100 kW: LTL 0.52 per kWh (approx. EUR 0.15 per kWh) ▪ Installed capacity exceeding 100 kW: LTL 0.61 per kWh (approx. EUR 0.18 per kWh) Feed-in tariffs for solar power installations not integrated in buildings (Item 1.2. Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.56 per kWh (approx. EUR 0.16 per kWh) Maximum feed-in tariffs for solar power installations not integrated in buildings (Item 1.2. Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 100 kW: LTL 0.52 per kWh (approx. EUR 0.15 per kWh) ▪ Installed capacity exceeding 100 kW: LTL 0.48 per kWh (approx. EUR 0.14 per kWh)
Biogas	Feed-in tariffs for power plants using landfill gas (Item 1.7. Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.43 per kWh (approx. EUR 0.12 per kWh) Maximum feed-in tariffs for power plants using landfill gas (Item 1.7. Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 500 kW: LTL 0.41 per kWh (approx. EUR 0.12 per kWh) ▪ Installed capacity exceeding 500 kW: LTL 0.33 per kWh (approx. EUR 0.10 per kWh) Feed-in tariffs for power plants using biogas derived from anaerobic digestion or other biodegradable organic waste or substrates (Item 1.8 Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.55 per kWh (approx. EUR 0.16 per kWh) Maximum feed-in tariffs for power plants using biogas derived from anaerobic digestion or other biodegradable organic waste or substrates (Item 1.8 Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 500 kW: LTL 0.51 per kWh (approx. EUR 0.15 per kWh) ▪ Installed capacity exceeding 500 kW up to 1000 kW: LTL 0.48 per kWh (approx. EUR 0.14 per kWh) ▪ Installed capacity exceeding 1000 kW up to 2000 kW: LTL 0.46 per kWh (approx. EUR 0.13 per kWh) ▪ Installed capacity exceeding 2000 kW: LTL 0.44 per kWh (approx. EUR 0.13 per kWh)
Hydro-power	Feed-in tariffs for hydro-power plants (Item 1.4 Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.27 per kWh (approx. EUR 0.08 per kWh) Maximum feed-in tariffs for hydro-power plants (Item 1.4 Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 1000 kW: LTL 0.24 per kWh (approx. EUR 0.07 per kWh) ▪ Installed capacity exceeding 1000 kW: LTL 0.22 per kWh (approx. EUR 0.06 per kWh)

Biomass	Feed-in tariffs for power plants using biomass (Item 1.5. Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.40 per kWh (approx. EUR 0.12 per kWh) Maximum feed-in tariffs for power plants using biomass (Item 1.5. Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 5000 kW: LTL 0.34 per kWh (approx. EUR 0.10 per kWh) ▪ Installed capacity exceeding 5000 kW: LTL 0.31 per kWh (approx. EUR 0.09 per kWh) Feed-in tariffs for reconstructed power plants using biomass (Item 1.6 Resolution No. O3-335/2013): ▪ Installed capacity of up to 10 kW: LTL 0.37 per kWh (approx. EUR 0.11 per kWh) Maximum feed-in tariffs for reconstructed power plants using biomass (Item 1.6 Resolution No. O3-335/2013): ▪ Installed capacity exceeding 10 kW up to 5000 kW: LTL 0.32 per kWh (approx. EUR 0.09 per kWh) ▪ Installed capacity exceeding 5000 kW: LTL 0.29 per kWh (approx. EUR 0.08 per kWh)

Source: RES-Legal, 2014