Electricity Market Liberalization in Estonia

Lelde Elere
Kristjan Loorits
Thesis advisor: Professor Einar Hope

Master thesis within the main profile of Energy, Natural Resources and the Environment

Norwegian School of Economics
Bergen, Spring 2013

Abstract

The aim of the master thesis is to describe and analyze the deregulation process of the Estonian electricity sector. The analysis is based on a textbook model, which summarizes attributes that have led to successful electricity sector deregulation in other countries. According to the analysis, Estonia has followed the textbook model rather closely – it has separated competitive segments from natural monopolies, established a single system operator, created a wholesale spot market, unbundled electricity tariffs and created independent regulatory agencies. We conclude that the deregulation process has been successful. However, we identify the concentration of the generation market as a threat to an efficient market. The future challenge of Estonia is integration in the common European electricity market which is dependent on building sufficient transmission capacities and Europe-wide harmonization of regulations. Integration in the European Internal Electricity Market will contribute to improved effectiveness of the market, security of supply and increased long-term social welfare.

Table of Contents

1 Introduction

The electricity sector has historically been government controlled all over the world due to high fixed costs involved with the production and transmission of electricity and the strategic importance of energy sector. During the last 30 years most developed countries, however, have gone through electricity sector liberalization in order to provide better incentives for controlling the construction and operating costs of generating capacities, to encourage innovation in supply technologies and to promote more efficient use of transmission and distribution networks (Joskow, 2008). The results of the reforms have varied greatly in different countries. Joskow (2008) has developed a “textbook” model which includes the features that have led to successful market deregulations.

In the last two decades the Estonian electricity sector has undergone a remarkable transformation from a centrally controlled domain in the service of the whole Soviet Union to a deregulated free market. The market liberalization process has been challenging but Estonia has implemented the changes step by step and since the beginning of 2013 the electricity market is open for all consumers. As a member country of the European Union, the changes in the Estonian electricity market have been strongly shaped by the policies of the European Union, in particular the three Energy Packages adopted in 1996, 2003 and 2009.

Our research is motivated by the lack of existing research on the Estonian electricity market deregulation. As Estonia opened its electricity market to all consumers only in the beginning of 2013, the existing literature does not provide a comprehensive overview and analysis of the liberalization process. The purpose of this thesis is to analyze the electricity market deregulation process in Estonia and highlight the positive aspects and shortcomings of the Estonian reforms. Methodologically we compare the process in Estonia with the ideal “textbook” model based on the experience of successful countries.

Our paper is structured in the following way. In Section 2 we cover the historical overview of the Estonian energy sector. Section 3 presents the current situation in the Estonian energy market; special attention is given to the electricity market. In Section 4 we describe and analyse the market liberalization process that has taken place in the Estonian electricity market. Section 5 describes the prospects of Estonia integrating into the internal energy market of the European Union. Finally, the last section concludes the paper.

2 History of the Estonian Energy Sector

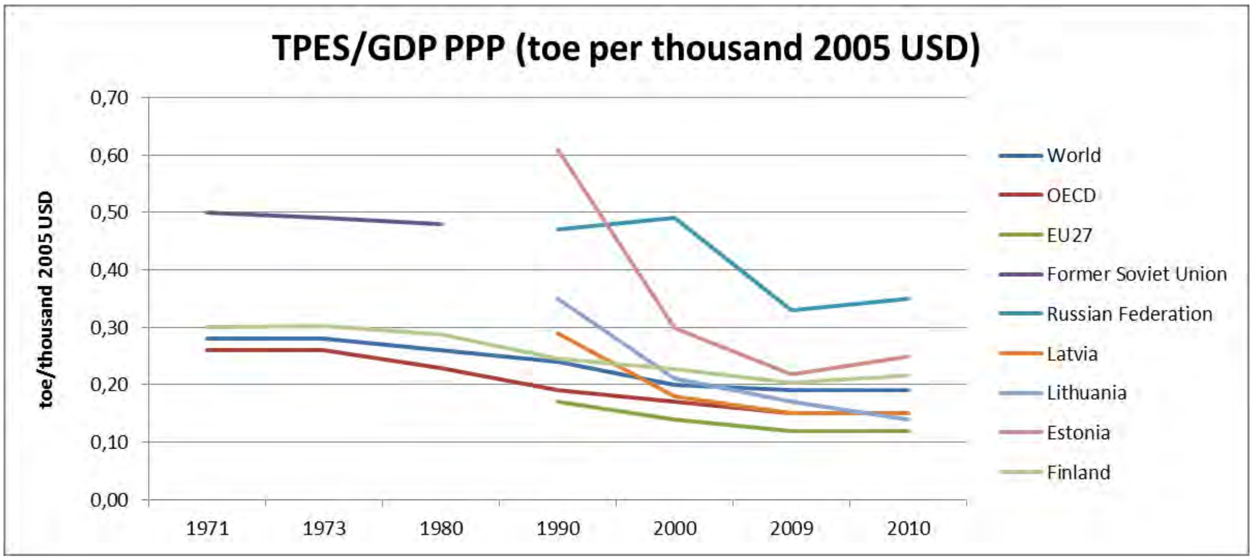
2.1 Before the collapse of the Soviet Union

In this paragraph there is a short overview about the history of energy production facilities in Estonia before the collapse of the Soviet Union. Electric energy was first used in Estonia in the end of the 19th century. Larger cities got their first power stations in the beginning of the 20th century: Pärnu in 1907, Viljandi and Tartu in 1910, Tallinn in 1913, Võru in 1914 and Valga in 1915 (Kala, 1974). The natural resources used in Estonia for the production of electricity were hydropower, oil shale and peat. The first power stations using peat were Ulila in 1910 and Ellamaa in 1923. Electricity production from oil shale started in 1924 while the first large hydropower station was built on Jägala river in 1922 (Rand). During the Soviet Union the economy and energy sectors were centrally controlled, and all natural resources were in the service of the whole empire. Thus, two large oil shale thermal power stations, Baltic power plant (765 MW) in 1959 and Estonian power plant (1610 MW) in 1969 were built to take advantage of the local resources and to export electricity to other parts of the Soviet Union (Eesti Energia, 2013a). In addition, three other large power plants were constructed during the occupation period. Kohtla Järve oil shale thermal plant was built (30 MW) in 1949, Ahtme oil shale thermal plant (25 MW) in 1952 (Hamburg, Estonian National Energy Strategy, 2007) and Iru oil-fired power plant (165 MW) in 1978 (Eesti Energia, 2013b, Põhivõrk, 2007).

During the Soviet occupation the Estonian energy sector was developed as a part of the energy system of the USSR (Hamburg, Estonian National Energy Strategy, 2007). It has largely influenced the development of the Estonian energy sector during the independence period. On the positive side, during Soviet Union extensive energy infrastructure was built to supply other parts of the empire with electricity produced in Estonia. Thus, large power plants and strong grid connections with former republics of the Soviet Union – Russia and Latvia, were installed. On the other side, the cost of energy was not well communicated to the final consumer thanks to various subsidies and controlled electricity prices. Consumers had little concern about energy costs; therefore, buildings and technologies were designed keeping in mind cheap energy (Vilemas, 2010). In addition, planned economy did not merit efficiency and often encouraged inefficiency as future resource allocation for enterprises was based on historical consumption patterns (Ürge-Vorsatz, Miladinova, & Paizs, 2006). Thus, companies that operated during

Soviet time had little incentives to become more efficient and Estonia inherited these large inefficiencies. The comparison of energy efficiencies between Soviet Union, neighbouring former Soviet republics, Estonia and the Western world can be seen in Figure 1. The historical TPES (Total Primary Energy Supply)/GDP indices using purchasing power parities show that Estonia inherited an economy which was more than 3 times energy inefficient than the OECD area.

Figure 1. Total Primary Energy Supply per GDP using purchasing power parities



Source: International Energy Agency, 2012

An independent state energy policy began in 1986-1987 during the national awakening period. The first energy development plan "kW" was drafted thanks to the initiative of the Tallinn University of Technology power engineering researchers (Hamburg, Analysis of Energy Development Perspectives, 2010). First, the "kW" team proposed to create economically effectively and independently operating energy companies to match the needs of a new sovereign country. The draft recommended creating a separate company responsible for each economic function: energy production and transmission, mining of oil shale, and imports of natural gas and other fuels. Second, the group suggested to increase efficiency in the energy sector and to develop a combined heat and power production. In addition, some gas turbine stations were to be constructed in order to cover peak loads. As the existing power capacity was more than sufficient to cover the country's own needs, the "kW" group recommended to stop further developments to increase the energy supply, namely the construction of Viru power plant, mine of Kuremäe and new projects in the Baltic Power Station (Hamburg, Analysis of Energy Development Perspectives, 2010).

In March 1990 the first state energy strategy plan "General principles for the development of the Estonian Energy until 2030" was written by a temporary research team coordinated by the Estonian Academy of Sciences and the National Planning Committee of ESSR (Ots, 1990). The work was based on the assumptions that the country was already independent and there was a liberal market economy in place. First, the research team suggested creating state organizations which manage national energy development and laws which regulate the industry. National companies such as Eesti Energia (energy production and transmission), Eesti Põlevkivi (mining of oil shale) and Eesti Kütus (imports of natural gas and other fuels) should be formed to manage a certain part of the energy industry in the country. Second, the state should control energy prices, encourage cooperation with neighbouring countries and increase energy efficiency. In terms of future energy mix the share of wind, hydro and solar energy was predicted to stay under 1% in 2030, the construction of heat and power production plants should be encouraged, oil shale should be used until its expected depletion in 2010-2020 and a nuclear power plant should be built in 2010 to satisfy the energy demand after oil shale reserves were to be depleted. Finally, the research group recommended renewing the existing power facilities, increasing integration with neighbouring countries by building an electricity cable to Finland and making the necessary changes in the education system to prepare the future generation of energy specialists (Ots, 1990).

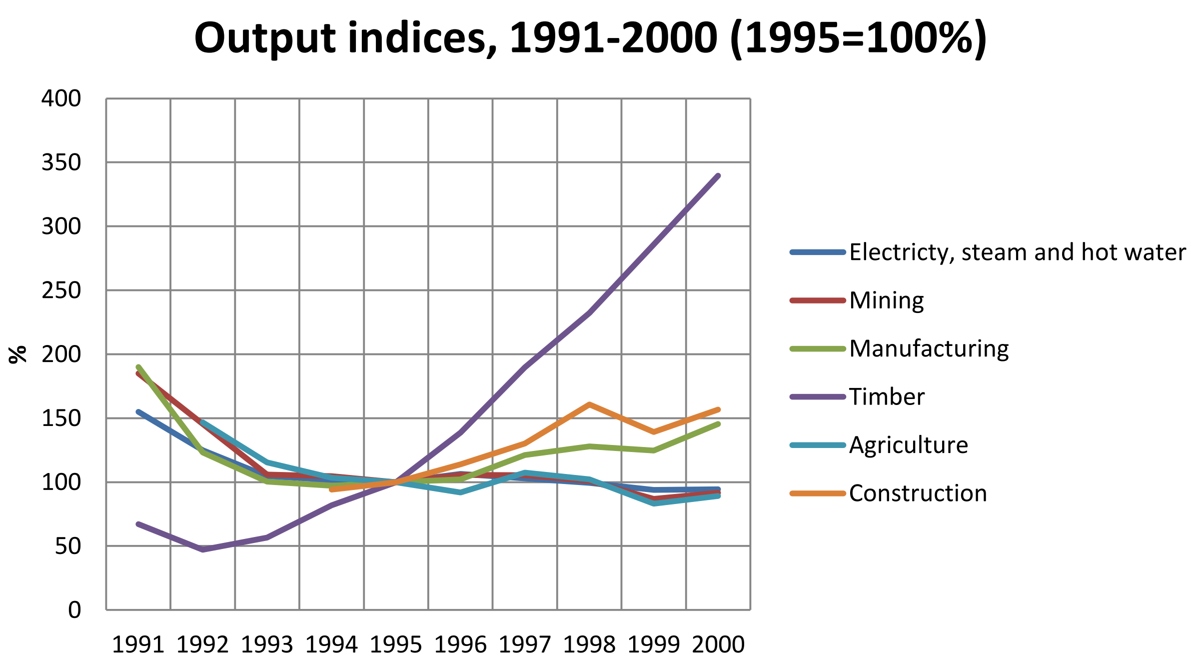
2.2 Collapse of the Soviet Union

On 20th of August 1991 Estonia regained its independence. The country had been occupied by the Soviet Union since World War II. The following transitional period brought significant changes in the political, economic and social landscape. The previous style of a centrally controlled economy did not suit the needs of a small young democratic country. Some of the more important steps towards a free market economy were passing the first laws on property rights in early 1992, monetary reform in June 1992 and adopting a flat tax rate in 1994 (Laar, 2007). One of the major tasks was also guaranteeing a stable supply of energy for the country.

After the collapse of the Soviet Union in 1991 the main tasks of the energy sector were to increase the efficiency of production and transmission and to grow the share of local fuels (oil shale, peat, hydropower) in the energy mix. An equally important task was to create the necessary legal framework to regulate the new market. Estonia used the support of many foreign experts (Denmark, Sweden, Finland, etc.) and received financial aid from the World Bank and European Bank of Restructuring and Development which in addition to aiding the restructuring of the energy sector also helped to educate local energy specialists and civil servants (Ministry of Economic Affairs and Communications, 2001).

Most of the old business connections with the Soviet markets disappeared in the beginning of 1990s and the country was in the process of finding new partners in the West. However, these processes took time and one of the biggest consequences was the sharp drop in manufacturing. As can be seen from Figure 2 then the manufacturing output halved in 1994 compared to 1991. The other sector that lost some of its importance was the agriculture sector while sectors like timber and construction started to gain momentum (Ministry of Economic Affairs and Communications, 2001).

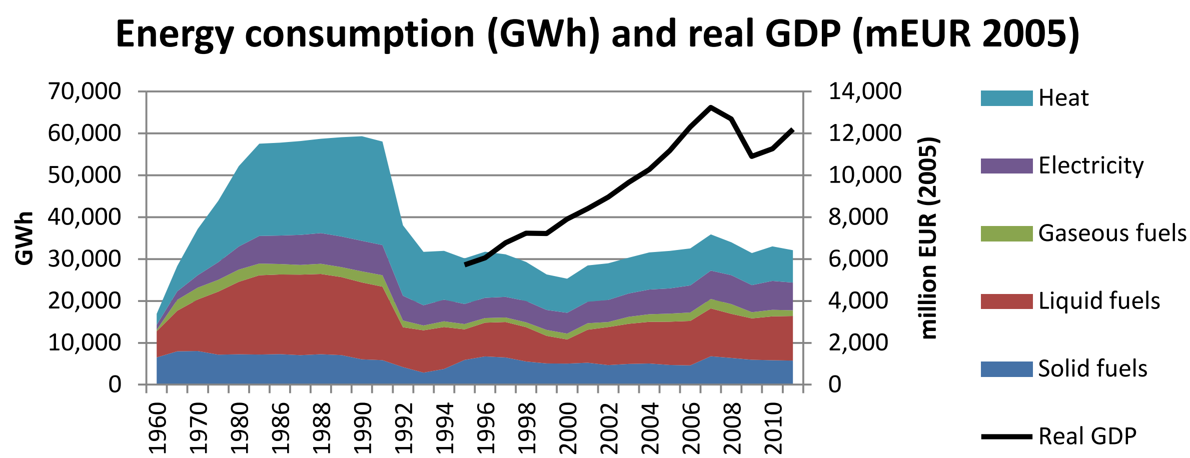
Figure 2. Output indices of Estonia in 1991-2000



Source: Statistics Estonia, 2008

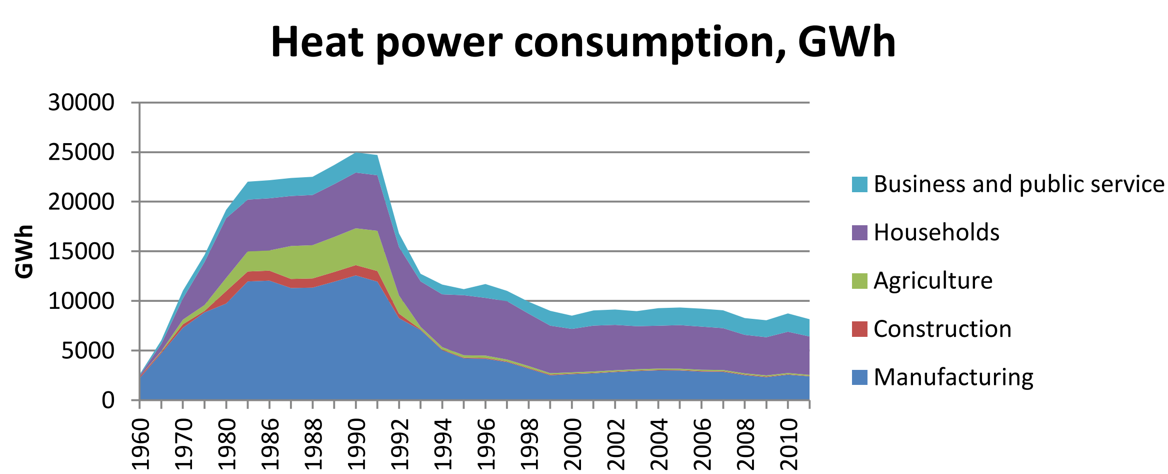
These structural changes in the economy had a strong effect on the overall energy consumption which can be observed in Figure 3. There were significant changes in the heat power and electricity consumption in Estonia which can be observed in Figure 4 and Figure 5. The overall heat power and electricity consumption decreased over 50% and 30% respectively in couple of years after the collapse of the Soviet Union. The decrease can be mainly attributed to the manufacturing and agricultural sectors. The high share of oil shale in the primary energy production balance in Figure 6 shows the importance of this resource for the Estonian economy. The increase in the share of firewood from 10% to 20% after the country regained its independence is mainly the result of a new statistical methodology proposed by Eurostat which captures the use of firewood better (Ministry of Economic Affairs and Communications, 2001).

Figure 3. Energy Consumption and Real GDP of Estonia



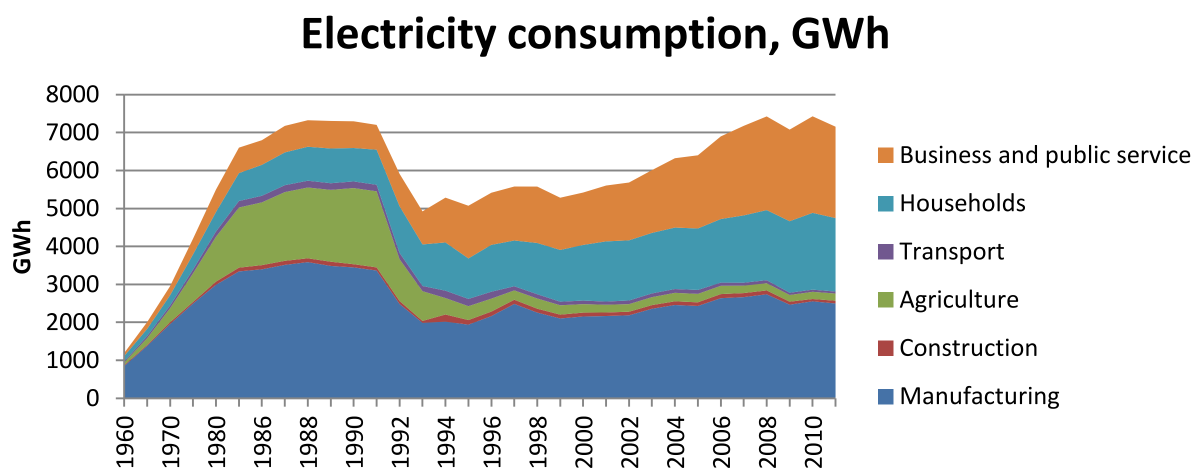
Source: Statistics Estonia, 2013a

Figure 4. Heat Power Consumption in Estonia



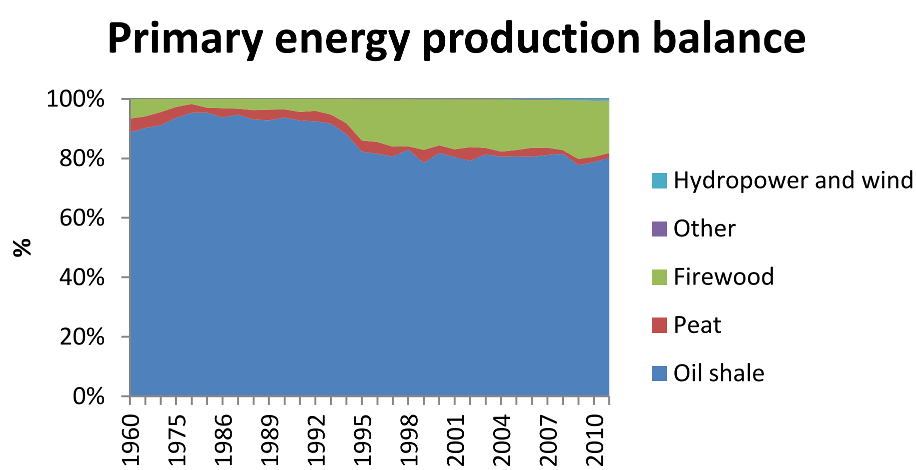
Source: Statistics Estonia, 2013b

Figure 5. Electricity Consumption in Estonia



Source: Statistics Estonia, 2013c

Figure 6. Primary Energy Production Balance in Estonia



Source: Statistics Estonia, 2013a

2.3 Preparations for a Market Economy (1995-2003)

The development of the country continued at a fast pace during the first decade of independency. Many important initiatives were undertaken to make a transition to a market economy. One of the essential steps was the signing of the Agreement of Association between Estonia and the European Union in 1995 which was the first step in becoming a full member of the European Union (Estonian Ministry of Foreign Affairs, 2013). The agreement showed the advantages and responsibilities of a potential member of the European Union. Among other policies the document urged Estonia to supervise the current monopolistic situation in the energy market and strive towards an open fuel and energy market (Hamburg, Analysis of Energy Development Perspectives, 2010).

The energy policies of this period were described in the “Fuel and Energy Sector long-term National Development Plan until 2005” composed in 1998 (Hamburg, Analysis of Energy Development Perspectives, 2010). The primary goals of the plan were the optimization of power system operations and the minimization of environmental pollution. Some other important initiatives included the “Energy and the International Development Research Program – Energy 2000” created as a joint work of energy researchers in 1995, adoption of the Energy law in 1997 and the restoration of the Estonian membership in the World Energy Congress in 1998 (World Energy, 2013). One of the first steps towards market liberalization was undertaken in July 1999 when the Estonian electricity market was opened to consumers whose consumption was larger than 40 GWh/year (Parliament of Estonia, 2012). In the end of the period, in 2002, Estonia ratified the Kyoto protocol promising to decrease the emissions of greenhouse gases by 8% in 2008-2012 compared to the level of 1990. (Eesti energeetika 2007)

The period can be characterized by improved cooperation among the Baltic Sea region countries. For example in 1999 the representatives of the Baltic countries met in Pärnu, Estonia with the objective to create a Baltic electricity market. A single market would enable to increase the number of competing power producers, to allow consumers to choose their favourite supplier, to create uniform rules in the energy sector of the Baltic countries and to integrate more easily with the Nordic electricity region (Hamburg, Analysis of Energy Development Perspectives, 2010).

In terms of the overall energy consumption we can see in Figure 3 a downward trend until 2000 as the economy was still gradually getting more energy efficient. However, in the new millennium the energy consumption started to increase as economic growth began to have a larger impact than improvements in energy efficiency. Nevertheless, we can see in Figure 4 that the overall heat power consumption continued to decline in this period led by the decrease in the manufacturing sector. On the other hand, the total electricity consumption rose to 6 TWh in 2003 compared to 5 TWh in 1995. The biggest growth was in the business and public service sectors, and in households.

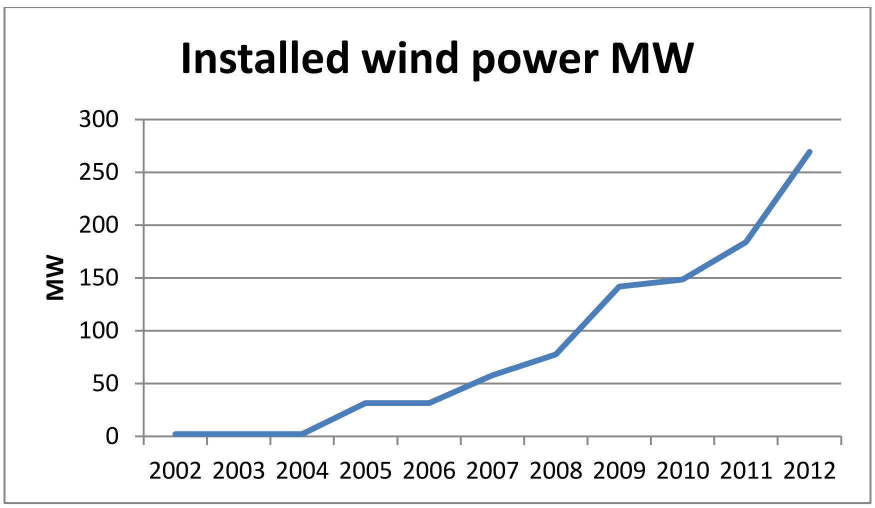
2.4 Stable Development (2003-2012)

In May 2004 Estonia became a full member of the European Union (Estonian Ministry of Foreign Affairs, 2009). Energy was one of the most complicated chapters in the accession negotiations. According to the EU directive on Internal Electricity Market, Estonia had to open 35% of its electricity market upon joining the EU. However, the liberalization of the electricity market in such an early phase would have led to two unwanted scenarios. On the one hand, if Russia would have been able to sell their cheap energy to Estonia without worrying about the extra environmental costs connected to emissions trading then Eesti Energia would have soon bankrupted by not being able to compete with such low prices. Thereafter, the electricity market of Estonia would have been controlled by the Russian electricity monopoly (Estonian Ministry of Foreign Affairs, 2009). On the other hand, if Russian energy producers would have had to cover the environmental costs (emissions trading) imposed in the EU then they would have not been able to compete on the Estonian energy price levels and Eesti Energia would have had full monopolistic market control due to its earlier dominant market position (Ellerman & Buchner, 2007). The negotiations resulted in an agreement on a transition period for the opening of the Estonian electricity market – only by the end of 2008 at least 35% of the market had to be opened. In addition, Estonia declared its desire to fully open the electricity market for all business consumers by the end of 2012 (Estonian Ministry of Foreign Affairs, 2009).

The period can be characterized by a stable development in the energy sector. The technological advancements allowed building two new blocks with fluidized-bed boilers in the Narva power plants (Estonian power plant and Baltic power plant) which decreased the fuel consumption by 20% (Soosaar, Vares, Laur, & Tenno, 2007). The Estlink cable between Estonia and Finland with the capacity of 350 MW started operating in 2007 (Ministry of Economic Affairs and Communications, 2008). The third state energy development plan "Fuel and Energy Sector long-term National Development Plan until 2015" composed in 2004 highlighted the need to renew the existing facilities connected to the energy sector, to strive towards better market regulation and to produce at least 5.1% of electricity from renewables by 2010 (Parliament of Estonia, 2012).

Rising fuel prices and growing concern about the environment led to important changes in the minds of the policy makers all over the world. Thanks to EU initiatives in promoting renewable energy the topic gained momentum also in Estonia. EU established a scheme for greenhouse gas emission allowance trading in the end of 2003. Estonia was facing a situation where in 2008-2012 it had to reduce emissions 8% against the 1990 levels. However, considering that during the reference year Estonia was still part of USSR with a very energy intensive economy, the country had already achieved the target. Thus, several energy production enterprises used the favorable situation and for example, Eesti Energia sold in 2006-2007 emission quotas for more than 95 million EUR in the Nord Pool electricity exchange (Kleesmaa, 2010). Estonia also started to turn more attention towards its renewable energy sources, mainly wind power. As can be seen in Figure 7 then installed wind power exceeded 250 MW in 2012 (Estonian Wind Power Association, 2013).

Figure 7. Installed Wind Power in Estonia



Source: Estonian Wind Power Association, 2013

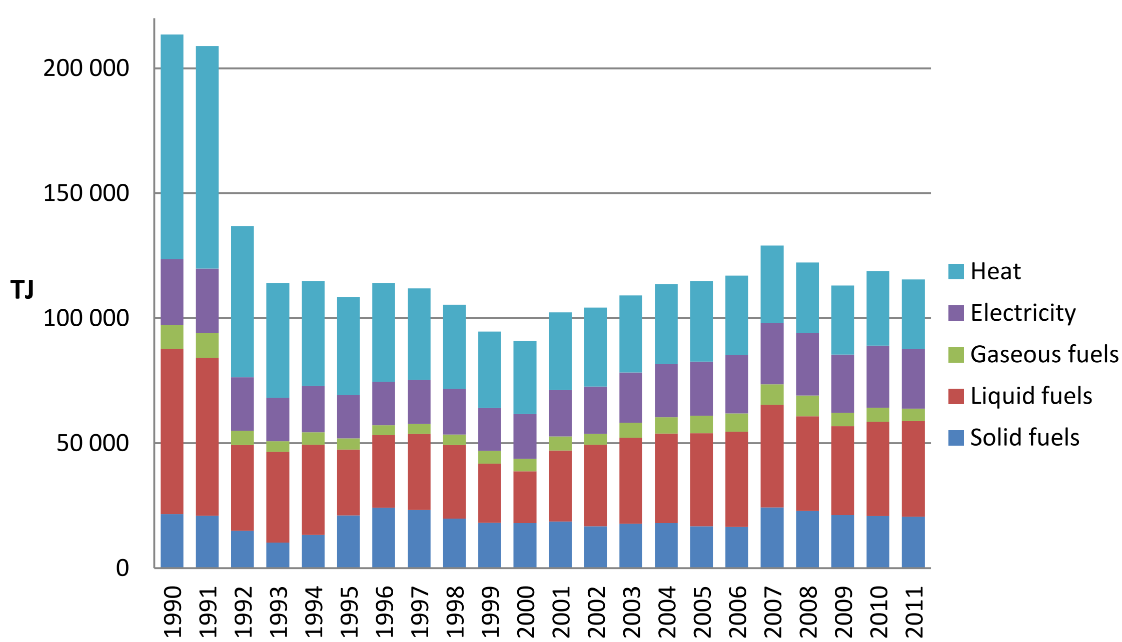
In terms of the overall energy consumption we can observe in Figure 3 an upward trend until the economic crisis of 2007. The overall heat power consumption continued to decline thanks to higher energy efficiency during the whole period which can be seen in Figure 1. The consumption of electricity rose until the financial crisis of 2007 stabilizing slightly above 7 TWh/year. The largest growth can be attributed to the business and public service sector, and to households.

3 Energy Market in Estonia

3.1 Primary Energy Supply and Final Consumption

Total primary energy supply (TPES) in Estonia was 232 th. TJ (64TWh) in 2011 (Statistics Estonia, 2013a). Estonia is one of the most energy intensive economies in the European Union. Its TPES/GDP ratio (in PPS) is twice as high as the average in the EU (Please see Figure 1 in the History Section). This can partly be explained by the energy mix in the country – a lot of energy is used for the conversion process from oil shale to electricity. However, the legacy of Soviet Union occupation also plays a role; many buildings have low thermal performance, part of the equipment is old and inefficient. According to the Ministry of Economic Affairs and Communications (2011) there is an estimated 25% energy savings potential in buildings, and 25% heat and 10% electricity savings potential in the industrial sector. In 2011 the final energy consumption was 115 th. TJ (32 TWh). The historical development of the energy consumption during the last two decades can be seen below in Figure 8. The national target approved by the government aims to keep the energy consumption in 2020 at 33.6 TWh - the same level as in 2010 (Estonian Government, 2011).

Figure 8. Final Energy Consumption.

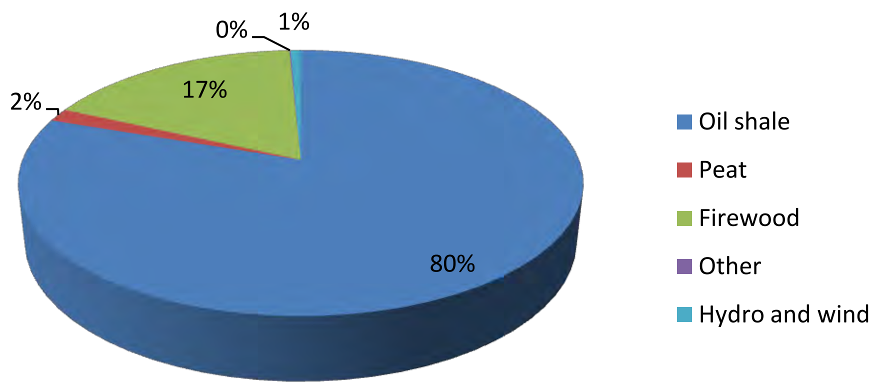


Source: Statistics Estonia, 2013a

3.2 Energy production

The energy demand in Estonia is mostly satisfied by domestic production; domestic energy production accounted for 90% of total primary energy supply in 2011. The remaining part of energy demand is covered by imports. The composition of primary energy production in Estonia is shown in Figure 9.

Figure 9. Estonian Primary Energy Production



Source: Statistics Estonia, 2013d

3.2.1 Oil shale

Estonia is unique in the world due to the fact that its primary energy source is oil shale, which constitutes around 80% of the domestic energy production. Oil shale in Estonia is different from many other countries with oil shale reserves (e.g. USA) as it does not contain shale oil or gas trapped within the shale formations. Oil shale in Estonia is a fine-grained sedimentary rock containing kerogen which is extracted underground or in open pits and can be used directly as a fuel or processed to produce shale oil and gas. It has a relatively low calorific value, and it is more pollutive than conventional fuels, therefore only a handful of countries mine oil shale (European Academies Science Advisory Council, 2007). But since Estonia is limited in other cheap energy sources, oil shale industry has been developed since 1916. During the Soviet times oil shale from Estonia was the main energy source for North-West part of Soviet Union, and at its peak in 1980 the maximum production reached 31 million tons in a year (Koel, 1999). After regaining independence, the production of oil shale decreased sharply by around 40% due to lower energy consumption and disappearing export markets. In 2011 Estonia produced 18.7

million tons of oil shale and is, thus, the biggest oil shale producer in the world (Alllix, et al., 2010). According to Eesti Energia, there are 1-2 billion tons of recoverable oil shale reserves in Estonia (Eesti Energia, 2013c). With the current rate of production, this would be enough to continue producing for another 50 to 100 years.

The environmental issues connected to oil shale are complex. First, the strongest impact of the oil shale industry is the disruption to land use. Large areas of land have to be taken away from traditional uses such as agriculture, recreation or residential neighborhoods. In addition, there is a strong influence on the original ecosystem of plants and animals. Due to large scale operations, re-establishing original biodiversity after extraction is problematic if not impossible. Second, the waste material after processing occupies a larger volume (up to 25%) than the extracted material; therefore, it cannot be fully deposited underground and has to be disposed above ground. As the market for shale waste is small and the residues contain toxic salts and substances which need to be disposed with great care, the oil shale waste disposal poses great challenges and risks for contaminating the atmosphere, surface and ground water. Third, electricity generation from oil shale produces a higher level of harmful atmospheric emissions (mainly carbon dioxide) than coal. Finally, noxious materials produced during the mining and processing of oil shale are a threat to the local water supply. This issue is for example more problematic with oil shale than with coal because of the greater volume of waste. (European Academies Science Advisory Council, 2007)

In a global context considerable quantities of oil shale are mined in China, Brazil, Russia, Germany and Australia; however, the oil shale industry of Estonia is currently the most developed in the world (European Academies Science Advisory Council, 2007). The leading energy company of Estonia, Eesti Energia, has even expanded some of their operations outside of the country to US and Jordan (Eesti Energia, 2013d). The historical global commercial oil shale mining figures are presented in Appendix 2. World Oil Shale Miningthe Green River Formation at the intersection of Utah, Colorado and Wyoming has the largest oil shale beds in the world from 1.2 to 1.8 trillion barrels. The fast pace of crude oil consumption and rising oil prices have increased the interest in alternative energy sources in US, including oil shale. The research and development in US may offer new, more effective technological solutions for oil shale mining in the future available also in Estonia. In 2003 the US Bureau of Land Management started an oil shale development program where companies could apply for research, development and demonstration leases. Several major energy firms like Shell, ExxonMobil and American Shale Oil LLC applied for and received various lease awards. (Alllix, et al., 2010) Shell has been experimenting with an unconventional method of extracting shale oil from oil shale – in-situ retorting. The process heats oil shale in the ground using vertical underground electric heaters and then extracts the liquid from the ground. As this solution involves no mining or shale waste, the effect on the environment is significantly reduced. However, currently the commercial application of this method is questionable and no production location using in-situ retorting exists anywhere in the world (Bartis, LaTourrette, Dixon, Peterson, & Cecchine, 2005). All in all, it can be said that Estonia is at the technological forefront of the oil shale industry and any significant technological improvements have to come thanks to new research and development efforts.

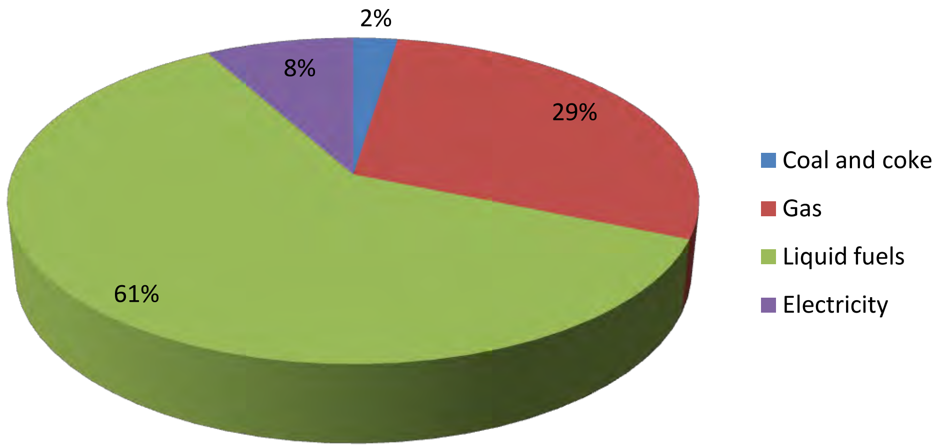
3.2.2 Renewable Energy

Approximately 20% of the domestic energy production comes from renewable energy sources. By far the biggest renewable energy source in Estonia is firewood. It is mostly used for heating in households and district heating systems. According to different sources (Tallinn University of Technology and the European Environment Energy) environmentally sustainable biomass potential in 2030 could be around 26-30 TWh per year compared to the current primary energy supply from biomass of 10 TWh (European Environment Agency, 2006). Most of the potential lies in energy crops, peat and firewood (Paist, et al., 2007). Estonia has a significant wind energy potential due to its long coastline with the Baltic Sea where the average wind speed is 7-9 m/s. According to the International Network for Sustainable Energy the theoretical yearly potential of wind energy in Estonia is around 10 TWh (INFORSE-Europe, 2011). Currently only a fraction of this potential is utilized - in 2012 the energy produced from wind power amounted to 0.45 TWh (Elering, 2013a). Despite having plenty of rivers, Estonia does not have a significant hydropower potential due to its flat topography. It is estimated that small scale hydroelectric power plants could produce 0.15-0.4 TWh annually. Solar heating could provide 2 TWh each year assuming that 15% of the roof area of dwellings can be used for this purpose. Photovoltaic energy production could provide additional 0.7 TWh if 20% of the roof area is used (INFORSE-Europe, 2011). Estonia does not have any proven oil, gas or coal reserves. To sum up, the renewable energy potential in Estonia more than covers the energy demand, however in order to use it, large amounts of investment would be required.

3.3 Imports and Exports of Energy

Estonia is one of the least dependent countries on energy imports in EU27 – imports accounted for 32% and net imports for mere 13% of the total primary energy supply in 2011. Estonia imports mainly oil products (60% of imports) and gas (29% of imports) (Statistics Estonia, 2013d). The breakdown of energy imports is shown in Figure 10. Estonia does not refine any crude oil itself, instead it imports refined petroleum products such as diesel oil, motor gasoline and heavy fuel oil. The biggest importers of oil products are Russia, Belarus, Lithuania and Finland. However, the latter countries mostly obtain their crude oil supplies from Russia and export refined products. Therefore, in reality Russia is the main supplier of petroleum products to Estonia. However, this could change in the future: two Estonian energy companies – VKG Energia and Eesti Energia – plan to start producing diesel fuel and gasoline from shale oil starting from 2016. The total capacity of the refineries will add up to 1.6 million tons of fuel per year compared to 0.6 millions tons of local yearly diesel demand (Eesti Päevaleht, 2012). This could be the most realistic option to decrease Estonian energy dependence. However, diesel fuel from oil shale would be more pollutive than from conventional oil, therefore stricter EU requirements on fuel quality could make it impossible to sell such fuel in Estonia more than 10-15% of the local consumption. Nevertheless, diesel from shale oil could still be exported to bigger markets (E24.ee, 2013).

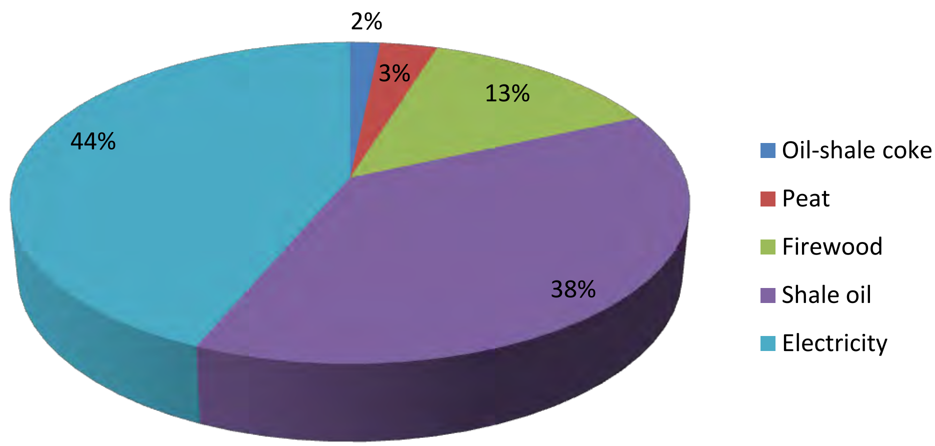
Figure 10. Estonian Energy Imports, 2011



Source: Statistics Estonia, 2013d

Russia also dominates the natural gas supply to Estonia as well as to the neighboring countries (Latvia, Lithuania and Finland). 100% of natural gas is imported through pipelines from the Russian producer Gazprom. Estonia has three pipeline connections with Russia and one with Latvia. 70% of the gas consumed in Estonia is imported through Latvia. This is because from October until March Russia does not have the capacity to import the gas directly to Estonia due to increased demand in Saint-Petersburg region. Latvia has a gas storage facility at Incukalns which is filled with gas in summer and is used to supply Latvia, Estonia and Russia during winter (Eesti Välispoliitika Instituut , 2006). Due to the Baltic countries being isolated from the European gas markets, Gazprom has been able to charge Estonian consumers much higher gas prices than the consumers in Western Europe. The Baltic and Finnish governments plan to build an LNG (liquefied natural gas) terminal in one of the four countries in order to diversify the gas supply options and facilitate competition in the natural gas market. In addition, a project Balticconector is being developed to connect Estonia and Finland with an undersea natural gas pipeline. The pipeline would be 80 km long and is estimated to cost 100 million euros (Gasum, 2011).

Figure 11. Estonian Energy Exports, 2011



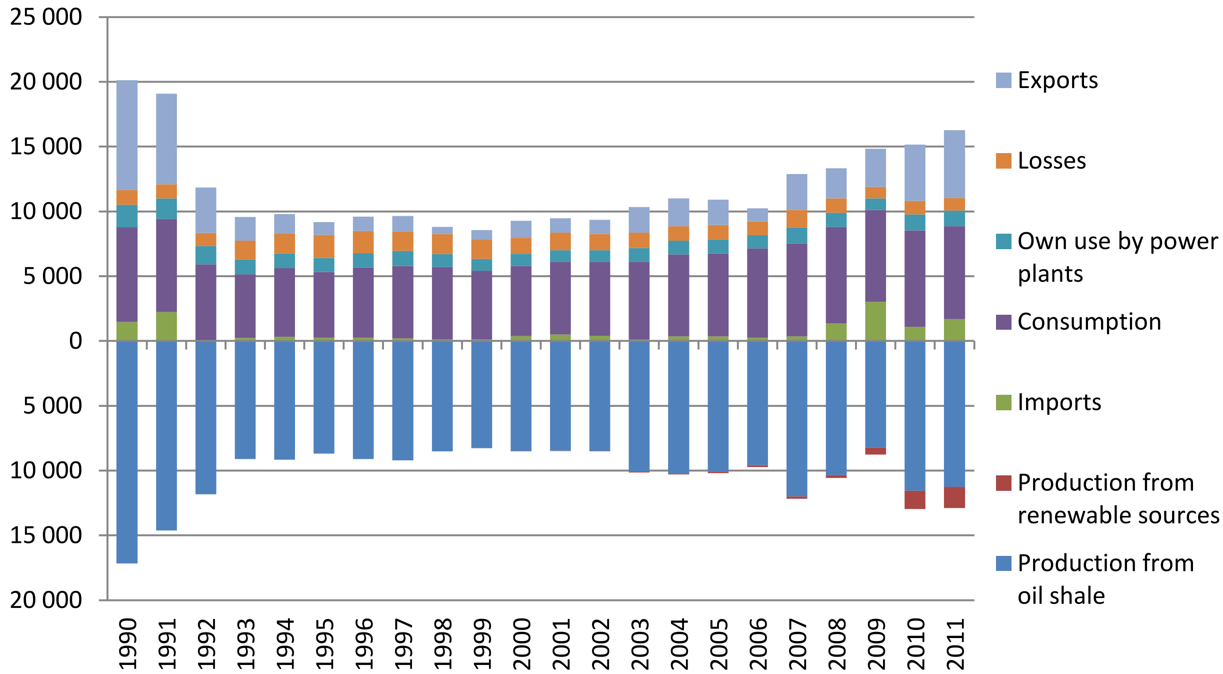
Source: Statistics Estonia, 2013d

Estonia exports around one fifth of its domestic energy production. In 2011 the largest part of energy exports (43%) was electricity - 5.3 TWh. Electricity balance is described in more detail in the next chapter. Another large item in the energy exports is shale oil (38% of exports) - in 2011 422 thousand tons of shale oil was exported. More than half of the exports went to Netherlands (54%); other important markets were Russia (15%) and Great Britain (8%) (Statistics Estonia, 2012). The rest of Estonian energy exports consist of firewood, peat and oil-shale coke.

3.4 Electricity Balance

Electricity consumption in 2012 reached 8.1 TWh. The average electricity consumption per capita in 2012 was 6,300 KWh which is slightly above the average in the EU. The domestic electricity production was 10.5 TWh, exceeding the consumption by almost one third. The primary energy source for electricity production in Estonia is oil shale; only 13% of production in 2012 came from renewable energy sources, mostly biomass and wind. Due to its large oil shale reserves, Estonia is a net exporter of electricity. In 2012 almost half of the electricity production (4.8 TWh) was exported to Latvia, Lithuania and Finland. Imports reached 2.7 TWh, making the balance of the system 2.2 TWh (Elering, 2012a). In Figure 12 a break-down of electricity balances during the last two decades is provided.

Figure 12. Electricity Balances 1990-2011, in TWh



Source: Statistics Estonia, 2012

Today the electricity consumption in Estonia is on a similar level as 20 years ago, however the structure of electricity use has changed significantly. In 1990 most of electricity was consumed by industry (47%) and agriculture (27%). After regaining independence, the electricity consumption in these two sectors decreased drastically. The electricity consumption of industry in 2011 was 2.5 TWh which is 28% lower than in 1990. In agricultural sector the decrease has been even more notable. In 2011 the electricity consumption in agriculture was 0.2 TWh – 10 times lower than in 1990. Business and public sector and households are the only segments where electricity consumption has constantly increased even during the recent economic recession. As a result, in 2011 the main consumers of electricity were industry (35%), businesses and public sector (34%) and households (27%). Figure 5 in the History Section shows the structure and development of electricity consumption.

3.5 Electricity Infrastructure

In September 2012 the installed net capacity of power plants in Estonia reached 2647 MW. The firm capacity or the capacity that can be used at any given time was 2275 MW[1]. An overview of the power plants and their capacity can be found in Table 1. More than 80% of the installed net capacity is located in the North-East part of Estonia, Narva region, where the oil shale mines are situated (Elering, 2012b). As a result, the main power flows in the national grid are from Narva to Tallinn (the capital) and Narva to Tartu (the second biggest city in Estonia).

Table 1. Power Plants in Estonia, September 2012

Power Plant	Installed Net Capacity, MW	Firm Capacity[1], MW
Narva Power Plants	2023.0	1942.0
Iru CHP Plant	156.0	150.0
Ahtme CHP Plant	24.4	5.0
VKG Põhja and Lõuna Power Plants	61.0	61.0
Tartu Power Plant	22.1	22.1
Tallinn Power Plant	21.5	21.5
Pärnu Power Plant	21.5	21.5
Industrial and Small CHP Plants	55.0	49.0
Hydroelectric Power Plants	4.0	3.0
Wind Turbines	258.0	0.0
Total	2647.0	2275.0

Source: Elering, 2012b

Estonia has a well developed electricity network with 5,226 km of transmission lines (110-330 kV) and 65,500 km of low and medium voltage (0.4-35 kV) (Estonian Competition Authority, 2012). The transmission network was mainly built in 1955-1985 as a part of a united electricity system in Soviet Union to provide Riga and Saint-Petersburg with electricity produced from the oil shale in Narva. After regaining independence, the biggest Estonian cities, Tallinn, Tartu and Pärnu have become the main electricity consumption centres, requiring investments into new transmission lines and strengthening the existing ones. The weakest part of the national transmission grid is the Western part of the country. In order to increase the security of supply in this region and the whole country, the transmission network operator is planning to build a new 330 kV line Tallinn-Pärnu-Tartu to be finished in 2019. A map of the national transmission system can be found in Appendix 1.

Estonia is well connected to the neighboring countries; there are three 330 kV lines to Russia and two 330 kV lines to Latvia. Since 2007 a direct current underwater cable to Finland (Estlink 1) has been in operation. It is the first interconnection between the Baltic and the Nordic electricity

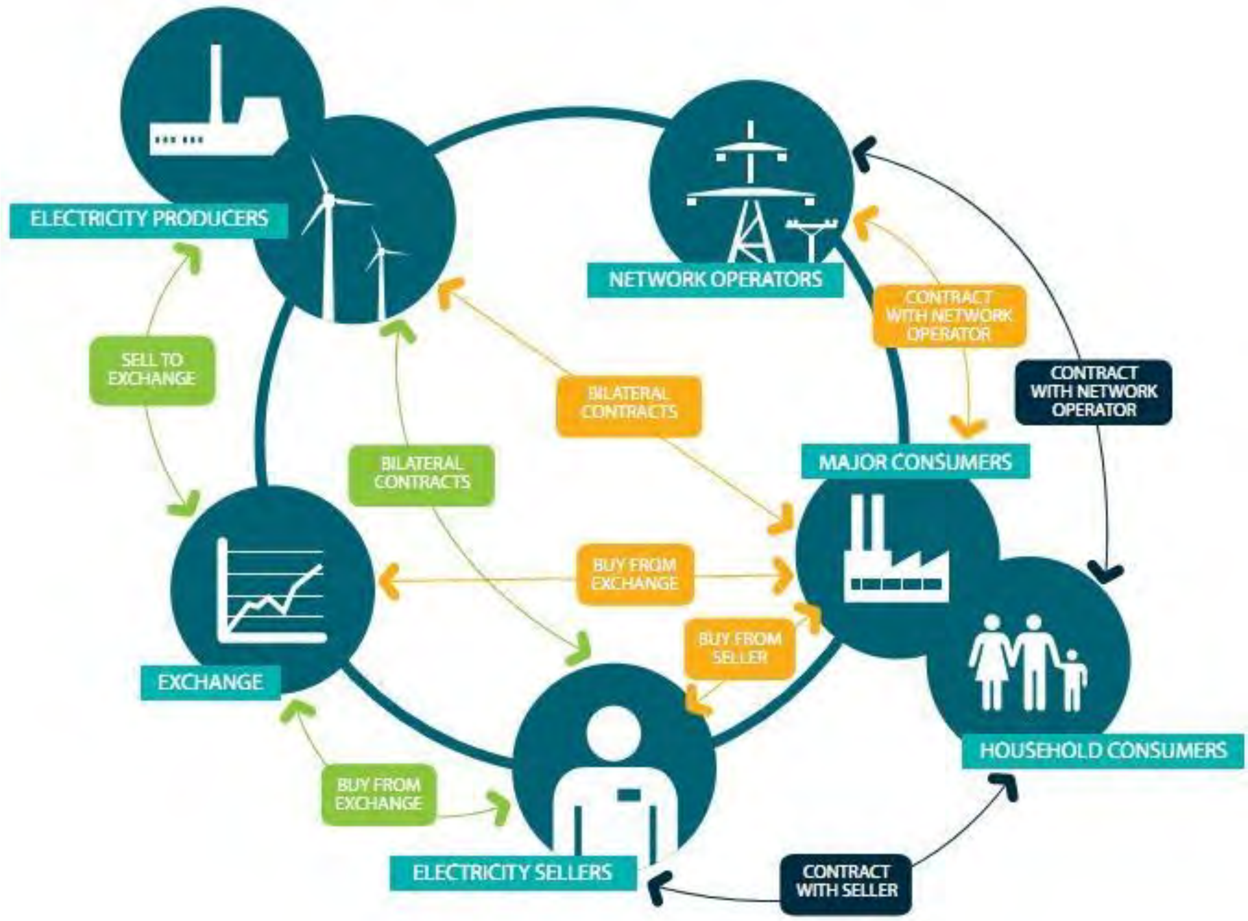
[1] Capacity that can be used at any given time taking into account planned repair, reconstruction, accidents and other restrictions (environmental, cooling, etc.)

markets and has a capacity of 350 MW. To further integrate the Baltic countries in the European electricity system, Estlink 2, a second underwater cable, is presently under construction and is planned to be finished in 2014. It will add 650 MW of new capacity between Estonia and Finland, which is enough to cover half of the Estonian electricity consumption in the winter months (Elering, 2013b). The estimated cost of Estlink 2 is 320 million euros out of which 100 million are sponsored by the European Union (Baltic News Service, 2010).

3.6 Electricity Market Structure

Already in 1999 Estonia made first steps towards market liberalization when large consumers who use more than 40 GWh of electricity per year were allowed to freely choose a supplier (Estonia Competition Authority, 2009). During the EU accession negotiations in 2003 Estonia agreed to deregulate its electricity market according to the EU directives. After a few years, in 2009, Estonia opened 35% of the market; large consumers who use more than 2 GWh of electricity per year gained the right to buy electricity from the open market. However, as the regulated tariffs were lower than the market prices, no consumers chose to exercise this right. Only in 2010 some competition started in the market when the electricity market law was amended so that large consumers had not only a right but also an obligation to buy electricity from the open market (Estonian Competition Authority, 2012). In January 2013, Estonia opened the electricity market for all consumers.

Figure 13. Electricity Market Structure in Estonia



Source: Elering, 2012c

Electricity market structure in Estonia can be characterized by four main activities: generation, retail supply, transmission and distribution. Electricity producers generate electricity and sell it to retailers and consumers through power exchange or bilateral contracts. Retailers in turn sell the electricity further to consumers with whom they have short or long-term contracts. Consumers are free to change their electricity supplier once a month. Physically the electricity is transferred from the producers to consumers through transmission and distribution network. In order to be able to consume electricity, consumers need to have a contract with a network operator. Transmission and distribution network operators are natural monopolies and are therefore regulated by the Estonian Competition Authority. All producers have an equal right to use the transmission and distribution network, thereby ensuring a fair competition in the electricity market. The structure of the electricity market in Estonia and the relationships between different market participants is illustrated in Figure 13.

3.6.1 Generation

Electricity generation in Estonia is very concentrated; the dominant producer with a 92% market share in the first quarter of 2013 is the state owned Eesti Energia (Eesti Energia, 2013e) (Elering, 2013c). Eesti Energia is a vertically integrated energy company which is active in oil shale mining, electricity production and trading, retail sale of electricity and distribution network operation. The second biggest electricity producer is VKG which is an integrated company in the oil shale industry. It has two cogeneration plants and holds a market share of around 3%[2]. The Finnish producer Fortum has around 2%[2] of market share. Its two cogeneration plants use biomass as fuel. Other cogeneration plants such as Tallinna Elektrijaam, Sillamäe Soojuselektrijaam have less than 1%[2] of market share. Wind energy producers had 2% of market share in the first quarter of 2013 (Elering, 2013d). Nelja Energia dominates this segment with more than half of the capacity.

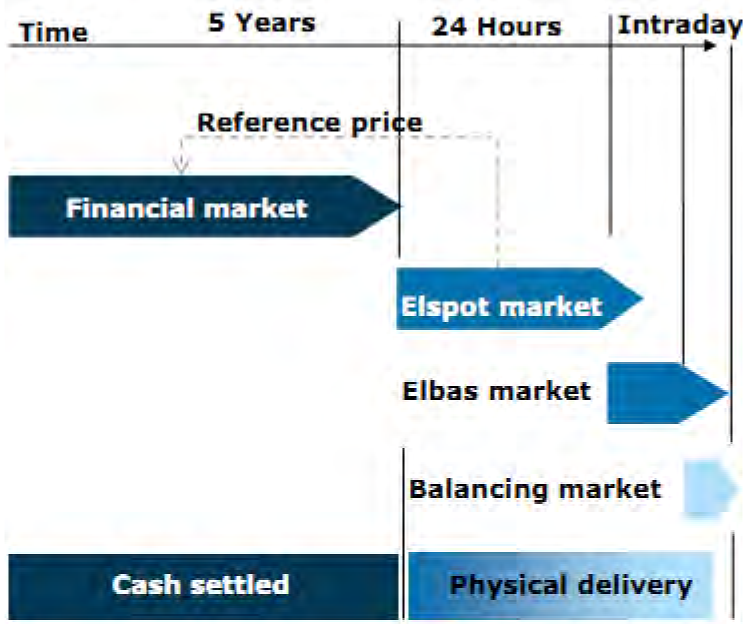
3.6.2 Wholesale market

Wholesale electricity market is a marketplace where electricity generators compete to offer their production to retailers and large consumers. In a deregulated market the wholesale trade can be organized in two ways – through bilateral contracts and power exchange. Bilateral contracts are non-standardized and are normally signed between producers and retail suppliers. The electricity prices in bilateral contracts are often based on the prices of financial instruments or the spot market prices. Bilateral contracts can be used only for trading inside Estonia due to the fact that the transmission capacity with neighboring countries is allocated in an implicit auction in the spot market on the power exchange (Elering, 2012d). In the implicit auction capacity and electricity are traded together therefore it is not possible to use bilateral contracts, in which the electricity is sold separately (BritNed Development Limited). However, in the first 4 months of 2013 99% of the electricity consumed in Estonia was traded through the power exchange (Elering, 2013d). The power exchange is organized by Nord Pool Spot which is one the biggest power exchanges in the world. Estonia joined Nord Pool Spot in 2010 and its other member countries include Norway, Denmark, Sweden, Finland and Lithuania. Nord Pool Spot serves as counterparty to all participants on the power exchange and guarantees the economic settlement of the trades thereby creating a secure power market for participants (N2EX, 2013). The parties

[2] According to authors' estimates

trading on Nord Pool Spot are producers, retail suppliers, brokers, distributors, transmission system operators (TSOs) and large consumers. Nord Pool Spot operates the physical delivery markets while the financial markets are operated by Nasdaq OMX Commodities. These markets are summarized in Figure 14 and described in more detail below.

Figure 14. Summary of Electricity Markets



Source: Nord Pool Spot, 2011

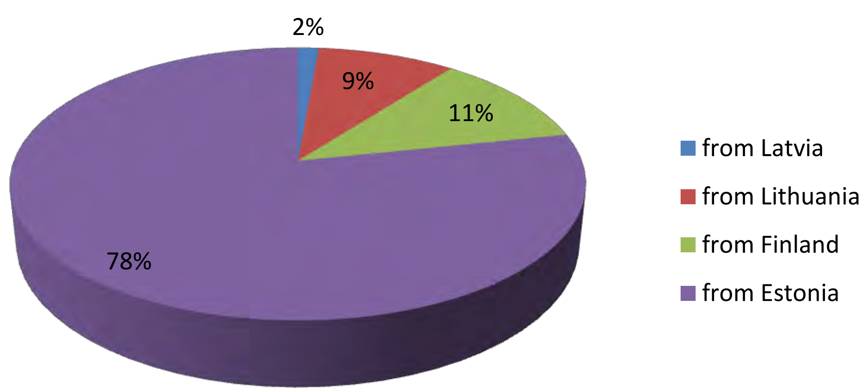
3.6.2.1 Physical Delivery Markets

3.6.2.1.1 Elspot

Elspot is a day-ahead market where electricity is traded in hourly contracts for physical delivery in the next day. All the bids and offers submitted by market participants are aggregated in supply and demand curves and the equilibrium determines the system price. The system price is the 'ideal' price which does not take into transmission capacity limitations. The system price is used as a reference price for most financial contracts traded on Nord Pool Spot. However, since there are capacity restrictions between different regions, the system price often cannot be used for actual trading. To take into account capacity restrictions, every week local TSOs decide on how many price areas there should be. Estonia, for example, is one price area. If the power flows traded between the price areas are higher than the transmission capacity, different prices are calculated for these price areas. The area that has a deficit of electricity receives a higher price and the area that has a surplus production obtains a lower price. Thus the area with high electricity price will have a new equilibrium quantity where more electricity will be produced and less electricity consumed (the other way around for the low electricity price area). The bids with a price higher than the area price and the offers with a price lower than the area price are accepted, and the respective buyers/sellers have an obligation to consumer/deliver the agreed amount of electricity. Imbalances will be taken care of by the TSO and settled towards the generators or consumers through balancing agreements (Nord Pool Spot, 2011).

98% of electricity bought on power exchange in Estonia was traded in the Elspot market. Volumes traded in the day-ahead market increased dramatically after the electricity market was opened in January 2013; the year-on-year increase in the first 4 months was 79% while the electricity consumption remained on the same level. The majority of the electricity bought was produced in Estonia (78%), 11% was imported from Finland, 9% from Lithuania and 2% from Latvia (Elering, 2013c). Elspot volumes bought in Estonia by producer's country are shown in Figure 15.

Figure 15. Elspot Volumes Bought in Estonia by Producer's Country



Source: Elering, 2013c

3.6.2.1.2 Elbas

Elbas is an intra-day market where the trading occurs up to 1 hour before physical delivery (Nord Pool Spot, 2011). Most of the power trading in Nord Pool Spot happens of Elspot, however, due to accidents and intermittent energy sources, it is not always possible to fulfill the obligations from the trading in the previous day. For example, wind speeds might be lower than predicted previously and the generator would not be able to produce the electricity that it has promised. Therefore Elbas has been created to complement the Elspot market and to help keeping the balance between the supply and demand. The prices are calculated based on the same principle as in Elspot. As more intermittent power capacities (such as wind) will be connected to the grid, Elbas will gain more and more importance (Nord Pool Spot, 2013a).

Similar to Elspot market also the Elbas volumes bought in Estonia have increased significantly after the opening of the electricity market – by 248%. However only 2% of the electricity bought through the power exchange was traded on Elbas (Elering, 2013c).

3.6.2.1.3 Regulating Power Market

Regulating power market is a market where the imbalances between demand and supply are corrected during the delivery hour. There are several reasons why these imbalances can arise: generators and power lines can fail and consumption can change unexpectedly. The Estonian TSO Elering is responsible for keeping the demand and supply in balance in the national electricity system and one of the tools to do this is the regulating power market. If there is more consumption or less production than expected, then the TSO needs to increase the production by up-regulation. If the consumption is less than expected, then the TSO will down-regulate the market. In order to do this, the TSO has signed regulating agreements with market participants and TSOs of neighboring countries. Based on the agreement market participants and other TSOs make bids for every hour for up- and down-regulation. If there is a need for up- or down-regulation, the TSO will choose the cheapest offer and order the respective market participants or TSOs to increase or decrease their capacity.

3.6.2.2 Financial market

In the physical markets participants face risks related to price fluctuations. In order to give the market participants tools to manage the risks, financial markets have been created. In the Nord Pool Spot area, the financial market is managed by Nasdaq OMX Commodities Europe. In the financial power market there is no physical delivery; trades are settled in cash during or after the trading period depending on the product. The contracts are traded with a time horizon up to 6 years for different time periods (day, week, quarter and year) (The NASDAQ OMX Group, 2013a). The products offered are base and peak load power derivatives: futures, forwards, options and contracts for difference (CfD). Futures and forwards are obligations to buy/sell a certain amount of power at a given time in future at a predetermined price. Futures require daily settlement while forwards are settled only after the contract's due date. In Nasdaq OMX Commodities Europe's financial market futures are traded only short-term (day and week). Forwards are used for longer time periods due to the fact that there is no daily settlement and thus less cash needs to be held in order to satisfy margin requirements (Nasdaq OMX Oslo, 2012). Options are similar to futures and forwards, however options give a right not an obligation to buy/sell power. Another difference is that options require only a premium to be paid in advance as opposed to the full contract price for futures and forwards. CfD are used to hedge against the risk that an area price will be different from the system price. It is an important product because futures and forwards do not take into account transmission restrictions, i.e. they use system price as a reference price. Since Estonian price area is not used in the system price calculation, CfD are especially important for the local market participants (Elering, 2012d).

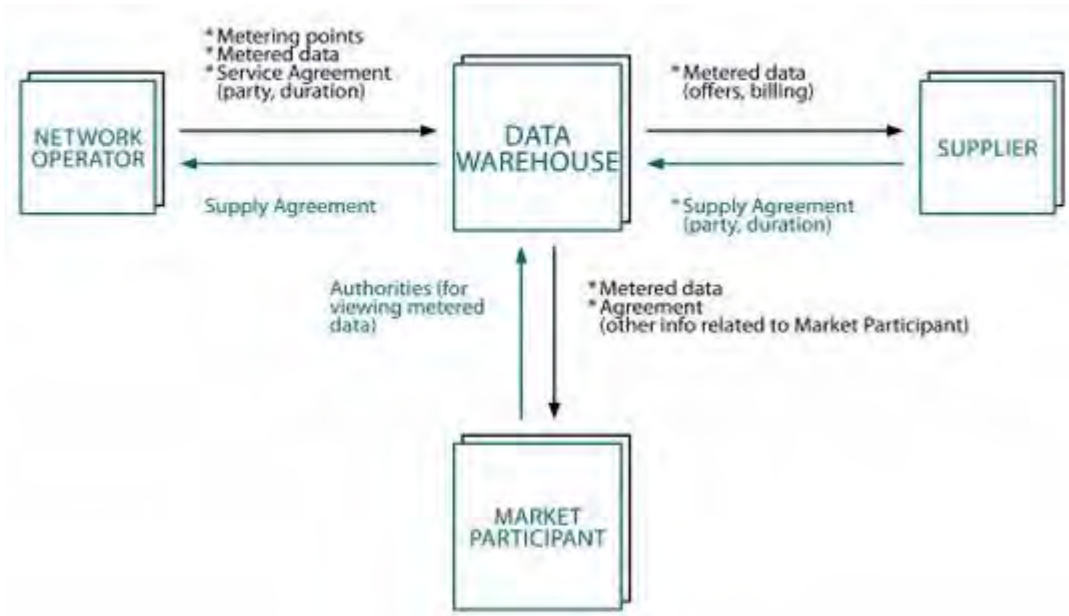
In addition to power derivatives, market participants can also trade carbon derivatives – European Union allowances (EUA) and Certified Emission Reductions (CER). EUA are allowances to emit 1 ton of carbon dioxide or equivalent amount of other greenhouse gases. A certain amount of allowances is allocated or auctioned to companies who can sell the excess allowances or buy the missing amount of allowances in the power exchange. After every year each company must provide enough allowances to cover its emissions or pay a heavy fine. It is an EU wide system covering 11,000 power plants and factories (European Commission, 2013b). CER are emission credits which developed countries can obtain by investing into projects which reduce emissions in developing countries. One CER corresponds to reduction of one ton of carbon dioxide or equivalent amount of other greenhouse gases. CER can replace up to 10% of the required European Union allowances (The NASDAQ OMX Group, 2013b).

3.6.3 Retail Market

Since 2013, when the electricity market was opened, all consumers can freely choose a retail seller. In order to become a retailer, it is necessary to obtain a license from the Estonian Competition Authority. In May 2013, there were 46 entities holding the license to be a retail seller (Elering, 2013e). However, only 10 were active, out of which 3 offered services only for business customers; others were distribution companies who also sold electricity to the consumers in their area (Ministry of Economic Affairs and Communications, 2013a). Consumers are able to change their retail supplier once a month by signing a contract at least 21 day before the change of a calendar month. Two main types of contracts are offered to consumers – fixed rate and variable rate (tied to the electricity price in the power exchange). There are three different websites where consumers can compare price offers of different retailers. However, there is no price comparison offered by the Competition Authority. If the consumers do not choose a retail seller, they receive a universal service where power is provided by their distribution network operator. However, because the price of the universal service is based on the spot price plus a margin, the consumers have a strong incentive to buy electricity in the open market. As a result, 65% of the consumers had chosen a retail seller by the 1st of January, 2013 (Ministry of Economic Affairs and Communications, 2013b). In the end of April, 72% of the electricity consumers based on the consumption points or 88% based on the consumption amount had a contract with an electricity seller (Elering, 2013f).

An important tool to ensure smooth retail market functioning is the data warehouse where all market participants can store and exchange data. It is operated by the Estonian TSO – Elering and was completed in 2012. It is compulsory for network operators and retail sellers to use the data warehouse. Distribution network operators are responsible for gathering and sending the data about each customer's electricity consumption. Retail sellers provide data about the contract with the consumer (such as the beginning and length of the contract). Consumers can use the database to see information about their consumption and contracts with the network operator and the retail seller. They can also authorize one or more retailers to access their data which enables the retail sellers to make personalized offers. The database is crucial for enabling real competition in the retail market as it gives the electricity retailers equal opportunities to approach consumers. Estonia is one of few countries in EU which has implemented such a database – in 2011 only UK had a central database to exchange data (Union of the Electricity Industry, 2011). The main processes for data exchange in data warehouse are illustrated in Figure 16.

Figure 16. Main Processes of Data Exchange in the Data Warehouse



Source: Elering, 2013g

Despite the large number of retail sellers, concentration in the retail market is very high. The state owned Eesti Energia held 71%, Elektrum Eesti - 12% and Baltic Energy Services 4% of the market share at the end of March 2013 (Elering, 2013f). Other suppliers had less than 2% of market share. Applying the Herfindahl–Hirschman Index (HHI) for Estonian retail market gives a result of more than 5000; a measure above 2500 indicates high concentration (U.S. Department of Justice, 2013).

3.6.4 System and Network Operators

Estonia has one transmission network operator – Elering which is also the system operator. Elering is an independent state owned company which was established in 2010 by separating the transmission network from the vertically integrated national energy company Eesti Energia. Elering owns the transmission network and is not involved in production or sales of electricity (Estonian Competition Authority, 2012). The main responsibility of Elering is to ensure a reliable functioning of the national electricity system by maintaining and developing the internal transmission system and external connections and managing the balance between production and consumption in real time. In order to ensure long-term security of electricity supply, Elering's duty is to integrate the Estonian market in the European electricity system by investing in new cross-border connections. Other tasks include ensuring an efficient operation of the electricity market, securing equal treatment of market participants and providing transparent information to the public (Elering, 2013h).

Distribution network operators operate electricity lines up to 110 kV. Responsibilities of the distribution network operators (DNO) are developing and maintaining reliable and efficient distribution network; ensuring market participants with equal access to the grid; and measuring and processing information about consumption (Riigikogu, 2012). As of May 2013 there were 36 DNOs, which is a rather high number for the size of the country. The biggest DNO with 87.5% market share is Elektrilevi which is owned by Eesti Energia. The company's previous name was Eesti Energia Jaotusvõrk, and the new brand name Elektrilevi was introduced in May 2012 in order to demonstrate a clear separation between the competitive business parts (such as production and sale) and distribution which is a natural monopoly. All other DNOs have less than 100 000 customers. VKG Elektrivõrk and Imatra Elekter have 2.8% of market share each, while TS Energia has 1% of market share (Estonian Competition Authority, 2012).

According to the Electricity Market Act (2012) the distribution network operators have to replace the existing manual electricity meters with remote meters by 2017. The biggest distribution network operator Elektrilevi has contracted Ericsson for installation of 630 000 remote meters. The new meters will be able to measure the consumption hourly. This will enable the electricity bill to be based on each client's actual hourly consumption instead of the current system where the bill is based on the monthly consumption divided into hours according to load profiling. Remote meters will give several benefits to market participants: consumers will be able to monitor their consumption and save costs by switching their consumption from peak hours to non-peak hours; retailers will gain the opportunity to offer new products based on the time of consumption; network operators will be able to detect fraud more easily and improve the power quality by having fast access to information about voltage deviations (Eesti Rahvusringhääling, 2012).

3.6.5 Regulation

The electricity sector in Estonia is regulated by the Electricity Market Act. All regulatory duties and rights stipulated by the law are executed by the Estonian Competition Authority. The Competition Authority is an independent government agency with no political functions. Its decisions can be disputed only by the administrative court of Estonia (Põldroos, 2010). Electricity producers, transmission and distribution network operators and retailers are required to obtain a license from Competition Authority to operate in the Estonian electricity market. The Competition Authority's main areas of responsibilities are:

1) ownership unbundling – separation of network operation from electricity production and sale;
2) technical functioning – monitoring the quality requirements and proper recording of quality indicators by the network operators and imposing fines in case of violation;
3) access to network – approving charges for network usage;
4) connection tariffs – approving methodology for connection tariffs;
5) cross-border issues – approving rules for calculating available transmission capacity and the transmission reliability margin;
6) monitoring the level of competition in the market;
7) monitoring the TSO – assessing general compliance, investments into the transmission grid, co-operation with other TSOs, etc.

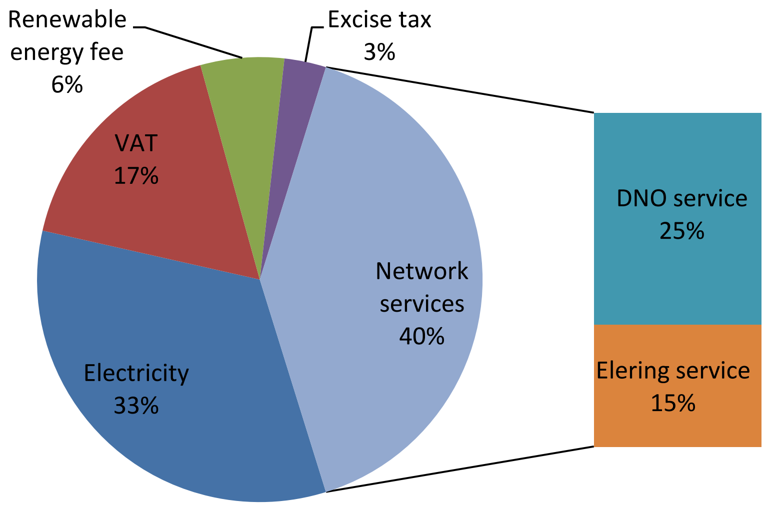
In additional to these duties, the Competition Authority carries out general supervision of market participants ensuring that they fulfill the provisions of the Electricity Act. The Authority is also obliged to report to the European Commission regarding the market dominance and co-operate with the Agency for the Cooperation of Energy Regulators which was created by the EU in order to facilitate market integration (Estonian Competition Authority, 2012).

3.6.6 Electricity Price

Electricity bill for the end consumer consists of several price components. Electricity price is the only unregulated component while network services, renewable energy fee and taxes are regulated. The proportions of different price components for an average household customer[3] of Eesti Energia are shown in Figure 17.

[3] with a fixed price agreement and annual consumption of 2400 kWh

Figure 17. Electricity Bill Components

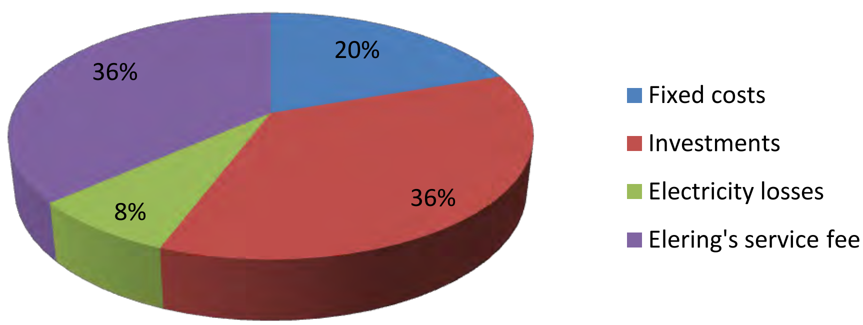


Source: Eesti Energia, 2013f

Electricity price is the second biggest component of the electricity bill (33%) and is dependent on the prices in the power exchange. For the variable price packages the electricity price is determined by the weighted average of Elspot price (according to load profiling) plus a sales margin to cover administrative costs. In the first five months of 2013 the weighted average monthly Elspot price in Estonian price area was 4.22 euro cents per kWh (Eesti Energia, 2013g). The sales margins in June 2013 were in a range from 0.21 to 0.47 euro cents per kWh (Elektrihind.ee, 2013). For fixed price packages the electricity price depends on the prices of futures to which a sales margin is added.

Network services fee is the biggest part of the electricity bill (40%). It is invoiced to customers by DNOs, and the fee is approved by the Estonian Competition Authority for a period of three years with an annual indexation. The Competition Authority uses data about economic performance and technical indicators submitted by the network operators to set an appropriate fee. There is a united methodology used for setting the fee for both transmission and distribution network operators and it is based on revenue-cap regulation. The tariff for DNO's is set such that it would cover investments in the network, fixed costs and electricity losses, Elering's service fee as well as reasonable return which in 2012 was set at 7.83% (Elektrilevi, 2013a). However, the network operators are given incentives to improve efficiency by having targets to improve electricity losses and limiting the fixed cost increase to RPI-x (retail price index minus fixed costs saving obligation of 1.5%) (Estonian Competition Authority, 2012). The network service fee for the dominant DNO Elektrilevi in June 2013 was 5.56 euro cents per kWh (Elektrilevi, 2013b). The proportions of different network service fee components for Elektrilevi are shown in Figure 18.

Figure 18. Proportions of Network Service Fee Components for Elektrilevi



Source: Elektrilevi, 2013

The renewable energy fee is set by Elering to subsidize the electricity generated from renewable sources or in CHP plants, and is paid by all consumers in proportion to their electricity consumption. Renewable energy is subsidized in order to achieve renewable energy targets set by European Commission and to promote renewable energy production. The level of subsidies is specified by the Electricity Market Act. Elering is responsible for paying out the subsidies and calculating the fee to be paid by the consumers which would cover the subsidies. In 2013 the renewable energy fee is 0.87 euro cents per kWh (Elering, 2012e).

Electricity excise tax is a government tax for funding environmental protection. In 2013 the excise tax is set at 0.447 euro cents per kWh (Imatra Elekter, 2012). VAT of 20% is added to all other electricity bill components (Eesti Energia, 2013f).

4 Electricity Market Liberalization

4.1 Market Liberalization Process

It is important to look at the development of the Estonian electricity market in the context of the whole European market liberalization process. European Union can influence a large part of its Members' energy policies and Estonia as a member has to adjust its policies according to the directives of the European Union. The changes in the Estonian electricity market have been strongly shaped by the policies of the European Union, in particular the three Energy Packages adopted in 1996, 2003 and 2009. Due to the Soviet heritage and monopolistic electricity market in the 1990s described in the previous sections, Estonia has had to work hard in order to keep up with the liberalization processes of EU and never had a good opportunity to shape the development independently. The biggest concerns of the Estonian policy makers have been energy security and reducing dependency from non-EU countries. Thus, in order to describe the Estonian market liberalization process we will first describe the progress in the EU in section 4.1.1 and then follow up with the advancements in Estonia in section 4.1.2.

4.1.1 European Union

The European Union has focused on a unified energy policy for the last 20 years. There are two important aspects which have increased the need for a common European energy policy. First, a large part of fossil energy sources (60% of liquid fuels and 30% of natural gas) are imported outside of the EU and second, the usage of fossil fuels has a strong effect on climate (Elering, 2012d). Therefore, the foundations of the European energy policy laid down in the Lisbon Treaty (Council of the European Union, 2007) are as follows:

a) *ensure the functioning of the energy market*
b) *ensure security of energy supply in the European Union*
c) *promote energy efficiency and energy saving and the development of new and renewable forms of energy*
d) *promote the interconnection of energy networks*

The first developments in the EU energy policy took place in the 1990s. At that time the energy landscape was highly monopolistic, prices were high and there was a lack of investments. Thus, the member states decided to establish a common internal electricity market to increase competition and efficiency in the production, transmission and distribution while strengthening security of supply and the competitiveness of the European economy (European Parliament, 1997). The first liberalization directives were adopted in 1996 with the Directive 96/92/EC. The document established rules regarding the organization and functioning of the electricity sector and access to the market. The main objective of the directive was to set rules how members should assign and manage a transmission system operator (TSO). First, countries had to designate a system operator for operating, maintaining and developing the transmission system of a country. Second, TSO had to behave in an objective, transparent, and non-discriminatory manner. To ensure this behavior, the transmission function had to be operated independently from other activities in a vertically integrated electricity company. In addition, flow of information between different activities had to be restricted, accounting had to be done separately for each activity, and regulatory authorities had to be given an opportunity to access the accounts (European Parliament, 1997).

Development of an internal European electricity market was planned to happen step by step. Therefore, in 2003 the EU adopted the Second Energy Package with the Directive 2003/54/EC transposed into national laws by July 2004 with some provisions coming into force in July 2007 (European Parliament, 2003). The basic conditions of the directive concerning "common rules for the internal market in electricity" described by Cova and Gregori (2009) are as follows:

a) *Free access to network for producers* to participate in the market. There should be no legal, administrative or discriminatory action for third party access to the distribution system operator (DSO) or the transmission system operator (TSO) networks, or for the connection licensing process
b) *Free access to network for consumers* willing to participate in the market. This means no geographical barriers and no discriminations among applicants, who require to be connected to the grid.
c) *Possibility for customers to change supplier* and make informed choices regarding who should supply them electricity, based upon the price and the quality of the electricity.
d) The possibility for producers to make informed choices on electricity generation should be based on *published information*. The information regarding tariffs should be easily

available and transparent. The market rules should be well defined and information regarding system constraints and the market should be available to those who require it.

e) *The market should strive to be liquid*. This means that it should have many participants and that no sole actor should be able to manipulate the price by their bids to the market. If one sole actor has that possibility, it can manipulate prices for his own interests. The term “liquid” implies a smooth price formation, which is not noticeably affected by a single bid. The regulator should have the possibility to restructure companies with a market share of the production assets that is too high, if such an actor takes advantage of its size to manipulate prices. To be liquid, the market must have a sufficient number of generators and consumers.

f) *Electricity prices should be cost reflective of the actual costs to produce electricity*. This also refers to internalizing external costs although external costs are difficult to assess. These costs are usually handled with taxes or, in the cases of GHG emission, through trading with carbon credits.

g) The network tariffs must be cost-reflective. This means that the TSO must act as a perfect monopoly, spreading its costs equally to users of its services. These costs must include long run costs meaning current and future investments and costs for the operation of the networks.

In 2007 the EU recognized that despite recent positive developments there were distortions of competition in the electricity sector. First, most wholesale markets remained national and had high levels of concentration in generation. Second, there was too much vertical integration of generation, supply and network activities. Third, cross-border trade was insufficient to put pressure on national producers. In addition, there was a lack of transparency in the electricity wholesale markets. Finally, the price formation was too complex and thus, created distrust in the system (European Commission, 2012a).

Therefore, to mend these shortcomings, the EU adopted the Third Energy Package with the Directive 2009/72/EC coming into force in 2009 (European Parliament, 2009). According to Goldberg (2010) the most important provisions of the Third Energy Package are unbundling of electricity networks at transmission level from the business of producing or supplying, regulatory oversight and cooperation, and transparency and record keeping. First, the EU argued that the unbundling of TSOs will lead to higher investments in the network. However, due to political pressure by the Member States the European Parliament agreed that there can be three options of unbundling: full ownership unbundling (full separation of transmission networks from supply and production activities), the independent system operator (ISO) model (vertically integrated firm may retain ownership of the network assets but network is managed by an ISO which is a separate entity) or the independent transmission operator model (preserved integrated supply and transmission activities but obliged such companies to comply with addition rules that ensure independent management (Goldberg, 2010). Second, as in some countries regulatory authorities had only been recently established with rather weak and dispersed powers then according to the directive the regulatory bodies had to be legally distinct and functionally independent of any other public or private entity. Finally, in order to effectively assess cases of market abuse and study past behavior of market participants, the directive set out a number of record keeping obligations to record all data relating to operational decisions and trades.

4.1.2 Estonia

The development of the Estonian electricity market has been closely linked to the advancements in the EU energy policy. The first law regulating the Estonian electricity market, the Energy Act, followed the direction of the First Energy Package of the EU and was passed in June 1997 and came into force in 1998. The document administered the fuel and energy sector (including electricity) and the supervision of these markets. In addition, the act established the Energy Market Inspectorate which was responsible in the electricity sector for issuing market licenses for import, export and sale of electricity, and for approving electricity prices for different market participants (Parliament of Estonia, 1998). Although the Energy Act was modeled according to the EU legislation the provisions were considered too general and not thorough enough according to a report "Electricity Sector Reform in the Candidate Counties, Balkan Countries and the Russian Federation" addressed to the EU (Union of the Electricity Industry, 2002). Nevertheless, due to the Energy Act the major energy producer Eesti Energia had to unite five regional electrical power networks in November 1998 and divide them into separate distribution (Eesti Energia Jaotusvõrk) and transmission (Eesti Energia Põhivõrk) units. These entities became independent economic units with their own accounting and auditing. However, they were still operating parts of Eesti Energia (Eesti Energia: Põhivõrk, 2007). In addition, in 1999

Eesti Energia separated its electricity production and sales operations by creating distinct subsidiaries (Narva Elektrijaamad) for the electricity generation (Narva City Council, 2008).

After the Second Energy Package of the EU was passed in June 2003, Estonia adopted the Electricity Market Act later that year governing the generation, transmission, sale, export, import and transit of electricity and the economic and technical management of the power system. The document focused on the principles of the operation of the electricity market based on the need to ensure an effective supply of electricity at reasonable prices and meeting environmental requirements and the needs of consumers, and on the balanced, environmentally clean and long-term use of energy sources (Parliament of Estonia, 2003). For example, as the Electricity Market Act prohibited network operators from simultaneously producing, distributing and selling power, then in April 2004 Eesti Energia had to establish a new independent and autonomous subsidiary responsible for transmission networks, Eesti Energia Põhivõrk, instead of the existing structural unit (Eesti Energia: Põhivõrk, 2007).

Despite the development towards a liberalized electricity market, the CESI report (2009) mentioned that in practice, in 2007 there was no functioning Estonian electricity market as there were no independent suppliers. The market was dominated by a single state owned vertically integrated company (Eesti Energia), which had 97% of the production capacity, 88% of the retail market and controlled the whole transmission network.

According to the EU Directive 2003/54/EC all Member States were supposed to open their electricity market to all non-household customers by July 2004 and to all customers by July 2007 (European Parliament, 2003). However, due to reasons mentioned in section 2.4 Estonia agreed to open its electricity market for large-scale consumers in 2009 and completely in 2013. In fact, these steps were undertaken slightly later – Estonian electricity market was opened in April of 2010 for consumers with a consumption of higher than 2GWh/year who accounted for approximately 35% of the market and the market was fully opened for small and household consumers in 2013 (Elering, 2012d).

In accordance to the Third Energy Package in November 2009, the government of Estonia separated Elering (previously Eesti Energia Põhivõrk), including the assets of the transmission system, from Eesti Energia in order to ensure the independence of the transmission network operator from electricity production and sales activities (Elering, 2010). In addition, when the market opened for large-scale customers in 2010, Estonia joined the Nord Pool Spot power exchange enabling the market participants to trade electricity. Furthermore, Estonia joined the intra-day Elbas power exchange in October later that year.

However, according to the European Commission report "Energy Markets in the European Union in 2011" (2012d) the effective competition in the electricity market has still been limited. For example in 2010 Eesti Energia had a clear dominant position, which accounted for 89% of total electricity production and for 88% of the retail market.

4.2 Analysis of the Estonian Electricity Market Liberalization

During the last 30 years most developed countries have gone through electricity market liberalization. However, compared to other industries (airlines, trucking, telecommunications, etc.) electricity sector reforms have been less successful and have remained often either incomplete, moved forward slowly or even gone backwards. For example electricity market restructurings in France, Italy, Belgium, Germany, Brazil and California have been rather difficult to implement (Joskow, 2008). Nevertheless, there are numerous positive examples where the liberalization has happened smoothly, for example in the Nordic countries, the UK, Chile, Texas and portions of Australia. Joskow (2008) describes a "textbook" architecture of desirable features for the electricity market liberalization process which the successful countries have followed. However, it is important to keep in mind that the ideal performance of perfectly competitive markets is never achievable in reality. We will analyze the Estonian electricity market liberalization process in the context of the "textbook" model and highlight the positive aspects and shortcomings of the Estonian reforms. The following section will analyze each part of the "textbook" model separately taking into account the situation in Estonia.

a) *Privatization of state-owned electricity monopolies to create hard budget constraints and high-powered incentives for performance improvements and to make it more difficult for the state to use these enterprises to pursue costly political agendas.*

Estonia has not privatized the state-owned electricity monopolies. The dominant electricity producer, Eesti Energia, with a market share above 90% is fully state owned. The government also controls the only transmission network operator Elering and the biggest distribution network operator (market share of 87.5%) Elektrilevi which is a subsidiary of Eesti Energia. Although some of the smaller electricity generators and distribution network operators are not owned by the state, we can say that in overall, the Estonian electricity sector has not been privatized and there are opportunities for the government to use its power to pursue costly political agendas and there is a risk of too weak incentives for performance improvements.

However, there are examples of countries like Australia and the Nordic countries which have successfully gone through an electricity market liberalization process without full privatization (Joskow, 2008). Moreover, Newbery (1998) believes that competition is much more important than privatization in terms of the benefits of the electricity market reforms. Nevertheless, Joskow (2008) warns that public firms might invest into new generating facilities without considering market incentives and take advantage of direct or indirect subsidies; such a behavior will undermine private sector's willingness to develop their business and make new investments.

b) *Vertical separation of potentially competitive segments (e.g. generation, marketing and retail supply) from segments that will continue to be regulated (distribution, transmission, system operations) either structurally (through divestiture) or functionally.*

The separation of electricity generation, distribution, transmission and retail supply in the Estonian electricity market has happened step by step as discussed in the previous sections. The split-up should help against cross-subsidization of competitive businesses from regulated sectors. In addition, it should enable fair access to distribution and transmission networks upon which the competitive segment depends (Joskow, 2008). First, in 1998, the monopolistic electricity firm Eesti Energia united five regional electrical power networks and divided them into separate distribution (Eesti Energia Jaotusvõrk) and transmission (Eesti Energia Põhivõrk) units with their own accounting and auditing. Second, in 1999 Eesti Energia separated its electricity production and sales operations by creating distinct subsidiaries for the electricity generation. Third, in 2004 Eesti Energia established an independent and autonomous subsidiary responsible for transmission networks, Põhivõrk, instead of the existing structural unit. Finally, in 2009, the government separated Elering (previously Eesti Energia Põhivõrk), including the assets of the transmission system, from Eesti Energia in order to ensure the independence of the transmission network operator from electricity production and sales activities. The distribution network operator Elektrilevi (previously Eesti Energia Jaotusvõrk), which has a market share of 87.5%, remains to be separated only functionally. The change of the brand name in May 2012 should demonstrate a clear separation between the competitive business parts (e.g. production and sale) and distribution which is a natural monopoly. However, there is an ongoing discussion in Estonia whether Elerktrilevi should be separated from Eesti Energia also in terms of ownership or not. On the one hand, Kallas (2013) believes that as long as the distribution network and generation units have the same owner, equal rights for all electricity sellers are not guaranteed. On the other hand, the minister of finance of Estonia, Jürgen Ligi (2013), claims that due to the special nature of the Estonian electricity sector which is highly dependent on oil shale the separation of Elektrilevi would generate extra costs and be too costly for Eesti Energia and the state. He adds that currently Eesti Energia benefits from lower financing costs thanks to the economic stability of the distribution network (Müller & Ojakivi, 2013).

Despite Eesti Energia's dominant market position and the ongoing discussion about the ownership of the distribution network, the generation and retail supply sectors are open for competition and are either structurally or functionally separated from regulated distribution and transmission networks.

c) *Horizontal restructuring of the generation segment, to create an adequate number of competing generators to mitigate market power and to ensure that wholesale markets are reasonably competitive.*

As mentioned earlier electricity generation in Estonia is very concentrated; the state owned Eesti Energia is the dominant producer with a 92% market share in the first quarter of 2013. The company has not been horizontally split up into several companies to increase competition among generators, and there has been no discussion about this issue in the political landscape or in the Estonian media. The next biggest electricity producers, VKG, Fortum and Nelja Energia have market shares of 3%, 2% and 1% respectively. In addition, according to the report of the Estonian Competition Authority (2013) oil shale mining sector is not working according to the principles of a liberal market. First, the mining companies are all part of vertically integrated organizations which use the oil shale for heating, or producing electricity, shale oil or cement. Thus, although for example Eesti Energia is selling part of their oil shale production to other buyers, there is a risk that the resource is not processed in the most effective manner but is used by the owner company of the mining firm. Second, the oil shale mining licenses are not auctioned but have been assigned to four companies by the government. If all these companies mine the maximum quantity allowed - 20 million tons of oil shale per year, the existing mining licenses will be used up in 33 years. However, changing the existing agreements is risky, legally questionable and the government does not want to send signals to the generators that discourage long term planning and investments. Therefore, it is unclear how existing companies could increase their production quantity or how new entrants could acquire some new mining licenses if no changes in the legal framework will be made. Currently Eesti Energia is allowed to mine 75% of the annual maximum quantity, VKG 13,8%, Kiviõli Keemiatööstus 10% and Kunda Nordic Tsement 1,2% (Estonian Competition Authority, 2013).

Thus, the market power of Eesti Energia is a concern in the Estonian electricity market. The issue of strong market power has been identified in many other markets like Chile, Columbia, New Zealand, Brazil and some areas of Continental Europe. Generator market power is increased if transmission constraints limit the geographic expanse of competition (Joskow, 2008). Estonia is well connected to its neighboring countries Latvia and Russia; however, there are no direct electricity imports from Russia. The interconnection with Finland will be increased in 2014 from 350 MW to 1000 MW. Also almost all electricity in Estonia is traded on power exchange which means that the market is open for local and foreign competition. All in all, currently the transmission constraints increase the market power of Eesti Energia but after the completion of Estlink 2 in 2014 the Estonian market will be better integrated with the Nordic electricity market and the wholesale sector in Estonia will become more competitive thanks to foreign competitors. Nonetheless, currently such a concentrated market structure is an obstacle for a well-functioning wholesale market and a deregulated electricity sector in Estonia.

d) *Horizontal integration of transmission facilities and network operations to encompass the geographic expanse of "natural" wholesale markets and the designation of a single independent system operator to manage the operation of the network, to schedule generation to meet demand and to maintain the physical parameters of the network (frequency, voltage, stability), and to guide investments in transmission infrastructure to meet reliability and economic standards.*

In 1998, Eesti Energia united five regional electrical power networks to encompass majority of Estonia and divided them into separate distribution (Eesti Energia Jaotusvõrk) and transmission

(Eesti Energia Põhivõrk) units with their own accounting and auditing. Currently Estonia has one transmission network operator – Elering (previously Eesti Energia Jaotusvõrk), established in 2010, which is also the system operator. The main responsibility of Elering is to ensure a reliable functioning of the national electricity system by maintaining and developing the internal transmission system and external connections and managing the balance between production and consumption in real time.

There are over 30 distribution network operators; however, the biggest, Elektrilevi (previously Eesti Energia Jaotusvõrk), a subsidiary of Eesti Energia, has a market share of 87.5%. Responsibilities of the DNOs are developing and maintaining reliable and efficient distribution network; ensuring that market participants have equal access to the grid; and measuring and processing information about consumption.

All in all, the transmission and distribution networks of Estonia encompass the geographic expanse of "natural" wholesale markets and there is a clearly designated single independent system operator who manages the operation of the electricity network. In addition, there are 36 DNOs who are responsible for maintaining an efficient distribution network.

e) *The creation of voluntary public wholesale spot energy and operating reserve market institutions to support requirements for real time balancing of supply and demand for electric energy, to allocate scarce network transmission capacity, to respond quickly and effectively to unplanned outages of transmission or generating facilities consistent with the need to maintain network voltage, frequency and stability parameters within narrow limits, and to facilitate economical trading opportunities among suppliers and between buyers and sellers.*

The Electricity Market Act states that the Estonian TSO is responsible for contracting a power exchange operator. In 2010 Elering decided to join the Nord Pool Spot (NPS) which has more than 15 years of experience in operating power exchange in the Nordic countries. Estonia has joined both day-ahead and intra-day markets. Although the participation on the power exchange is voluntary, liquidity in the NPS Estonian price area since the full opening of the electricity market in the beginning of 2013 has been very high. In the first 4 months of 2013, 99% of the electricity consumed in Estonia was bought on the power exchange; the corresponding number of 2012 in all Nord Pool Spot regions was 77% (Nord Pool Spot, 2013b). Such a high level of liquidity short time after the market opening indicates that market participants trust Nord Pool Spot. It also helps to decrease the market power of the dominant producer Eesti Energia since the electricity price is transparently formed on the power exchange and is available to all market participants. The regulating power market is currently operated by the TSO, Elering, based on bilateral agreements. According to Baltic Energy Market Interconnection Plan a common Baltic – Nordic regulating power market should be created in 2013, however, as no official announcements about the expansion of the regulating power market have been made, the process is likely to be delayed (Public Utilities Commission of Latvia; Estonian Competition Authority; Lithuanian National Control Commission for Prices and Energy, 2011).

Nord Pool Spot and regulating power market are essential for well functioning ancillary services: the implicit auction principle on Nord Pool Spot allows to efficiently allocate the network transmission capacity; mismatches created by unplanned outages of transmission or generating facilities can be corrected by Elbas or regulating power market; and real time balancing between demand and supply is done by TSO in the regulating power market.

f) The development of active "demand-side" institutions that allow consumers to react to variations in wholesale market prices and fully integrate demand side responses to energy prices and reliability criteria into wholesale and retail markets.

The development of an active "demand-side" system that allows Estonian consumers to react to electricity prices is still in its early phase. First, thanks to Elspot, Elbas, the regulating power market and the Nasdaq financial market the electricity prices which reflect true price signals are available to all electricity market participants. Second, the data warehouse allows market members to analyze valuable information about electricity consumption patterns which can be used to make better future decisions by taking into account the development of the electricity price. Third, the installment of smart remote meters by 2017 will improve the information about consumption even more and give the users the opportunity to plan their electricity usage by hour. Nevertheless, these steps only give the consumer a chance to plan their future electricity consumption based on historical consumption and expected electricity prices. It is unlikely that without automated price response systems that can react to live movements in electricity prices, consumers will significantly manually adjust their behavior acting upon information about consumption and prices. Joskow (2008) says that in general too little demand response systems have been installed and the current instruments which are poorly integrated with spot markets have the risk of influencing electricity consumption inefficiently. In short, there is a lot of room for improvement in terms of "demand-side" reaction in Estonia but the first steps towards a responsive market have been made.

g) *The application of regulatory rules and supporting network institutions to promote efficient access to the transmission network by wholesale buyers and sellers in order to facilitate efficient competitive production and exchange. This includes mechanisms efficiently to allocate scarce transmission capacity among competing network users, and to provide for efficient siting and interconnection of new generating facilities.*

The transmission network operator, Elering, is responsible for the application of regulations which promote efficient and equal access to the transmission network by wholesale buyers and sellers. The TSO has to secure equal treatment of market participants and provide transparent information to the public. All retail sellers have equal access to the grid and the tariffs for network usage are regulated by the Estonian Competition Authority. The connecting of new generating facilities to the distribution and transmission networks is regulated by the Electricity Market Act and the Grid Code. Based on the legislation network operators have developed conditions for connecting to the grid which are approved by the Competition Authority and are publicly available on network operator's website. The charges for connecting to a network are calculated according to the principles stated in the Grid Code and are based on actually incurred costs (Estonian Competition Authority, 2012). As previously discussed, the cross-border transmission capacity, similar to Nordic countries, is allocated in an implicit auction in the spot market on the power exchange. If the power flows traded between the price areas are higher than the transmission capacity then the area that has an electricity deficit receives a higher price and the area that has a surplus production obtains a lower price which results in new equilibrium quantities. In the end, imbalances will be taken care of by the TSO and settled towards the generators or consumers through balancing agreements. The national transmission capacity in Estonia is sufficient in order to avoid congestions.

h) *The unbundling of retail tariffs to separate prices for retail power supplies and associated customer services to be supplied competitively from the regulated "delivery"* *charges for using distribution and transmission networks that would continue (primarily) to be provided by regulated monopolies.*

Prices for electricity and network services have been separated since 1998. However, the electricity prices initially remained regulated for most consumers. Only in the beginning of 2013 electricity prices for all consumers became non-regulated as the market was fully opened. The tariffs for transmission and distribution network services which are operated by natural monopolies are regulated by the Estonian Competition Authority. Electricity prices are described in more detail in section 3.6.6. The unbundling of retail tariffs is beneficial as it gives the right incentives to market participants: consumers can respond to electricity prices by adjusting their consumption; electricity generators can make investment plans based on the market electricity price in the power exchange; and transmission and distribution network operators are able to invest in new network capacities while still having to keep control over their costs. Most electricity consumers receive one electricity bill with breakdown of different cost components since the biggest distribution network operator Elektrilevi is owned by the biggest electricity retailer Eesti Energia. Other consumers who have chosen a different retailer or are serviced by another distribution network operator receive two separate bills.

i) Where policymakers have determined that retail competition will not be available (e.g. for domestic and small commercial customers), distribution companies or alternative designated suppliers would have the responsibility to supply these customers by purchasing power in competitive wholesale markets or, if they choose, to build their own generating facilities to provide power supplies. However, in the latter case the associated charges for power would be subject to wholesale market-based regulatory benchmarks, primarily competitive procurement processes.

Estonia has gradually introduced retail competition for all customers. First, in July 1999 the Estonian electricity market was opened to consumers whose consumption was larger than 40 GWh/year. Second, in 2009 large consumers (35% of the market) with electricity consumption of more than 2 GWh of electricity per year gained the right to buy electricity from the open market. However, as the regulated tariffs were lower than the market prices they started to use the open market only in 2010 when it became mandatory. In January 2013 the electricity market opened for all consumers.

In order to incentivize participants to switch from universal service to a retail seller in case the customers do not sign a contract with a retail supplier, they receive a universal service bill which is based on the spot price and an additional margin. As a result, in the end of April already 72% of the consumers had a retail contract. Joskow (2008) says that since especially smaller customers are slow to switch to a competitive supplier the country needs to provide in the short run a regulated “default service” to these customers but design the terms and conditions in a way that speeds up the transition (e.g. high margins). Some countries like US, Spain and France have done the opposite and have offered users of universal service some sort of price reductions or other consumer protection benefits. As a result, it has been impossible for retailers to profitably offer their services to attract consumers (Joskow, 2008). Texas in US, on the other hand, set the default service price well above the competitive wholesale price which has resulted in a high percentage of electricity consumers participating in the open retail market (Public Utility Commission of Texas, 2009).

There are also some discussions whether retail competition is beneficial for residential and small customers. Joskow (2008) believes that if a distribution company would purchase power for the consumers by using a portfolio of short term contracts acquired in the competitive wholesale markets, the system could pass along the correct associated costs for the final customers. Green & McDaniel (1998) showed that there are high short term losses (due to supplying domestic customers with precise meters that record hourly electricity consumption, better data management systems, etc.) incurred when a competitive retail market is introduced. In addition, Salies & Waddams (2004) found that in the UK market the customers were not making the best decision in choosing their supplier and some of the retailers abused the passiveness of electricity consumers to their advantage. There is no consensus whether the long run benefits from competition outweigh the short term losses of introducing the open retail market or the other way around. The situation in Estonia is better for retailers thanks to the creation of the data warehouse which stores information about each customer’s electricity consumption. The customers can authorize one or more retailers to access their data which enables the retail sellers to make personalized offers. The database is crucial for enabling real competition in the retail market as it gives the electricity retailers equal opportunities to approach consumers.

j) *The creation of independent regulatory agencies with good information about the costs, service quality and comparative performance of the firms supplying regulated network services, the authority to enforce regulatory requirements, and an expert staff to use this information and authority to regulate effectively the prices charged by distribution and transmission companies and the terms and conditions of access to these networks by wholesale and retail suppliers of power, are also an important but underappreciated component of successful reforms.*

As mentioned in previous sections the electricity sector in Estonia is regulated by the Electricity Market Act which was first adopted in June 2003. An independent government agency, the Estonian Competition Authority is responsible that all regulatory duties and rights of the Act are followed by the electricity market participants. The main areas of responsibilities of the organization are described in section 3.6.5. These include approving tariffs for network services and methodology for connection charges. In order to obtain Competition Authority's approval for network tariffs, network operators need to submit detailed data such as technical data, a profit and loss statement, a balance sheet, investment plans, data about fixed assets and a forecast for expected sales volumes of different network services. Submission of the data is mandatory by the law and the Competition Authority has the right to request any additional information or perform on-site monitoring. In addition, network operators are also obliged to report service quality indicators such as duration of interruptions caused by faults and planned activity. If the network operators fail to comply with service quality requirements, the Competition Authority has the right to impose a fine (Estonian Competition Authority, 2012).

Joskow (2008) argues that a well-designed regulatory framework is important because the share of regulated services in the total electricity bill of the consumer represents a significant fraction of the final price of electricity. In addition, the regulated segment can have a strong influence on the competitive segment of the market because it provides the infrastructure upon which the market relies. Well-functioning regulations have led to better service quality in England, Wales, Brazil, Peru and Argentina. On the other hand, Germany and New Zealand started off at the wrong foot by liberalizing the market without any sector regulator at all (Joskow, 2008).

As the Competition Authority of Estonia is an independent government agency with no political functions and its decisions can be disputed only by the administrative court of Estonia we believe that the agency has enough power and legislative credibility to enforce efficient competition in the electricity sector. However, the risk of political influence has to be considered in a small and young democracy like Estonia.

k) *Transition mechanisms must be put in place to move from the old system to the new system. These mechanisms should be compatible with the development of well-functioning competitive markets.*

Estonia has moved towards a liberal electricity market step by step since the collapse of the Soviet Union. The development has been closely linked with the advancements in the EU energy policy and its energy packages. The transition has been supported by setting clear deadlines about the next phases of the liberalization (e.g. 2009 market opening for large consumers, 2013 opening for all market participants). Although all electricity consumers can now participate in an open market it is still too early to evaluate the results of market deregulation. However, based on the previous points we can see that Estonia has followed the recommended "textbook" model rather closely and the implementation of reforms can be assessed as successful. Despite the strong market concentration in the wholesale market this is an encouraging sign about the development of the Estonian electricity market.

5 Integrating Estonia into the Internal Energy Market of European Union

The three main objectives of the energy policy of the EU are security of supply, competitiveness and sustainability. However, in order to achieve these goals, there has to exist a well-interconnected internal energy market coordinated by the Member States. One of the priorities of EU's Second energy package was to connect "energy islands" with the internal electricity market. Baltic countries, including Estonia, were identified as one of the "islands". The view to integrate Baltic States into the European energy network was endorsed by the president of the European Commission José Barroso who recommended setting up a work group chaired by the European Commission on "Baltic Interconnections" in October 2008 (High Level Group, 2009). In addition to this initiative, in June 2008 ENTSO-E, a group of European electricity transmission operators was established to ensure cross-border cooperation and to develop a ten-year Europe-wide network development plan covering also the Baltics and Estonia (European Feaderation of Local Energy Companies, 2009). In order to integrate Estonia and other Baltic countries into the internal energy market of the European Union it is important to improve the interconnections with other parts of Europe, mainly the Nordics and Eastern Europe, and to create a unified rules for trading electricity which would allow for easy and efficient electricity trading between the Member States.

5.1 Interconnections

5.1.1 Baltic Energy Market Interconnection Plan

The future developments in the physical cross-border infrastructure of the Baltics and Estonia have been described in the Baltic Energy Market Interconnection Plan (BEMIP). BEMIP was created as an initiative of the European Commission. The first meeting of the work group of high level representatives of 8 countries, Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany, and Norway as an observer, took place in November 2008. By June 2009 the action plan for better integration was formulated (High Level Group, 2009). Although the document also takes into account the gas market, we will focus on the parts about the electricity sector.

The demand for interconnections is determined by the electricity generation and power flows. In terms of non-renewable energy production no major changes are expected but the region around the Baltic Sea is a good location for renewables and there are plans to install more than 10 GW of renewable generating capacity by 2020 (European Feaderation of Local Energy Companies, 2009). In addition, Finland is constructing its third nuclear power station, Olkiluoto 3 (start delayed to 2016), with a capacity of 1600 MW (Reuters, 2013) and there are plans of building a nuclear reactor in Lithuania. Thus, BEMIP has tried to take into account future developments in the electricity market to better plan the physical infrastructure of the region. The upcoming interconnectors can be seen in Figure 19. They are vital for the integration of the Baltic States into the European network because currently the only access to Europe that the three Baltic States have is the underwater cable, Estlink 1, with a capacity of 350 MW between Estonia and Finland. The two important future projects concerning Estonia are Estlink 2 and the third interconnector between Estonia and Latvia (High Level Group, 2009). Estlink 2 with a capacity of 650 MW will be the second underwater cable connecting Estonia and Finland. The project with an estimated cost of 320 million euros is expected to be finished in 2014 (Baltic News Service, 2010). The third interconnection with a capacity of 500 MW between Estonia and

Latvia is planned to be built the earliest by 2020. The estimated costs of construction are 67 million euros (High Level Group, 2009).

Figure 19. Baltic Energy Market Interconnection Plan

Source: European Commission, 2013a

In order to connect the whole Baltic region to the Nordics and rest of the Europe there are several other interconnectors planned in BEMIP. Two important projects will connect the Baltics from its most southern country, Lithuania, to Sweden and Poland. The scheduled link between Lithuania and Sweden is called NordBalt. The underwater cable with a length of 400 km and a capacity of 700 MW should be completed in 2016 (European Commission, 2012b). The connection between Lithuania and Poland is named LitPol and its first stage with a capacity of 500 MW is expected to finish in 2015. By 2020 the transmission capacity will be increased to 1000 MW (LitPol link report). To better integrate Nordics with continental Europe there is a project named Kiregers Flak to connect 1600 MW of offshore wind power in the Baltic Sea with

Germany, Sweden and Denmark before 2020, and in addition, to provide new transmission capacity between these countries (Energinet.dk, 2013). Finally, there are several interconnectors planned between Poland and Germany to improve market integration but also to combat loop flows caused by wind generation in the Northern countries (European Commission, 2009).

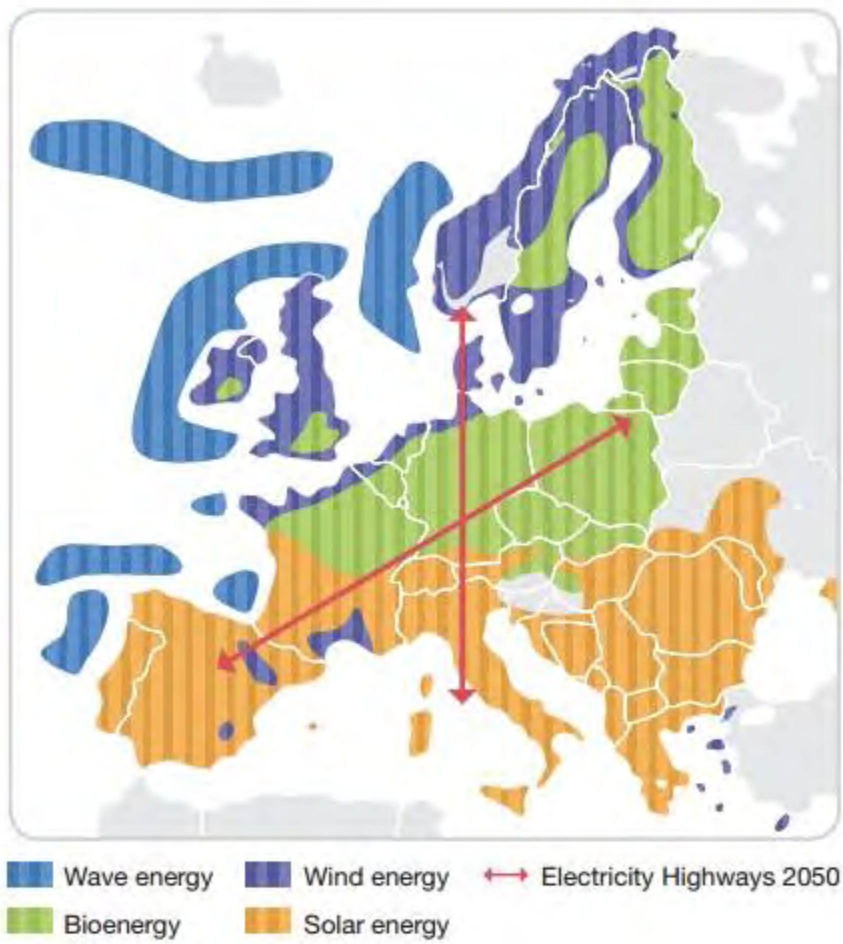
The BEMIP action plan also highlighted the importance of energy efficiency, namely, improving the efficiency of heating systems by renovating combined heat and power units and district heating systems (High Level Group, 2009).

5.1.2 European Network of Transmission System Operators for Electricity

In addition to BEMIP, the integration of the Baltic countries into the European electricity market is coordinated by the European Network of Transmission System Operators for Electricity (ENTSO-E). The organization was created in June 2008 in order to harmonize norms concerning access to European electricity grids, to enable the synchronization of grid operations and, to coordinate and plan investment in the network (European Feaderation of Local Energy Companies, 2009). ENTSO-E united the 6 former regional associations of electricity TSOs: BALTSO (Baltics), ATSOI (Ireland), NORDEL (Nordics), UCTE (continental Europe), UKTSOA (United Kingdom) and ETSO (the predecessor of ENTSO-E) (ENTSO-E, 2013e). The vision of ENTSO-E is to become and stay the focal point of European issues related to TSOs and staying connected with the users, EU institutions, regulators and governments (ENTSO-E, 2013a).

The organization has three integrated plans for different time horizons. The most detailed of them is called the Ten-Year Network Development Plan which delivers a structured vision for European grid development in the next 10 years (ENTSO-E, 2012). The planned interconnectors for the Baltic region in this report correspond to the ones in BEMIP. The program analysing the medium term is named “Visions towards 2030” (ENTSO-E, 2013b). There are no further electricity infrastructure projects planned in the Baltics until 2030 in addition to the ones mentioned already in BEMIP (ENTSO-E, 2013c). The project with the longest time perspective is “e-Highways2050”. The aim is to develop a pan-European transmission network able to serve the needs between 2020 and 2050 (ENTSO-E, 2013d). As the EU wants to increase the share of renewable energy sources in electricity consumption higher than 60% by 2050 (European Commission, 2012c) and complete the internal electricity market integration, the infrastructure needs to be further developed to achieve these objectives. A comprehensive network is needed to facilitate the transport of renewable energies to consumption centres in the middle and West of Europe. In overall, wind energy will be produced around the North Sea, solar energy in Southern Europe and Northern Africa, and electricity from biomass will come from Eastern Europe and Russia. Electricity highways need to be constructed in order to facilitate the necessary power flows and the development of a renewable Europe (e-Highway2050, 2013). The project can be seen more in detail in Figure 20.

Figure 20. Renewable Energy Sources Development by 2050



Source: e-Highway2050, 2013

5.2 Harmonization of Regulations

As important as it is to have sufficient transmission capacities, in order to have a well functioning Internal Electricity Market, it is also essential to have common rules. The European

Union aims to harmonize the regulations for the regional electricity markets by 2014 (Nord Pool Spot, 2013c). In order to facilitate integration of national and regional markets, a group of experts, which included participants from European Commission, regulators, TSOs and representatives of member states, have developed an EU-wide Target Model, which was presented at the Florence Forum in 2009. The topics covered in the Target Model are design of forward, day-ahead, intra-day and balancing markets, capacity calculation and governance. The Target Model will be the blueprint of how the Internal Electricity Market should be organized (The Council of European Energy Regulators). ENTSO-E is currently working on common rules called Network Codes which are based on the Target Model and which will become legally enforceable after the approval by the European Commission. The Agency for Cooperation of Energy Regulators, who is responsible for implementation of this project, has created four cross regional roadmaps which consist of different pilot projects (Agency for Cooperation of Energy Regulators, 2012a).The four roadmaps are the following:

1) Market coupling – The Target Model envisages market coupling as the way to unite different European day-ahead markets. The focus in the roadmap is on implementing the North West Europe (NWE) project which will couple the day-ahead markets in Central Western Europe, the Nordic countries, the Baltic countries, Great Britain and the SwePol link between Sweden and Poland. This means that also Estonia will be a part of the NWE project. The project is expected to be launched in November 2013. Gradually all European day-ahead markets should become a part of a single European price coupling (Agency for Cooperation of Energy Regulators, 2012b).
2) Cross-border intraday – The Target Model for intra-day trade is continuous implicit auction with capacity pricing reflecting congestion, intraday capacity recalculation and possibility to trade sophisticated products. Similar to the market coupling, NWE project, where Estonia is one of the participants, has been chosen as the pilot project to test the interim solution. The project will be launched 2013/2014 (Agency for Cooperation of Energy Regulators, 2012c).
3) Long-term transmission rights – The Target Model aims to give market participants possibility to hedge against congestion costs by having harmonized rules for long-term transmission rights. In order to achieve this, it is necessary to harmonize allocation rules,

allocation platform, nomination procedures, and decide on implementation of physical or financial transmission rights (Agency for Cooperation of Energy Regulators, 2012d).

4) Capacity Calculation – The goal is to have a fully coordinated capacity calculation methodology in all European electricity markets. Two methods have been proposed – available transfer capacity and flow-based method. The latter one is preferred especially in highly interdependent networks (Agency for Cooperation of Energy Regulators, 2012e).

After the Target Model will be implemented, the electricity will theoretically be able to flow freely across the borders of the member states. However, in order to achieve a free trade of electricity practically, it will be crucial to expand the transmission capacities. When both of these things are achieved, Estonia will be able to benefit from the integration in the European internal market through improved effectiveness of the market, security of supply and increased long-term social welfare.

6 Conclusion

After the collapse of the Soviet Union, Estonia inherited a very energy inefficient economy. Energy in the Soviet Union was cheap due to various subsidies and controlled prices, therefore buildings and technologies were designed accordingly. In addition, the centrally planned economy encouraged inefficiency as future resource allocations were based on historical consumption patterns. On the positive side, Estonia was also left with large oil shale power plants and strong grid connections with Russia and Latvia since the electricity sector in Estonia was developed to be able to supply other parts of the empire. Due to the well developed oil shale sector Estonia is one of the least dependent countries on energy imports in the European Union.

In the last two decades the Estonian electricity sector has undergone great transformation. The liberalization process has been mainly driven by the regulations of the European Union. As a member country of European Union, Estonia has a legal obligation to comply with the EU directives. Thus, the development of the electricity market has been strongly influenced by the policies of the European Union especially the three Energy Packages adopted in 1996, 2003 and 2009. Estonia has gradually implemented electricity market deregulation since 1997; in the beginning of 2013 the electricity market was opened for all consumers.

Our analysis shows that Estonia has followed the textbook model rather closely – it has separated competitive segments such as generation and retail supply from natural monopolies such as transmission and distribution networks, established a single system operator, created a wholesale spot market, unbundled electricity tariffs and created independent regulatory agencies. Estonia went even further than most countries and created a central database where all market participants can store and exchange data. The database is crucial for creating real competition in the retail sector as all retail suppliers have equal opportunities to approach consumers. Overall, we conclude that the deregulation process has been successful. However, there remain some concerns about the competitiveness of the generation and wholesale market; the vertically integrated incumbent company Eesti Energia has a market share of 92% and is indirectly subsidized by the government. As long as there will not be sufficient transmission capacities with other European countries, Eesti Energia's market dominance will remain an obstacle to a well-functioning wholesale market.

Despite the positive developments, Estonian electricity market is still largely isolated from the rest of Europe; Estonia together with the other Baltic countries currently has only one interconnector with the other European countries. Consequently, the security of supply has been an important issue for the Estonian government. This has contributed to Eesti Energia's market dominance; in order to keep control of the strategically important oil shale sector, Estonia has not privatized or horizontally separated Eesti Energia. However, in the future Estonia should strive to achieve both competitive energy markets and security of supply at the same time. This can be done by integrating the Estonian electricity market in the common European market. In order for that to happen it is essential to invest in interconnections with other parts of Europe, mainly the Nordics and Eastern Europe. Another measure that is needed for the integration in the European market is harmonization of regulations for trading electricity across the borders of different member states. To sum up, Estonia has achieved remarkable progress in reforming its electricity sector, however there are more challenges yet to overcome.

Works Cited

Agency for Cooperation of Energy Regulators. (2012a). *Cross Regional Roadmaps*. Retrieved from ACER: http://www.acer.europa.eu/Electricity/Regional_initiatives/Cross_Regional_Roadmaps/Pages/Cross-Regional-Roadmaps.aspx

Agency for Cooperation of Energy Regulators. (2012b). *Market Coupling*. Retrieved from ACER: http://www.acer.europa.eu/Electricity/Regional_initiatives/Cross_Regional_Roadmaps/Pages/1.-Market-Coupling.aspx

Agency for Cooperation of Energy Regulators. (2012c). *Cross-Border Intraday*. Retrieved from ACER: http://www.acer.europa.eu/Electricity/Regional_initiatives/Cross_Regional_Roadmaps/Pages/2.-Cross-border-Intraday.aspx

Agency for Cooperation of Energy Regulators. (2012d). *Long-Term Transmission Rights*. Retrieved from ACER: http://www.acer.europa.eu/Electricity/Regional_initiatives/Cross_Regional_Roadmaps/Pages/3.-Long-Term-Transmission-Rights.aspx

Agency for Cooperation of Energy Regulators. (2012e). *Capacity Calculation*. Retrieved from ACER: http://www.acer.europa.eu/Electricity/Regional_initiatives/Cross_Regional_Roadmaps/Pages/Capacity-Calculation.aspx

Alllix, P., Burnham, A., Fowler, T., Herron, M., Kleinberg, R., & Symington, B. (2010). Coaxing Oil from Shale. *Oilfield Review*.

Baltic News Service. (2010). *European Commission endorses Estlink 2 investment*. Retrieved from Estonia.eu: http://estonia.eu/news/150-european-commission-endorses-estlink-2-investment.html

Bartis, J. T., LaTourrette, T., Dixon, L., Peterson, D., & Cecchine, G. (2005). *Oil Shale Development in the United States: Prospects and Policy Issues.* Santa Monica: RAND Corporation.

BritNed Development Limited. (n.d.). *Implicit Auctions*. Retrieved from BritNed: http://www.britned.com/Trading/Implicit%20auctions

Council of the European Union. (2007). Treaty of Lisbon. *Official Journal of the European Union Volume 50*.

Cova, B., & Gregori, L. (2009). *Assessment of the electric markets in the Baltic region.* CESI.

E24.ee. (2013). Euroopa Liidu kütusedirektiiv ohustab põlevkivitööstust .

Eesti Energia. (2013a). *Energeetika ajalugu.* Retrieved May 8, 2013, from Eesti Energia: https://www.energia.ee/c/document_library/get_file?uuid=3cbe8bd1-611e-45a5-b6ed-4f69f69cbee1&groupId=10187

Eesti Energia. (2013b). *Iru elektrijaam.* Retrieved May 8, 2013, from Eesti Energia: https://www.energia.ee/organisatsioon/iru

Eesti Energia. (2013c). *Oil Shale*. Retrieved from Eesti Energia: https://www.energia.ee/en/polevkivi

Eesti Energia. (2013d). *About Us.* Retrieved May 27, 2013, from Enefit Utah: http://enefitutah.com/experience/expertise/

Eesti Energia. (2013e). *Interim Report 1st Quarter 2013.* Tallinn.

Eesti Energia. (2013f). What is in My Bill. Tallinn, Estonia.

Eesti Energia. (2013g, June 1). *Electricity exchange price*. Retrieved from Eesti Energia: https://www.energia.ee/en/elektri-turuhind

Eesti Energia: Põhivõrk. (2007). *Annual Report 2006/2007.* Tallinn: Eesti Energia.

Eesti Päevaleht. (2012). Euroopa Komisjon võib kuulutada Eesti diisliküttuse rämpsuks.

Eesti Rahvusringhääling. (2012, August 17). Remote Electricity Meters to Cost €94 Million.

Eesti Välispoliitika Instituut . (2006). *Eesti Energiajulgeolek Euroopa Liidu Energiapoliitika Kontekstis.*

e-Highway2050. (2013). *Modular Development Plan of the Pan-European Transmission System 2050.* Berlin: Deutsche Energie-Agentur GmbH.

Elektrihind.ee. (2013, June 1). *Paketid*. Retrieved from Elektrihind.ee: http://www.elektrihind.ee/paketid

Elektrilevi. (2013a). *Price for the Network Service*. Retrieved from Elektrilevi: https://www.elektrilevi.ee/en/hind

Elektrilevi. (2013b). *Network fees in Estonia and neighbouring countries*. Retrieved from Elektrilevi: https://www.elektrilevi.ee/en/vorgutasud-naaberriikides

Elering. (2010). *Annual Report 2009.* Tallinn: Elering.

Elering. (2012a). *Annual report 2012.*

Elering. (2012b). *Eesti Elektrisüsteemi Tarbimisnõudluse Rahuldamiseks Vajaliku Tootmisvaru Hinnang.* Tallinn.

Elering. (2012c). *Full opening of the Estonian electricity market.* Tallinn: Elering toimetised.

Elering. (2012d). *Elektrituru Käsiraamat.* Tallinn.

Elering. (2012e). *Renewable Electricity Charges for Consumers*. Retrieved from Elering: http://elering.ee/renewable-energy-charges/

Elering. (2012f). *Elering Tootmispiisavuse Aruanne.* Tallinn.

Elering. (2013a). *Elektrisüsteemi kokkuvõte: 2012.* Retrieved from Elering: http://elering.ee/public/Infokeskus/Kuukokkuvotted/2012/Elektrisusteem_2012aasta_kokkuvote.pdf

Elering. (2013b). *Ülevaatlikud Faktid*. Retrieved from Elering: http://estlink2.elering.ee/ulevaatlikud-faktid/

Elering. (2013c). *Elektrituru kokkuvõte aprill 2013.* Tallinn.

Elering. (2013d). *Elektrisüsteemi kokkuvõte I kvartal 2013.* Tallinn.

Elering. (2013e, May). *Registry of open suppliers.* Retrieved from Elering: http://elering.ee/register-of-open-suppliers/

Elering. (2013f, April). *Share of Contract-Based Electricity Purchases Climbs to 88% in April*. Retrieved from Elering: http://elering.ee/press-center/

Elering. (2013g). *Data Warehouse*. Retrieved from Elering: http://elering.ee/data-warehouse/

Elering. (2013h). *About the Company*. Retrieved from Elering: http://elering.ee/about-the-company-2/

Ellerman, A. D., & Buchner, B. K. (2007). The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results. *Review of Environmental Economics and Policy*, 66-87.

Enefit Utah. (2013). *Oil Shale Resources.* Retrieved May 27, 2013, from Enefit Utah: http://enefitutah.com/wp-content/uploads/2013/03/shaleoil_reserves_big.jpg

Energinet.dk. (2013, May 14). *Grid connection of Kriegers Flak offshore wind farm.* Retrieved June 5, 2013, from Energinet.dk: http://energinet.dk/EN/ANLAEG-OG-PROJEKTER/Anlaegsprojekter-el/Havbaseret-elnet-paa-Kriegers-Flak/Sider/default.aspx

ENTSO-E. (2012). *10-Year Network Development Plan 2012.* Bruxelles: ENTSO-E.

ENTSO-E. (2013a). *Mission and Vision.* Retrieved June 5, 2013, from ENTSO-E: https://www.entsoe.eu/about-entso-e/mission-and-vision

ENTSO-E. (2013b). *Annual Report 2012.* Bruxelles: ENTSO-E.

ENTSO-E. (2013c). *Scenario Oultook and Adequacy Forecast 2013-2030.* Bruxelles: ENTSO-E.

ENTSO-E. (2013d). *The E-Highway2050 Project.* Retrieved June 6, 2013, from ENTSO-E: https://www.entsoe.eu/major-projects/the-e-highway2050-project/

ENTSO-E. (2013e). *Following a Proud History.* Retrieved June 5, 2013, from ENTSO-E: https://www.entsoe.eu/about-entso-e/a-proud-history/

Estonia Competition Authority. (2009, April 4). Retrieved from Eesti Elektroenergeetika Selts: http://www.eees.ee/FAILID/PDFid/22.04.09/Elektrituru%20avanemisest-22.04.09.pdf

Estonian Competition Authority. (2012). *Estonian Electricity and Gas Market Report 2011.* Tallinn.

Estonian Competition Authority. (2013). *Põlevkivisektori konkurentsiolukorra analüüs.* Tallinn: Estonian Competition Authority.

Estonian Government. (2011). *National Reform Programme "Estonia 2020".* Tallinn.

Estonian Ministry of Foreign Affairs. (2009). *Estonia's Way into the European Union.* Tallinn.

Estonian Ministry of Foreign Affairs. (2013). *Estonia and the European Union: Association Agreement.* Retrieved May 8, 2013, from Estonian Ministry of Foreign Affairs: http://www.vm.ee/?q=en/node/8482

Estonian Wind Power Association. (2013). *Installed Capacity.* Retrieved May 8, 2013, from Estonian Wind Power Association: http://www.tuuleenergia.ee/en/windpower-101/statistics-of-estonia/installed-capacity/

European Academies Science Advisory Council. (2007). *A study on the EU oil shale industry – viewed in the light of the Estonian experience* .

European Commission. (2009, June 17). *The Baltic Sea Region States reach agreement on the Baltic Energy Market Interconnection Plan.* Retrieved June 5, 2013, from Europa: http://europa.eu/rapid/press-release_IP-09-945_en.htm

European Commission. (2012a). *Electricity.* Retrieved May 15, 2013, from European Commission: http://ec.europa.eu/competition/sectors/energy/electricity/electricity_en.html

European Commission. (2012b). *Electricity interconnection: Sweden - Lithuania (Nordbalt-01).* Bruxelles: European Commission.

European Commission. (2012c). *Energy Roadmap 2050.* Luxembourg: Publications Office of the European Union.

European Commission. (2012d). *Energy Markets in the European Union in 2011.* Bruxelles: Publications Office of the European Union.

European Commission. (2013a). *Baltic Energy Market Interconnection Plan.* Retrieved June 5, 2013, from European Commission: http://ec.europa.eu/energy/infrastructure/bemip_en.htm

European Commission. (2013b, January 4). *The EU Emissions Trading System (EU ETS)*. Retrieved from European Commission: http://ec.europa.eu/clima/policies/ets/index_en.htm

European Environment Agency. (2006). *How much bioenergy can Europe produce without harming the environment?* Office for Official Publications of the European Communities.

European Feaderation of Local Energy Companies. (2009). *2008 Annual Report.* Bruxelles: European Feaderation of Local Energy Companies.

European Parliament. (1997). Directive 96/92/EC of the European Parliament and of the Council. *Official Journal of the European Communities No L 27/20*.

European Parliament. (2003). Directive 2003/54/EC of the European Parliament and of the Council. *Official Journal of the European Union L 176/37*.

European Parliament. (2009). Directive 2009/72/EC of the European Parliament and the Council. *Official Journal of the European Union L 211/55*.

Gasum. (2011). *Balticconector Executive Summary.*

Goldberg, S. (2010). *European Energy Review 2010: Special Edition on the EU Third Energy and Climate Change Packages.* Herbert Smith.

Green, R., & McDaniel, T. (1998). *Competition in Electricity Supply: Will "1998" be worth it?* Berkley: University of California Energy Institute.

Hamburg, A. (2007, April 2007). Estonian National Energy Strategy. *Oil Shale Vol.24*, pp. 332-336.

Hamburg, A. (2010). *Analysis of Energy Development Perspectives.* Tallinn: Tallinn University of Technology.

High Level Group. (2009). *Baltic Energy Market Interconnection Plan.* European Commission.

Imatra Elekter. (2012). *Electric Energy Price List on voltage 0.4 (0.23) kV*. Retrieved from Imatra Elekter: http://www.imatraelekter.ee/index.php?page=258&

INFORSE-Europe. (2011). *Sustainable Energy Vision for Estonia.* Retrieved from INFORSE-Europe: http://www.inforse.org/europe/pdfs/Estonia-note.pdf

International Energy Agency. (2012). *Energy Balances of non-OECD Countries 2012.* Paris: International Energy Agency.

Joskow, P. L. (2008). Lessons Learned From Electricity Market Liberalization. *The Energy Journal*, 9-42.

Kala, K. (1974). *Eesti NSV Elektrifitseerimise ajalugu.* Tallinn: Valgus.

Karnau, A. (2013, April 9). Kallas tõstis taas teemaks Eesti Energia tükeldamise. *Äripäev*.

Kleesmaa, J. (2010). Impact of CO2 Trade on Electricity Producers Depending on the Use of Different Energy Sources in Estonia. *Discussions on Estonian economic policy: Theory and practice of economic policy*.

Koel, M. (1999). Estonian Oil Shale. *Oil Shale*.

Laar, M. (2007, August 7). The Estonian Economic Miracle. *Backgrounder*.

Ministry of Economic Affairs and Communications. (2001). *Eesti Energeetika 1991-2000.* Tallinn: Ministry of Economic Affairs and Communications.

Ministry of Economic Affairs and Communications. (2008). *Estonian Energy in Figures 2007.* Tallinn: Ministry of Economic Affairs and Communication.

Ministry of Economic Affairs and Communications. (2011). *Mid-term Overview of Implementation of Energy Efficiency Plan 2007–2013 and Further implementation.* Tallinn.

Ministry of Economic Affairs and Communications. (2013a). *Elektrituru Avanemine 2013*. Retrieved from Avatud 2013: http://avatud2013.ee/

Ministry of Economic Affairs and Communications. (2013b). *Elektrileping on olemas 65 protsendil tarbimiskohtadest*. Retrieved from Avatud 2013: http://avatud2013.ee/elektrileping-on-olemas-65-protsendil-tarbimiskohtadest/

Müller, A., & Ojakivi, M. (2013, April 9). Ligi: Eesti Energia tükeldamine läheks kulukaks. *Estonian Public Broadcasting*.

N2EX. (2013). *Organisation physical market*. Retrieved from N2EX: https://www.n2ex.com/aboutn2ex/Physical_market/

Narva City Council. (2008). *Narva linna energiamajanduse arengukava 2009-2015.* Narva: Narva City Council.

Nasdaq OMX Oslo. (2012). *Trade at NASDAQ OMX Commodities Europe's Financial Market.*

Newbery, D. M. (1998). *Freer Electricity Markets in the UK: A Progress Report.* Cambridge: Department of Applied Economics.

Nord Pool Spot. (2011). *Nord Pool Spot presentation.*

Nord Pool Spot. (2013a). *Intraday market*. Retrieved from Nord Pool Spot: http://www.nordpoolspot.com/How-does-it-work/Intraday-market-Elbas/

Nord Pool Spot. (2013b). *Trading and services*. Retrieved from Nord Pool Spot: http://www.nordpoolspot.com/TAS/

Nord Pool Spot. (2013c). *European Integration - Overview*. Retrieved from Nord Pool Spot: http://www.nordpoolspot.com/How-does-it-work/European-Integration/

Ots, A. (1990). *Eesti Energeetika arengu üldpõhimõtted aastani 2030.* Tallinn: MM IK rotaprint.

Paist, A., Parve, T., Kask, Ü., Nuutre, M., Loosaar, J., Veski, A., & Pertmann, I. (2007). Biokütuste ja Tuuleenergia Alastest Uuringutest Tallinna Tehnikaülikoolis. In H.-L. Help, S. Jakobson, & G. Varlamova, *Teadusmõte Eestis: Tehnikateadused* (pp. 113-120). Tallinn: Eesti Teaduste Akadeemia Kirjastus. Retrieved from Fyysika.ee.

Parliament of Estonia. (1998). The Energy Act. *Riigi Teataja*.

Parliament of Estonia. (2003). *Electricity Market Act.* Retrieved May 15, 2013, from Estonian Competition Authority: http://www.konkurentsiamet.ee/?id=19475

Parliament of Estonia. (2012). *Kütuse- ja energiamajanduse pikaajaline riiklik arengukava aastani 2015 (visiooniga 2030).* Tallinn.

Põhivõrk. (2007). *Aruanne Eesti elektrisüsteemi tootmisseadmete piisavusest .* Tallinn.

Põldroos, J. (2010, July 26-27). Estonian Experience Regarding Competition Law, Policy and Institutions: Some Implications for African Small States. Windhoek, Namibia.

Public Utilities Commission of Latvia; Estonian Competition Authority; Lithuanian National Control Commission for Prices and Energy. (2011, November). *Work Plan 2011- 2014.* Retrieved from Agency for the Cooperation of Energy Regulators:

http://www.acer.europa.eu/Electricity/Regional_initiatives/Pages/Work-Programmes-2011-2014.aspx

Public Utility Commission of Texas. (2009). *Report to the 81st Texas Legislature: Scope of Competition in Electric Markets in Texas.* Austin: Public Utility Commission of Texas.

Rand, R. (n.d.). *Eesti elektrifitseerimine kuni 1945. aastani.* Tallinn.

Reuters. (2013, February 11). *Finland's Olkiluoto 3 reactor seen delayed to 2016.* Retrieved June 6, 2013, from Reuters: http://www.reuters.com/article/2013/02/11/teollisuudenvoima-olkiluoto-idUSL5N0BBEZ520130211

Riigikogu. (2012, June 28). Elektrituruseadus. Tallinn, Estonia.

Salies, E., & Waddams, C. (2004). Charges, Costs and Market Power: the Deregulated UK Electricity Retail Market. *The Energy Journal Vol. 25, No. 3*, 19-35.

Soosaar, S., Vares, V., Laur, A., & Tenno, K. (2007). *Eesti Energeetika Arengujooni - 2005.* Tallinn: Tallinn University of Technology.

Statistics Estonia. (2008). *Volume Index of Industrial Productionby Economic Activity.* Retrieved May 8, 2013, from Statistics Estonia: http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=TO05&ti=T%D6%D6STUSTOODANGU+MAHUINDEKS+TEGEVUSALA+%28EMTAK+2003%29+J%C4RGI%2C+1995+%3D+100+%281992%2D2007%29&path=../Database/Majandus/24Toostus/04Toostustoodanguindeksid/02Aastastatistika/&lang=2

Statistics Estonia. (2012). *Taastuvate energiaallikate kasutuselevõtt on oluliselt vähendanud põlevkivi osatähtsust elektritootmises*. Retrieved from Statistics Estonia: http://www.stat.ee/57641

Statistics Estonia. (2013a). *Energy Balance Sheet.* Retrieved May 8, 2013, from Statistics Estonia: http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=FE02&ti=ENERGY+BALANCE+SHEET&path=../I_Databas/Economy/07Energy/02Energy_consumption_and_production/01Annual_statistics/&lang=1

Statistics Estonia. (2013b). *Heat Balance Sheet.* Retrieved May 8, 2013, from Statistics Estonia: http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=FE04&ti=HEAT+BALANCE+SHEET&path=../I_Databas/Economy/07Energy/02Energy_consumption_and_production/01Annual_statistics/&lang=1

Statistics Estonia. (2013c). *Electricity Balance Sheet.* Retrieved May 8, 2013, from Statistics Estonia: http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=FE03&ti=ELECTRICITY+BALANCE+SHEET&path=../I_Databas/Economy/07Energy/02Energy_consumption_and_production/01Annual_statistics/&lang=1

Statistics Estonia. (2013d). *Energy Balance Sheet by Type of Fuel or Energy, Terajoules.* Retrieved from Statistics Estonia: http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=FE024&ti=ENERGY+BALANCE+SHEET+BY+TYPE+OF+FUEL+OR+ENERGY%2C+TERAJOULES&path=../I_Databas/Economy/07Energy/02Energy_consumption_and_production/01Annual_statistics/&lang=1

The Council of European Energy Regulators. (n.d.). *Project Coordination Group (PCG)* . Retrieved from European Energy Regulators: http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_WORKSHOP/Stakeholder%20Fora/Florence%20Fora/PCG

The NASDAQ OMX Group. (2013a). *Product Specifications*. Retrieved from Nasdaq OMX: http://www.nasdaqomx.com/commodities/markets/products/

The NASDAQ OMX Group. (2013b). *Carbon*. Retrieved from NASDAQ OMX: http://www.nasdaqomx.com/commodities/markets/products/carbon/

U.S. Department of Justice. (2013). *Herfindahl–Hirschman Index*. Retrieved from The United States Department of Justice: http://www.justice.gov/atr/public/guidelines/hhi.html

Union of the Electricity Industry. (2002). *Electricity Sector Reform in the Candidate Countries, Balkan Countries and the Russian Federation.* Bruxelles: EURELECTRIC publications catalogue.

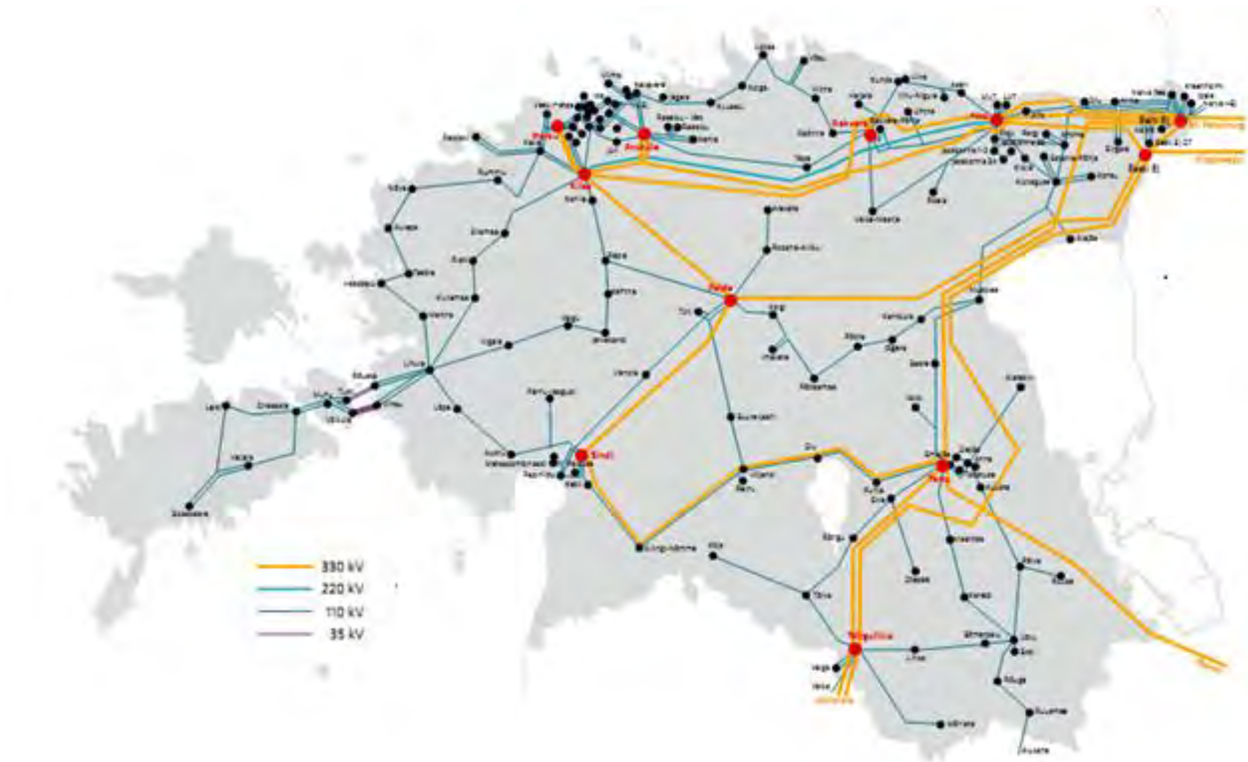
Union of the Electricity Industry. (2011). *Customer-Centric Retail Markets: A Future-Proof Market Design.* Brussels.

Ürge-Vorsatz, D., Miladinova, G., & Paizs, L. (2006). Energy in transition: From the iron curtain to the European Union. *Energy Policy 34*, 2279–2297.

Vilemas, J. (2010). *Energy Policy of Lithuania in 1990-2010 and Projections for the Future.* International Association for Energy Economics.

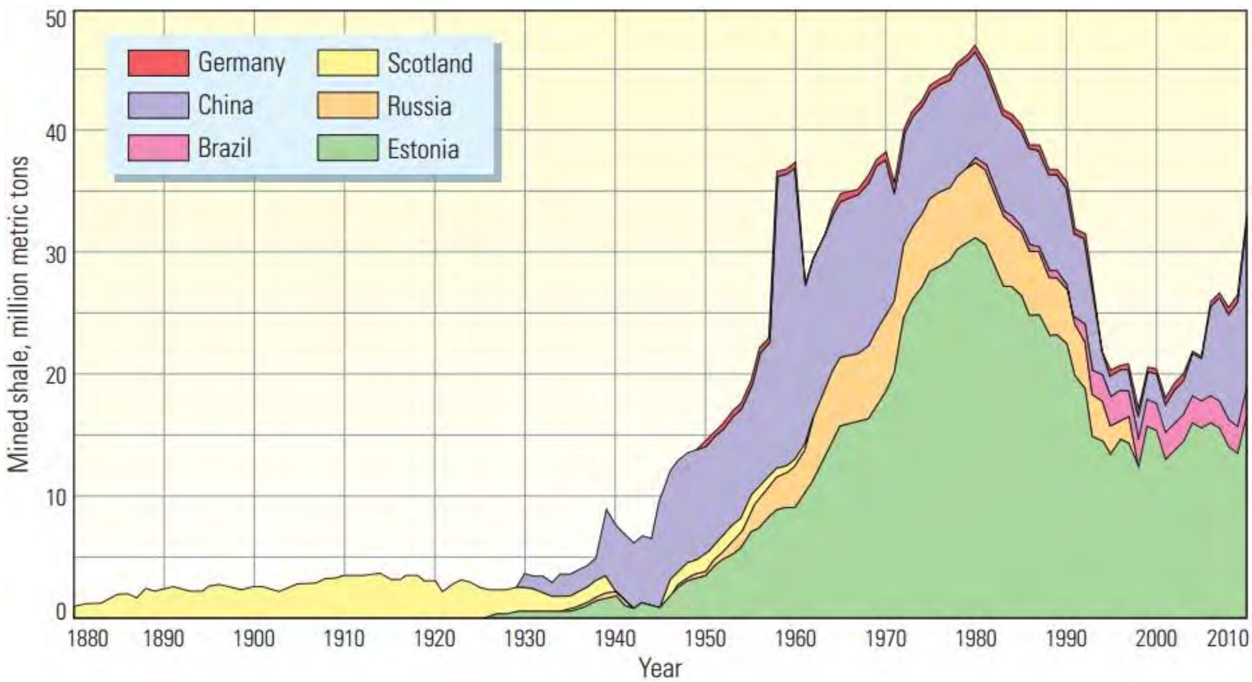
World Energy. (2013). *Estonian Member Committee*. Retrieved May 8, 2013, from World Energy: http://www.worldenergy.org/wec-network/member-committees/estonia/

Appendix 1. Map of Estonian Electricity Grid



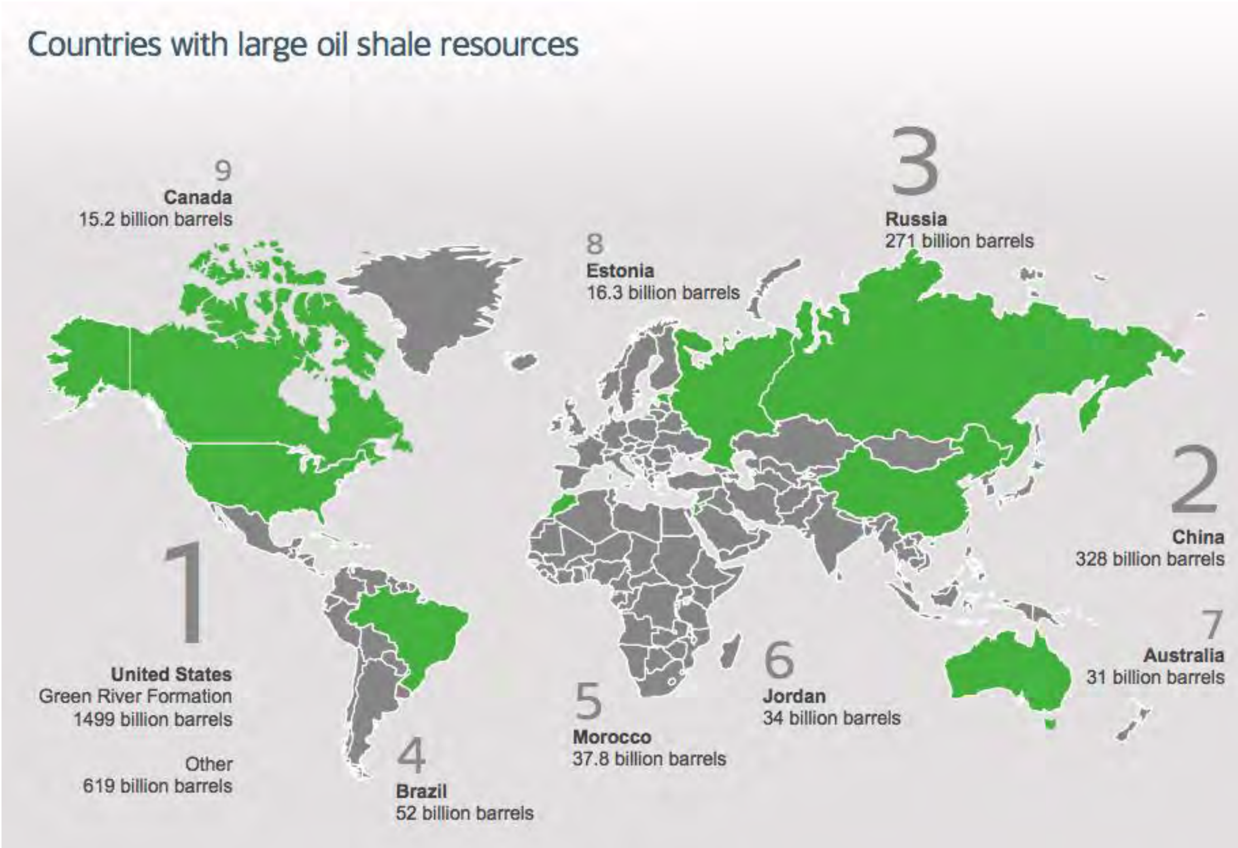
Source: Elering, 2012f

Appendix 2. World Oil Shale Mining



Source: Alllix, et al., 2010

Appendix 3. World Oil Shale Reserves



Source: Enefit Utah, 2013