THE ESTONIAN ENERGY SECTOR IN COMPARISON TO OTHER COUNTRIES

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The Estonian energy sector has undergone several significant changes in the past few years. The following article represents an effort to collect the most essential international reference data on the energy sector and assess Estonia's position with regard to these indicators. Moreover, we look into what each indicator actually reflects and have tried to disclose the factors affecting these indicators, and what one or another indicator shows about a country's energy sector. In addition, the trends of different indicators in Estonia have been analysed. The following text is based on the statistics compiled by the International Energy Agency and Eurostat for 2004 and 2005 and on the most recent data provided by Statistics Estonia.

CURRENT SITUATION OF ENERGY SECURITY IN EUROPE

Energy dependency is the share of imported sources of energy in a country's energy balance. Estonia is, in that respect, one of the most independent countries among the member states of the European Union, having ranked 5th with a share of 28.5% in 2004 (see Figure 1). Estonia imports natural gas and liquid fuels, and exports wood fuel and shale oil.

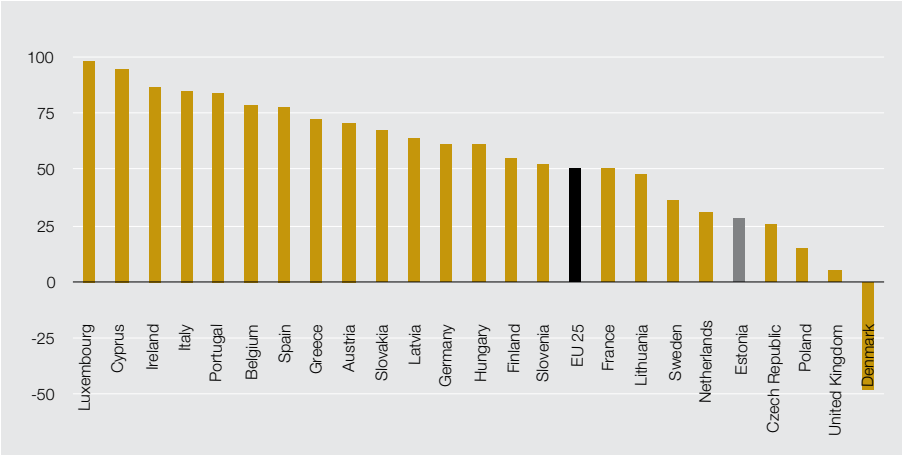

Figure 1. Energy dependency of EU member states in 2004 (%)

The European Union as a whole depends on imported sources of energy for nearly 50 per cent of its needs, and the trend is on the rise. Estonia is one of the few member states whose energy dependency has been decreasing year after year.

However, energy dependency does not reflect the balance of the member states' electricity imports and exports. In Estonia, the exports of electricity in 2005 accounted for approximately one-fifth of the electricity used, thus ranking third among the EU member states after Lithuania and

Bulgaria (see Figure 2). This fact also considerably affects other indicators discussed below as, among others, a large amount of oil shale was used to generate that electricity. This increases Estonia's need for primary energy, whereas this energy is not actually used in Estonia.

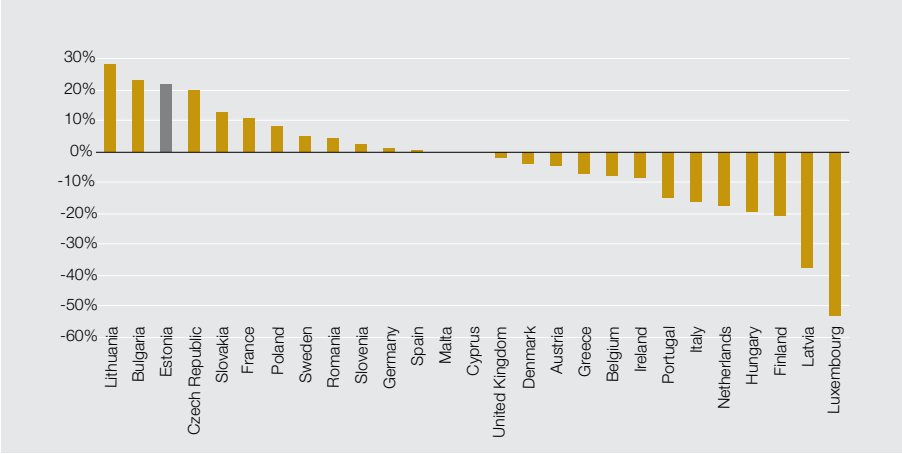

Figure 2. The share of electricity imports and exports in electricity consumption in the EU member states in 2005

Regarding **natural gas**, Estonia is one-hundred per cent dependent on imports from Russia. Meanwhile, natural gas accounts for less than fifteen per cent of Estonia's energy balance. Compared to other EU member states, this indicator is relatively low (see Figure 3). Natural gas plays an important role in Estonia's heating market with a share of more than 40%, but for the most part it is replaceable with liquid fuels: major boiler plants and power stations that use natural gas can operate on light fuel oil, shale oil or heavy fuel oil as an alternative. Pursuant to the District Heating Act, as of July 2008, all major Estonian heat producers are required to ensure the possibility of using reserve fuel to guarantee the supply of heat for three twenty-four hour periods.

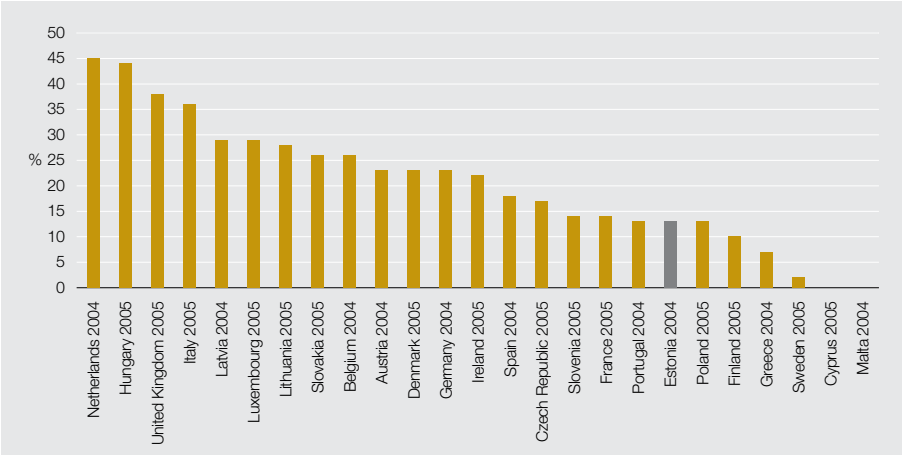

Figure 3. The share of natural gas in the energy balance of EU member states

Estonia's **technical links with its neighbouring countries** are extremely strong. Considering Estonia's electricity and gas consumption, the capacity of the links significantly exceeds maximum demand. In the case of electricity, maximum consumption stands at approximately 1,550 MW while the total capacity of the links is over 2,300 MW. As regards natural gas, maximum consumption stands at 6,700 nm3 per day while the daily capacity of the links is 15,000 nm3. Such a high level of connectivity is rare in the world; as for electricity, such a level exists only in Latvia, Lithuania and Switzerland. However, we should also mention that in the case of natural gas, the capacity of the links is technically not fully applicable due to internal network restrictions in neighbouring countries.

Estonia's transitional period for setting up **liquid fuel stocks** ends in 2010. Currently, over half of these stocks have been established. The Estonian Oil Stockpiling Agency, which was set up to establish and maintain the stocks, has guaranteed the successful implementation of the plans.

THE SITUATION OF THE ENERGY SECTOR IN ESTONIA

In comparisons of the energy sectors of different countries, the **energy intensity of the gross domestic product** (GDP) is frequently used. This indicator shows the volume of energy consumption in an economy; i.e., how much primary energy (energy contained in all utilised energy sources) is used per unit of GDP (measured in monetary terms) over the course of one year.

It is often thought that this indicator reflects the efficiency or inefficiency of the energy sector. The indicator is actually largely affected by the structure of the economy (in particular, the share of energy intensive industry in the economy), the ratio of imports and exports of energy carriers (countries that extract and export energy sources usually have higher energy intensity, whereas the indicator is lower in countries that import energy sources), the basis for GDP calculation (current or constant prices, purchasing power parity, etc.), changes in the currency exchange rate applied during the reference period (e.g., changes in the dollar and euro exchange rates across years), the climate (in colder climates the amount of fuel used tends to be greater), etc. Therefore, it is not really possible to use the energy intensity of GDP indicator as a tool to measure the efficiency of the energy sector in different countries. Nevertheless, it does allow for the assessment of the energy intensity of an economy.

According to the International Energy Agency (which comprises 137 countries), in 2005 the energy intensity of Estonia's GDP at the constant prices of 2000 stood at 458 toe[1]/USD (see Figure 4). With this indicator, Estonia rose from the 66th to the 59th position in a year among reference countries. Among the EU member states, Estonia ranked 20th, having passed Poland and Hungary in a year. Globally, Hong Kong took the lead (90 toe/USD) while Congo was the last (3,380 toe/USD). According to the preliminary data for 2006, Estonia's energy intensity at the constant prices of 2000 had fallen to 398 toe/USD. This should raise Estonia's position by a few notches, past Latvia among the EU countries.

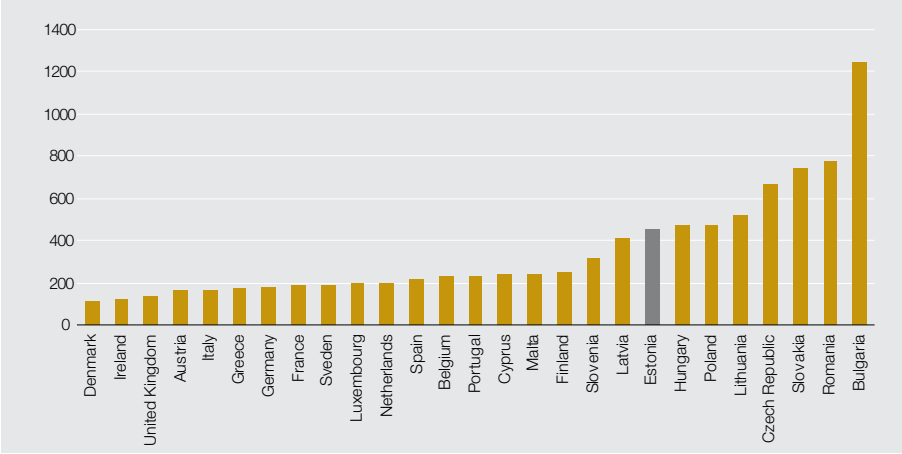

Figure 4. The energy intensity of GDP in EU member states in 2005 (toe/GDP; USD 2,000)

[1] Toe = tons of oil equivalent. (*Edit.*)

In terms of purchasing power parity, Estonia shared the 76th position in the world as regards the energy intensity of GDP, while ranking 24th among the EU member states (see Figure 5). The top position was occupied by Hong Kong, with Iraq being the last on the list. Within the EU, Estonia leaves behind the Czech Republic, Slovakia and Bulgaria and stands on par with Finland. With the 2006 indicators, Estonia should also exceed Finland.

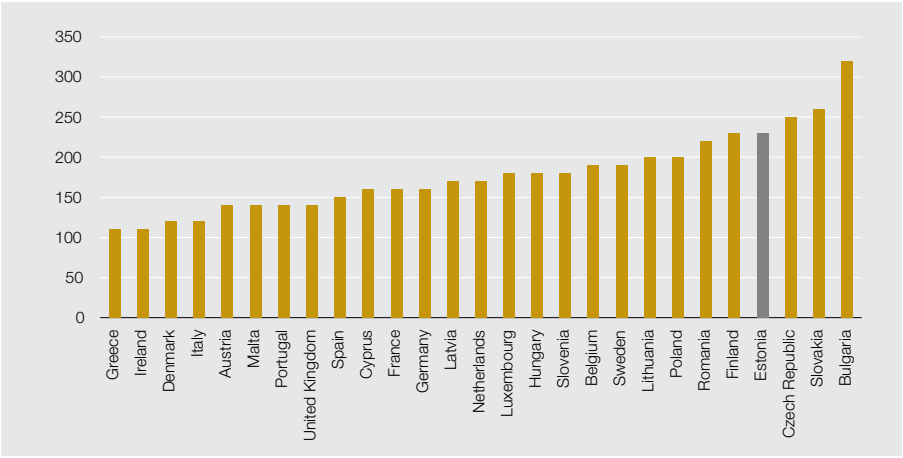

Figure 5. The energy intensity of GDP based on purchasing power parity in the EU member states in 2005 (toe/GDP; USD 2,000)

Several sources have largely overestimated Estonia's energy intensity of GDP, which is why Estonia has clearly occupied the last position in quite a few EU-25 rankings. The underlying reason for this is the revision of GDP calculation methods by Statistics Estonia in September 2006. Consequently, Estonia's GDP indicators from 2000 have been significantly adjusted. As a result, Estonia's GDP has increased considerably, which has also greatly improved the figures of the energy intensity of GDP. This adjustment has not yet been reflected in international databases.

In the case of Estonia, it is also possible to analyse the impact that the factors affecting the energy intensity of GDP have on that indicator. Estonia exports approximately 20% of the electricity produced from oil shale and nearly 80% of the shale oil produced from oil shale. Since the added value of energy products is fairly modest compared to other industries, the exports of energy products contribute relatively little to GDP while being quite energy intensive (nearly a quarter of the oil shale goes to exports). Thus, in comparison to other countries, the exports of energy products should be eliminated from Estonia's total primary energy consumption, which would reduce the total primary energy supply by nearly 10%. Similarly, the exports of these energy products should be subtracted from the GDP; the impact thereof is less than 1%.

The basis for calculating GDP plays an important role too. The following table presents Estonia's energy intensity indicators on the basis of different international indicators:

	2000	2001	2002	2003	2004	2005	2006
TPES/GDP (toe / USD 2,000)	811	815	692	597	516	458	398
TPES/GDP PPP (toe / USD 2,000)	324	312	277	281	261	233	209
TPES/GDP in current prices (toe/€)	747	693	597	603	562	467	383
TPES/GDP (toe/€2,000)	747	729	652	674	641	569	495
TPES/GDP PPP (toe/€2000)	298	280	261	317	324	290	260

TPES – Total Primary Energy Supply
GDP – Gross Domestic Product
PPP – Purchasing Power Parity

The abovementioned table also clearly demonstrates the impact of different currencies on energy intensity indicators. The indicators reflected in USD show a more impressive improvement in efficiency for Estonia owing to the significant decline in dollar exchange rates in recent years.

Considering the trend of the energy intensity of GDP, it can be clearly seen that Estonia's indicator has been growing rapidly, particularly in recent years (see Figure 6). Here, another globally unique trend can be detected: namely, Estonia's primary energy consumption has declined despite its rapid economic expansion (see Figure 7).

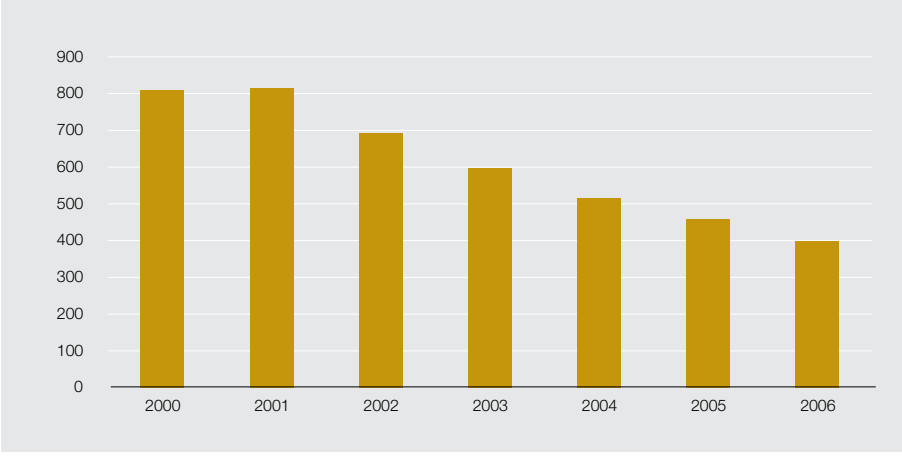

Figure 6. The energy intensity of GDP in Estonia (USD 2,000)

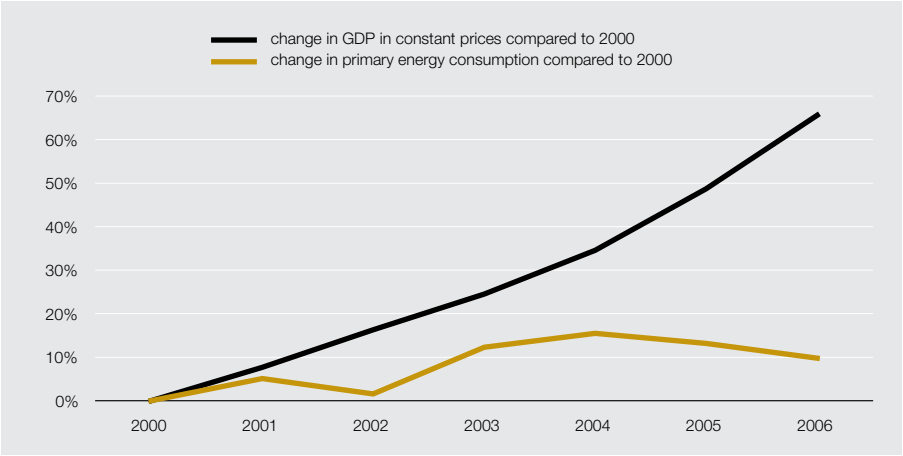

Figure 7. GDP changes in constant prices and primary energy consumption in Estonia

Analysing the reasons underlying the trend indicates that the consumption of heating energy has declined considerably in Estonia in recent years, and so has the losses of energy in power and heat networks. Thus, the investment channelled into the renovation of houses and construction of new heat-proof houses, and in particular, investment in the renovation of heat networks, has significantly reduced the total demand for energy. Energy consumption has grown quite modestly and has largely depended on the emergence of new energy intensive industries. Lower electricity exports have also had an impact and will most probably turn the primary energy consumption trend upwards again along with the completion of the Estlink submarine cable at the beginning of 2007.

Energy demand per capita is the ratio of the total consumption of primary energy to the number of residents. Based on this indicator, a country's prosperity in terms of energy supply is estimated. In comparison to other countries, this indicator is also affected by the same factors that distort the general national level of primary energy consumption and that are not so much related to people's relative welfare (e.g., the share of energy intensive industry in GDP, the imports and exports of energy carriers, climate, etc.). Still, a certain regularity can be seen here: countries with higher living standards are quite on top of the list in this respect, whereas less advanced countries lag behind.

Regarding energy demand per capita, Estonia held the 32nd position with 3.79 toe/cap[2] in 2005 among the countries analysed by the International Energy Agency (see Figure 8), staying at the same position as last year. The top three were Qatar (19.47 toe/cap, owing to oil products exports), Iceland (12.25 toe/cap, owing to an energy intensive metal industry) and Bahrain (11.18 toe/cap). The last three among the reference group were Senegal, Eritrea and Bangladesh (0.26, 0.18 and 0.17 toe/cap, respectively).

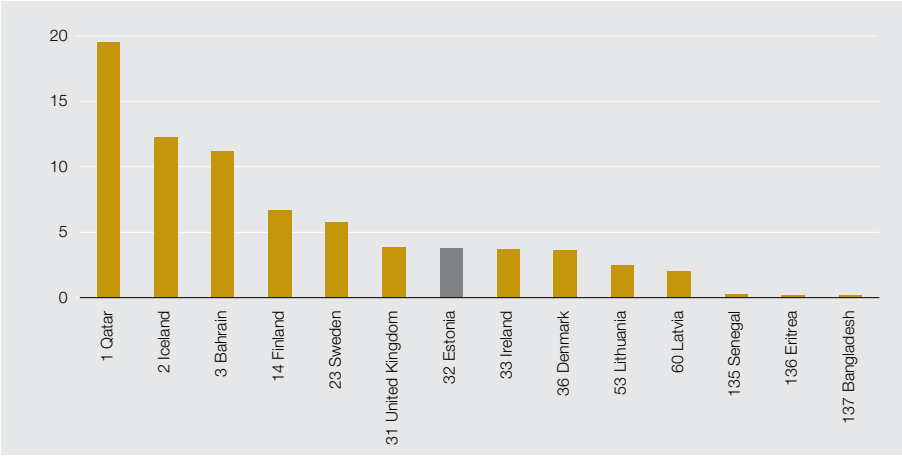

Figure 8. Primary energy consumption per capita in selected countries in 2005

Electricity demand per capita is calculated by dividing the sum of final electricity consumption and energy dissipation by the number of residents. The level of electricity consumption per capita also illustrates, to a certain degree, a country's living standards, but it is also affected by the share of large industries in a country's electricity consumption, climatic conditions and other factors.

In terms of this indicator, Estonia holds the 36th position in the world with 5,568 kWh per capita according to the 2005 data (see Figure 9). The top five are the Nordic countries, where the need for electricity is relatively high owing to climatic conditions, but where energy intensive industries also contribute significantly. The last on the list are tropical countries with low living standards, where the supply of electricity is not widespread.

[2] Toe/cap (toe per capita) = consumption of primary energy per capita. (*Edit.*)

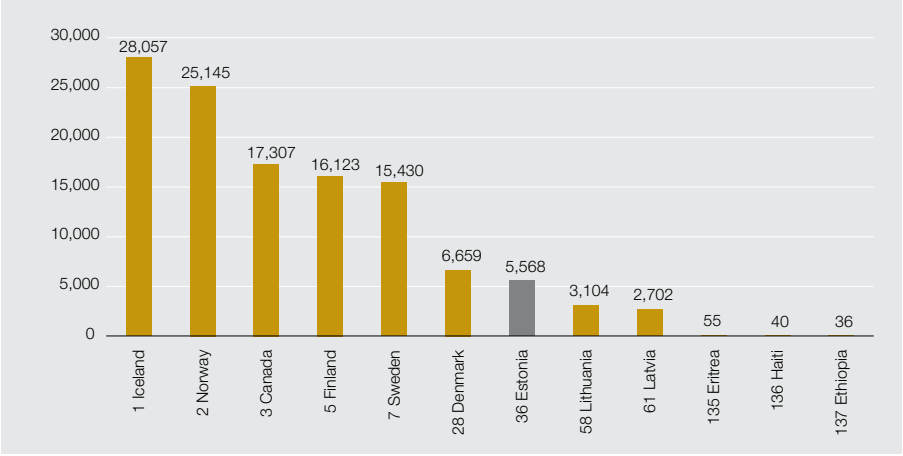

Figure 9. Electricity consumption per capita in selected countries in 2005

Carbon dioxide (CO2) emissions per capita largely show the pollution intensity of a country's energy sector, since the majority of a country's CO2 emissions is related to energy equipment and production.

Owing to the carbon dioxide intensive use of oil shale, electricity exports and its cold climate, Estonia is one of the countries that is worst off in the world regarding CO2 emissions, ranking 125th (see Figure 10). This indicator again reflects the trend that the biggest CO2 emitting countries are those who export energy sources, are located in a cold climate, or have energy intensive industries.

Estonia's indicators are also slightly distorted by one technical aspect: the flue gases emitted during the combustion of oil shale contains CO2, whereas the oil shale ash deposited in the ash-disposal areas binds around 2% of that CO2. However, the impact of this aspect on statistics is marginal.

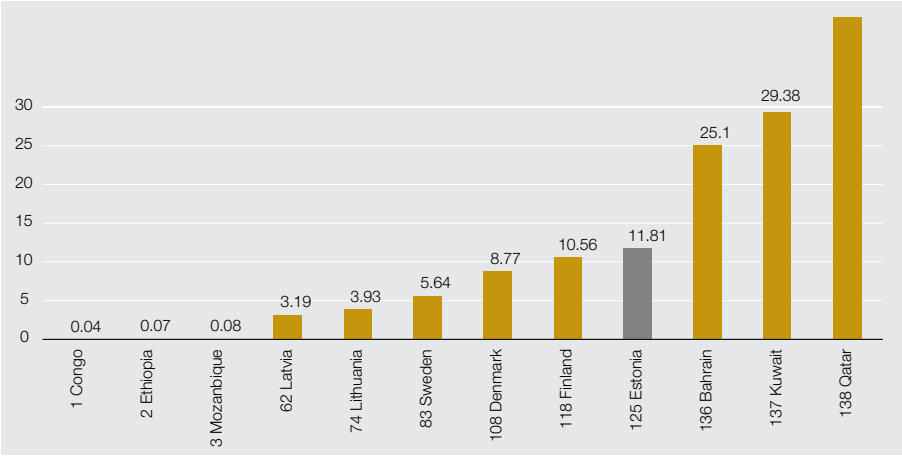

Figure 10. CO2 emissions per capita in selected countries in 2005

The CO2 intensity of the energy sector is calculated by dividing CO2 emissions by the volume of primary energy. Estonia's energy sector is one of the most CO2 intensive among the EU member states (see Figure 11). In 2004, only Poland emitted more CO2 emissions per energy unit. However, this indicator has considerably improved in Estonia in recent years after the implementation of new technology in oil shale-fired power plants and the wider use of renewable energy sources.

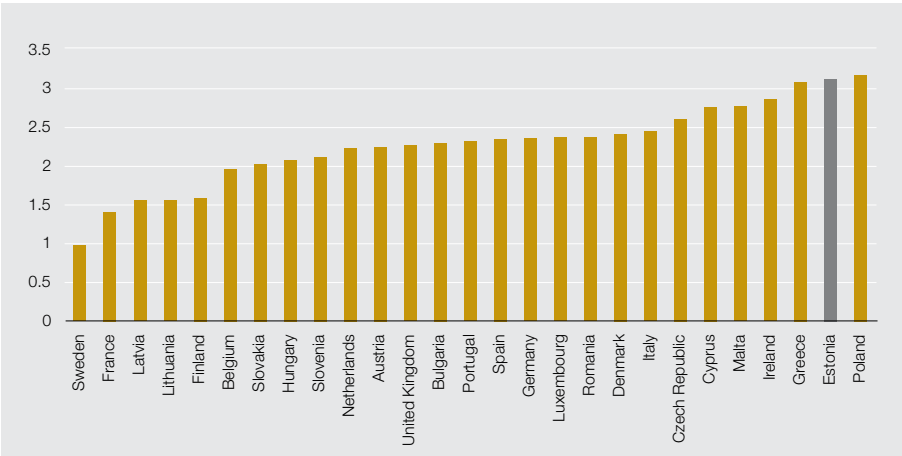

Figure 11. CO2 emissions per primary energy unit of consumption in the EU member states in 2005

For the sake of data comparability, the countries' climatic conditions, the ratio of imports to exports of energy sources and the structure of energy sources used should also be taken into consideration. In that respect, the best-performing countries are those that generate nuclear energy (Sweden, Lithuania, France, and Finland), have large hydroelectric resources (Sweden and Latvia) or import electricity (Latvia and Finland). All of the above cases do not entail the emission of CO2 in meeting the demand for electricity.

THE SHARE OF RENEWABLE ENERGY SOURCES

It might come as a surprise to many that the share of renewable energy sources in Estonia's energy balance is rather high (see Figure 12). The method for calculating this share is important here as well: namely, whether it is calculated as a percentage of primary energy or final energy consumption, or based on other energy statistics. The outcome is very diverse for Estonia, depending on the percentage of energy spent on its own use in oil shale-fired power plants and the percentage of exported energy. The share of renewable energy sources in Estonia's final consumption reached over 25% in 2005, which is the fifth best result among the EU countries. The percentage of renewable energy sources in Estonia's primary energy was 13%, placing the country in the 7th position among the EU countries. Dividing the domestic use of renewable energy sources by final energy consumption, Estonia ranks 3rd among the EU member states with a share of 17.6%.

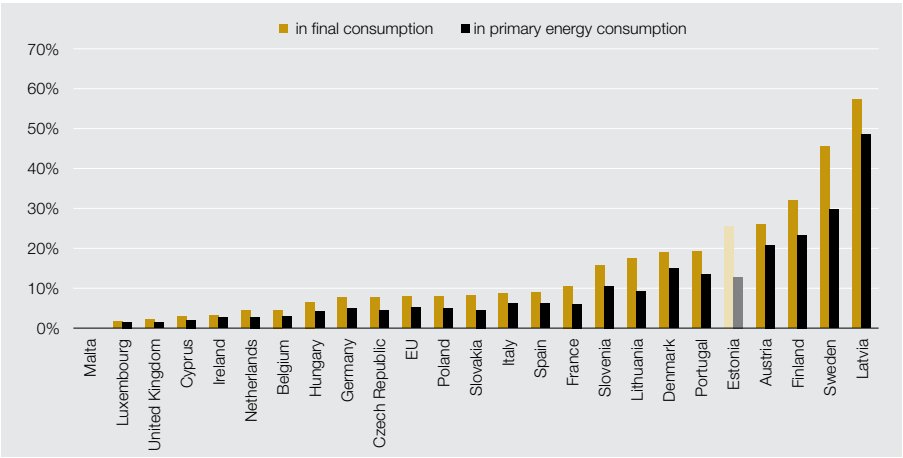

Figure 12. The share of domestic consumption of renewable energy sources in selected EU member states in 2005

The high share of renewable energy sources in Estonia's energy balance primarily stems from the extensive use of wood chips in the Estonian heating sector. The best performing countries in this respect are those where a large part of the electricity generated is from hydropower (Latvia,

Sweden and Austria). Meanwhile, Estonia and Finland are countries where the principal renewable energy source is wood. The use of renewable energy sources in Estonia has been constantly increasing since 1990 (see Figure 13).

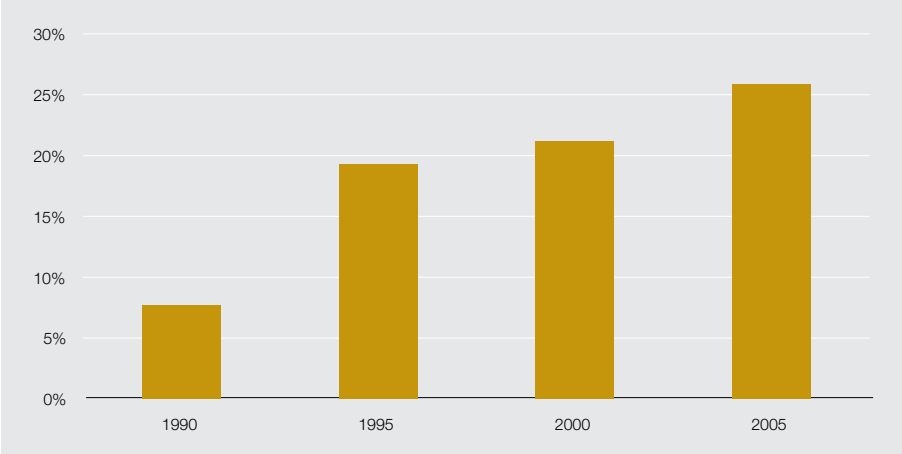

Figure 13. Changes in the share of renewable energy sources in final energy consumption in Estonia

In the 1990s, the prevailing trend was to substitute fossil fuels with wood chips in the heating industry, whereas from 2000 onward the share of renewable energy sources in electricity generation has been increasing. Based on the projects currently under construction, we might say that this upward trend is expected to continue in Estonia into the future (see Figure 14).

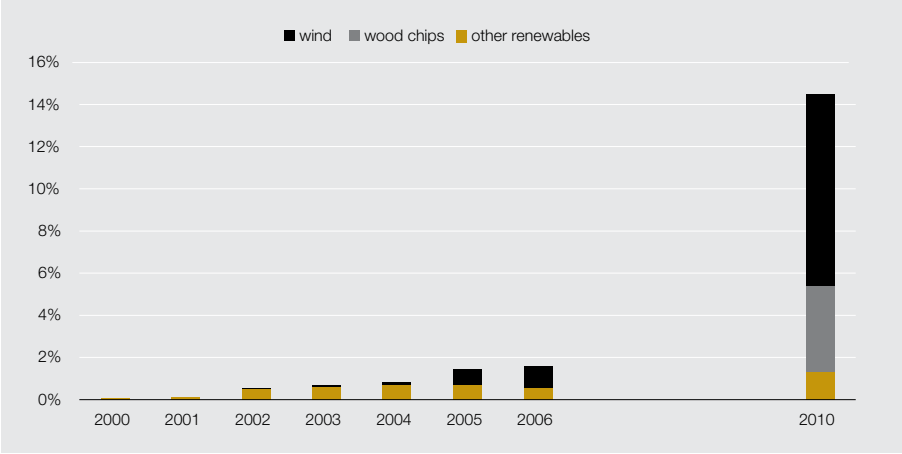

Figure 14. The development of the share of renewable energy in total electricity consumption in Estonia

Unlike in other countries where renewable energy sources mostly substitute for imported energy sources, renewable energy sources in Estonia essentially reduce oil shale-fired power generation. Thus, the increased use of renewable energy sources in Estonia should not affect the security of supply, provided that the use of natural gas is not increased so as to balance the production of renewable energy sources. If it needs to be done in the future, the possibility of also using alternative fuels (liquid biofuels, shale oil or gas) in gas turbines must be ensured.

CONCLUSION

Estonia is a country with a rather high security level of its energy supply: the infrastructure links with other countries are extremely strong, the dependency on imported energy sources is less than one-third and imported energy sources are partly replaceable with alternative fuels.

In international comparison, Estonia stands out with the extremely rapid development of its energy industry coupled with the need to more efficiently reduce CO2 emissions. In order to meet these objectives, Estonia aims to enhance the sustainability of its energy sector through the implementation of energy efficiency measures, the wider use of renewable energy sources and the introduction of new and environmentally friendlier technologies. Meanwhile, the goal is to avoid an increase in energy dependency arising from the need to secure the imbalances caused by the instability of wind power production.