THE COMPARATIVE STUDY OF THE SITUATION OF IMPORTANT ENERGY RESOURCES IN SLOVAKIA AND FINLAND

[1]Peter KAČMÁRY, [2]Jorma J. IMPPOLA

[1]Technical University of Košice, Faculty BERG, Institute of Logistics and Transport, Park Komenského 14, Košice, Slovakia, EU, peter.kacmary@tuke.sk

[2]Seinäjoki University of Applied Sciences, Faculty of Business, P.O. Box 412, Seinäjoki, Finland, EU, jorma.imppola@seamk.fi

https://doi.org/10.37904/clc.2023.4822

Abstract

Considering the ever-current topics regarding energy prices, availability and logistics in Europe and the world, it was found feasible and needful to make a comparative study of two European Union member countries, namely Slovakia and Finland. These countries have several features in common, like EU and NATO membership and therefore being eastern border of both, both having a population of about 5.6 million inhabitants, both having relatively high dependence on fossil fuel imports, both having also significant nuclear energy production capacity and both being a part of European energy markets. Both countries also have their own relatively abundant and earlier significant fossil energy resources (Slovakia has brown coal and Finland has peat), which both are nowadays non-preferred alternatives. This study mainly focuses on the comparison of energy needs, but also consumption itself, energy dependence on countries exporting energy commodities (for example Russia), energy logistics, development of renewable resources and brief simple future predictions in the time horizon 2-3 years. The study mainly focuses on the logistics (supply, transportation routes and storage) of important energy sources, such as electricity, natural gas, coal, nuclear power and of course renewable energy sources (RES) like biomass, wind, water and solar power and their utilization.

Keywords: Energy logistics, energy resources, energy policy, strategy, RES, market volatility

1. INTRODUCTION

As both Finland and Slovakia are EU and NATO eastern border countries and the population of both countries is almost the same (about 5,5 million inhabitants) it is worth to study and analyse the similarities and differences of logistics in both countries. This study is focused on energy logistics of Finland and Slovakia, and along similarities there can be found also big differences in the energy solutions and logistics.

Logistically Finland has been traditionally described as the northern gateway to the east and Slovakia has been known for ages as the crossing point of natural geographical north-south and west-east logistic corridors.

Before the Ukraine war Finland had a significant role in the logistics between EU and north-west Russia. Import, export and transit logistics connections were active. Materials and energy were transported by rail, road, air, pipeline and electric cables. The Stockholm-Turku-St. Petersburg corridor was an integral part of EU TEN-T programme (**Figure 1**). The EU's trans-European transport network policy, the TEN-T policy, is a key instrument for the development of coherent, efficient, multimodal, and high-quality transport infrastructure across the EU. It comprises railways, inland waterways, short sea shipping routes and roads linking urban nodes, maritime and inland ports, airports and terminals [1].

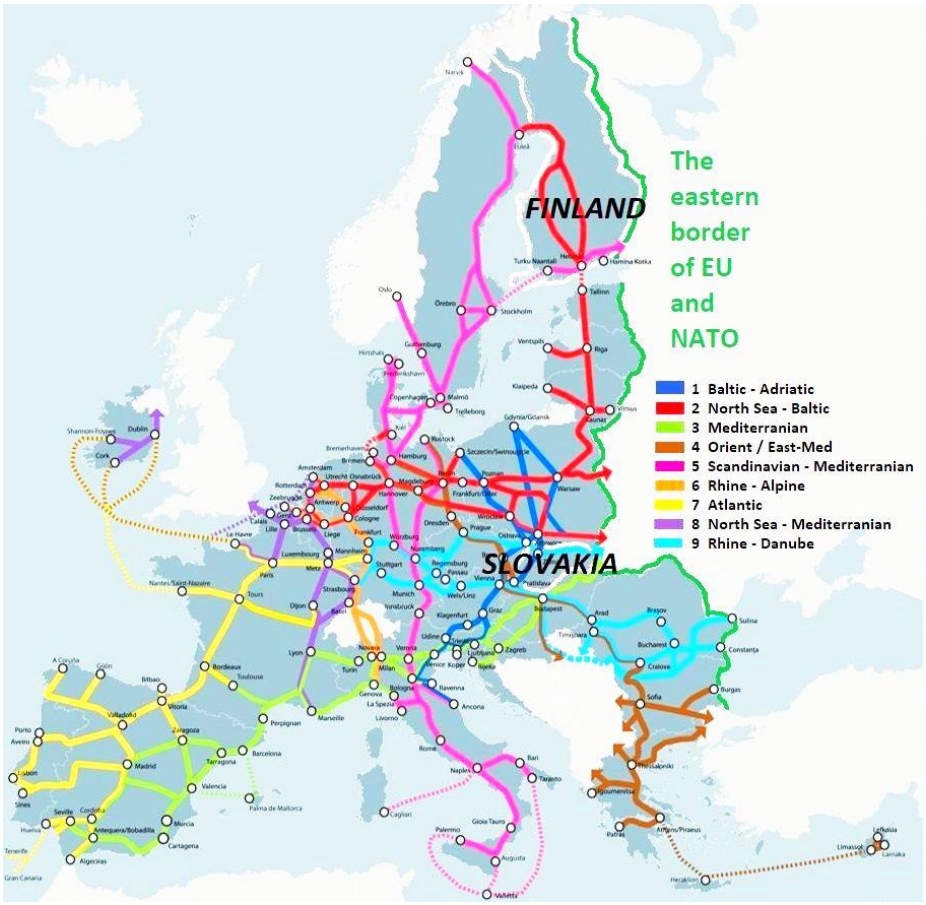


Figure 1 Finland and Slovakia in Europe and TEN-T core corridors. Modified by author, original image [2]

2. RESEARCH AND RESULTS

This chapter is dedicated to a more detailed description of the energy situation in the countries of Slovakia and Finland, their main energy sources and expected developments in the near future in the horizon of two to three years.

2.1 Slovakia

Slovakia is located in the eastern part of Central Europe, is the member of Visegrad 4 Group and it has an area of 49 035 km² (water area occupies 0.72% of the land) [3]. The population of Slovakia is 5.46 million inhabitants. The Slovak GDP was in total 107.7 billion € in 2022, which equals to approx. 20 000 € per capita [3]. Slovakia is comparatively low at an average elevation of 458 metres above sea level. It has mainly a temperate continental climate with relatively cool winters and warm summers and the average annual temperature is 10°C [4].

2.1.1 Electricity

According to OKTE (Organizer of the short-term electricity market) data, the total production of electricity in Slovakia last year reached 24.68 terawatt hours (TWh). Compared to the previous year, 2021, it was about 3 TWh less. And compared to 2020, the declination was even more significant.

Nuclear power plants in Jaslovské Bohunice and Mochovce produced more than 60% of all electricity produced in Slovakia in 2022. Water and gas power plants followed the production but in an incomparable low quantity (see **Figure 2** for more details). Last year, similarly to previous years, electricity production in Slovakia reached

a lower level than consumption. According to SEPS (Slovak Electricity Transmission System) figures, the consumption has been increased to 28.33 TWh, which means that almost 13% of the electricity consumed in Slovakia has to be imported [5].

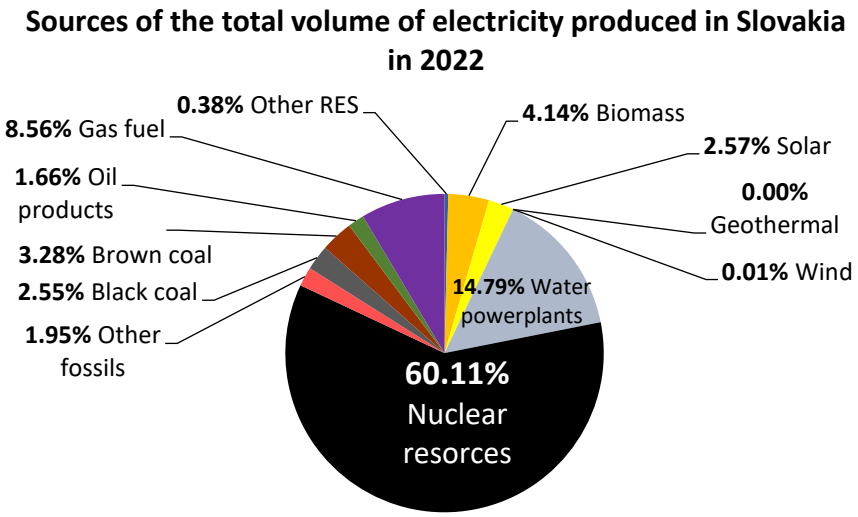
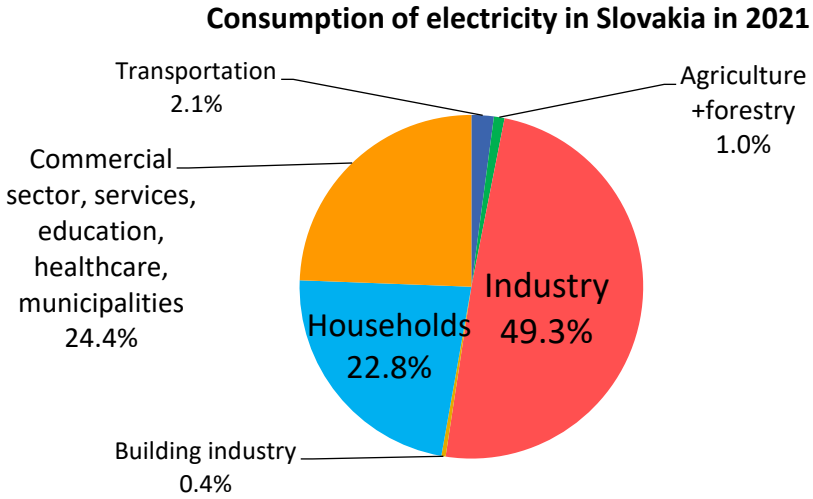


Figure 2 Ratio of the sources of electricity production in Slovakia in 2022 [6]

A closer look at electricity consumption by individual consumer segments is shown in **Figure 3**. As for the share of electricity consumption by households in Slovakia, they belong to the group of smaller consumers compared to EU countries. The most electricity is consumed by households in Finland, Sweden, France and Cyprus [6].



Source: https://faktyoklime.sk/infografiky/elektrina-sr (updated according to the Statistical office of the Slovak Republic)

Figure 3 Consumption ratio of electricity in Slovakia in 2021 by particular sectors

It is expected, that the situation of electricity import will be much different in 2023. In September 2022, the first fuel cassette was delivered to the third block of the second nuclear power plant Mochovce (actually the fifth active block in Slovakia). After a gradual tuning and start-up at its full capacity, the third block in Mochovce will cover 13% of electricity consumption in Slovakia, which is the current gap between the production and the consumption of electricity in Slovakia. Thus, Slovakia will become the self-sufficient country in the production of electricity [7]. The last fourth block of the Mochovce nuclear power plant is planned to operation in 2026 [8].

2.1.2 Natural gas

Natural gas has a very strong position in Slovakia's energy mix. The share of natural gas in the total consumption of primary energy in Slovakia in 2020 was about 25%, for comparison in the Czech Republic it was 18%, in Poland 17% and in Hungary even 34%. Slovakia has one of the most developed gas distribution system among other countries in the EU, as more than 94% of all residents have access to natural gas [9].

It is estimated that in 2021 roughly 3.2 to 3.5 billion m^3 of natural gas were imported to Slovakia from Russia. The share of dependence on the import of Russian natural gas decreased from 88% in 2020 to 69% in 2021. Although this tendency decreased rapidly in 2022 to around 30%, Slovakia's dependence on Russian nat. gas is still high. In 2020, natural gas consumption in Slovakia reached the level of 5 billion m^3. The consumption of natural gas has stagnated in recent years and is around 5 billion m^3 per year. Domestic production of natural gas in Slovakia reached approximately only around 75 million m^3, what represents about 1.5% of the total consumption of natural gas. The rest of the consumption has to be imported [9]. The situation with the shares of particular suppliers is variable, according to several sources, it could look as in the **Figure 4**.

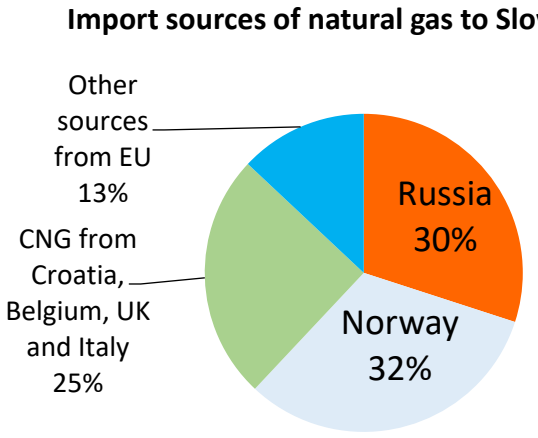


Figure 4 Particular supplier of natural gas to Slovakia in 2022 [10,11]

The monthly consumption of natural gas in Slovakia varies depending on the season. While in the winter months during the heating season it can reach 500-700 mil. m^3 per month, in the summer it can be 100-200 million m^3 per month., There can be seen the consumption of natural gas according to customer categories in 2020 in **Figure 5**. The share of households in Slovakia represented approximately 28%, while in EU it represents 24% [9].

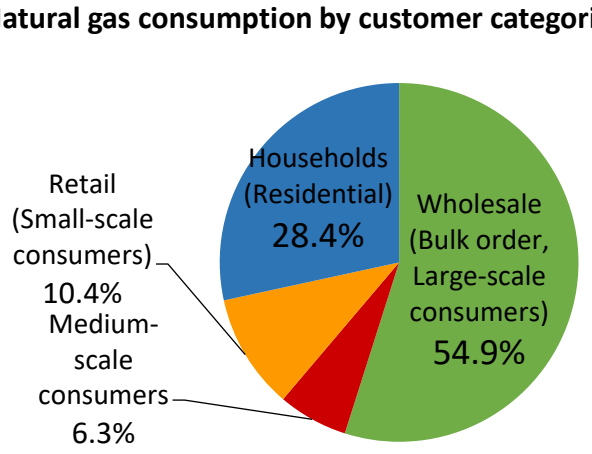
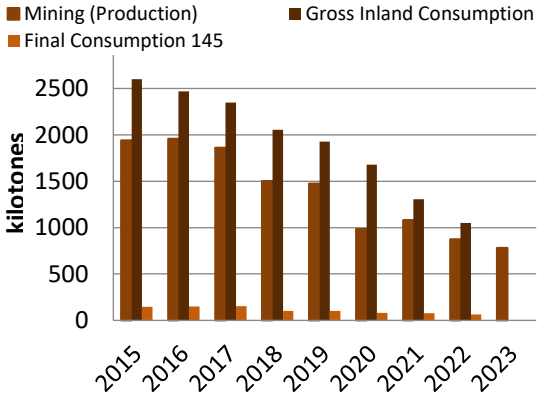


Figure 5 Customer segments of natural gas consumption

2.1.3 Brown and Black coal

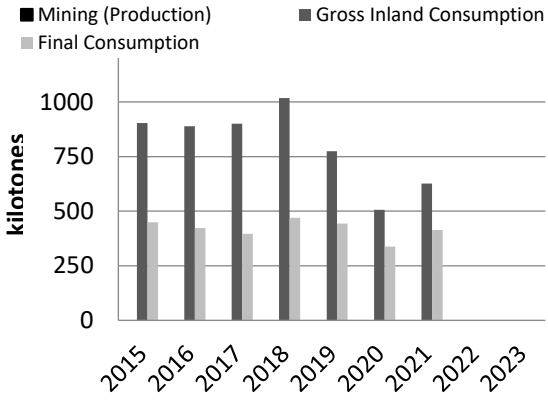
Brown coal and lignite mining is planned to be finished in Slovakia during the year 2023, despite the energy crisis in the world due to the invasion of Ukraine by Russia. In spite of still existed deposits of brown coal and lignite the production of electricity from lignite is unprofitable not only ecologically, but also economically in Slovakia. The last quantity of mined brown coal and lignite is expected in the volume of 780 000 tons in 2023 [12].

As for black coal, the situation is a bit different. The Slovak Republic has no black coal deposits at all. All consumption needs have to be imported, mainly from the Czech Republic, Poland and Ukraine. Part of the imported black coal is used for the production of coke (coking coal), the rest for the production of heat and the operation of the electricity power plant in Vojany (steam coal). The overview situation of brown coal and black coal (but preferably steam coal) is in **Figure 6** and **Figure 7**. The gross inland consumption means total consumption including coal for energy production and final consumption means coal for heating in commercial sector, services, education, healthcare, municipalities, residential and as well in industry.



Source: [stat. off. SR]

Figure 6 Brown coal and lignite production/ consumption



Source: [stat. off. SR]

Figure 7 Black coal (steam coal) production/ consumption

2.1.4 Wind and Solar power

As it can be seen from **Figure 1**, the share of RES in electricity production is quite far behind compared to other developed EU countries. From 2024, the share of electricity production from renewable sources will continuously increase, mainly from wind. Large projects for the construction of wind power plants are currently being resolved and approved. The expected output of these wind power plants will be comparable approximately to one block of a nuclear power plant [7]. On the other hand, it should be added that one of the risks of expanding the fields of wind power plants is several times higher material costs for the production of these devices and also the current problems with their reliability [13].

Substantial investments are expected in the construction of photovoltaic power plants (solar parks) from 2024 onwards. The accelerator of development is primarily high electricity prices and consumers' interest in RES for transport demand (the growth of electro-mobility) and heating. Higher prices of critical raw materials and low investments in electrical systems are “brakes” of development, according to the International Energy Agency [14].

2.1.5 Firewood

Demand for firewood has increased across Europe since 2022, but its production cannot be increased from month to month. This drives prices up and burdens exporters, who export firewood more and more

expensively. While the amount of tons of firewood exported from Slovakia in the seven months during the year 2022 was almost unchanged from year to year, exports in monetary terms grew by more than 60%. Energy split fuelwood and pellets are mainly exported from Slovakia as firewood. The largest producers and exporters are branches of foreign companies. Many domestic companies are not far behind. Italy became the largest buyer of firewood from Slovakia with about 45% of all exported volume of firewood [15].

Although export has not been changed in terms of volume, the import of firewood has dropped. Import of wood from the Czech Republic and Ukraine has fallen mainly at about 55 000 tons. Nevertheless, sources of firewood of the lowest quality, which is intended for heating, are in enough quantity from domestic trade. A problem can be in higher quality assortments, for example fibre wood intended for the pulp mill, or sawmill logs as firewood. The countries like Poland and even Hungary responded to the problems of reduced exports from the mentioned countries, but they were not enough to cover the entire shortfall in imports. The importance of Poland as a supplier in this segment is growing year by year. Poland thus displaced Czech wood from its import positions [16].

2.2 Finland

Finland is located in northern Europa (Scandinavia) and it has an area of 338 472 km² (of which lakes and other inland water bodies 34 524 km²) and the population of Finland is 5.56 million inhabitants. The Finnish GDP was 2022 in total 267 billion € which equals to 48 000 € per capita [17].

According to Climate Change Knowledge Portal [18] the climate of Finland displays features of both maritime and continental climates, depending on the direction of air flow. Considering its northern location, the mean temperature in Finland is several degrees higher than in most other areas at these latitudes, e.g. Siberia and southern Greenland. The temperature is higher because of the Baltic Sea, due to the inland waters and, above all, as a result of the air flows from the Atlantic Ocean, which are warmed by the Gulf Stream. The mean annual temperature is approximately 5.5°C in south-western Finland and decreases towards the northeast. The 0°C mean limit is approximately as far north as the Arctic Circle. The heating period in households is from September to may, which increases the energy consumption significantly.

The Finnish subarctic climate is characterised by irregular precipitation and typically there are rapid changes in the weather. The mean annual precipitation in southern and central Finland is usually between 600 and 750 mm, except near the coast, where it is slightly lower. During an average year, more than half of the days have some precipitation, except near the coastal regions. During severe winters, the Baltic Sea may freeze over almost completely, but during mild winters it remains open for the most part, except for the Gulf of Bothnia and the eastern part of the Gulf of Finland.

2.2.1 Electricity

According to Finnish energy statistics the total production of electricity in Finland was in 2020 81 TWh and in 2022 82 TWh. The change is low because of the aftermath of COVID-19 and especially very high energy prices during the heating season 2022-2023.

Nuclear power plants are in Loviisa (2 units á 507 MW) and Olkiluoto (2 first units á 890 MW, third unit (commissioned 2023) 1600 MW) and currently they produce about 40% of all electricity produced in Finland. In year 2022 the share of nuclear electricity was about 30% (**Figure 8**). Water, biomass and wind power plants followed the production but in electricity imports have also been significant source of electricity (see **Figure 8** for more details). This year the third nuclear reactor of Olkiluoto with net power 1 600 MW will significantly increase domestic electricity production and it will more than compensate the cancellation of Russia electricity import on 14th of May 2022, which was earlier about half of the net import. Like previous years, electricity production in Finland reached a lower level than consumption, so electricity must be imported.

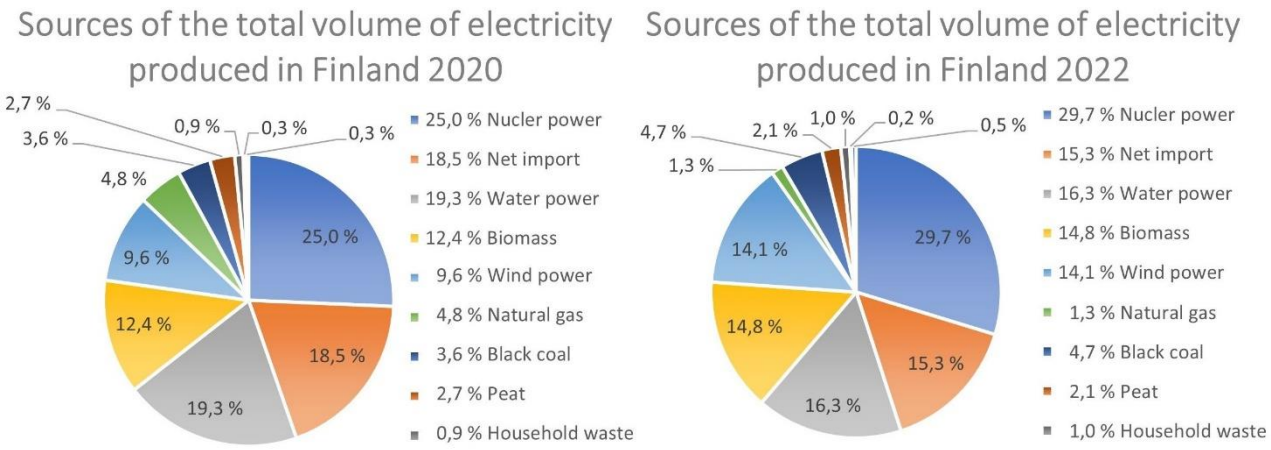


Figure 8 Ratio of the sources of electricity production in Finland in 2020 and 2022 [19,20]

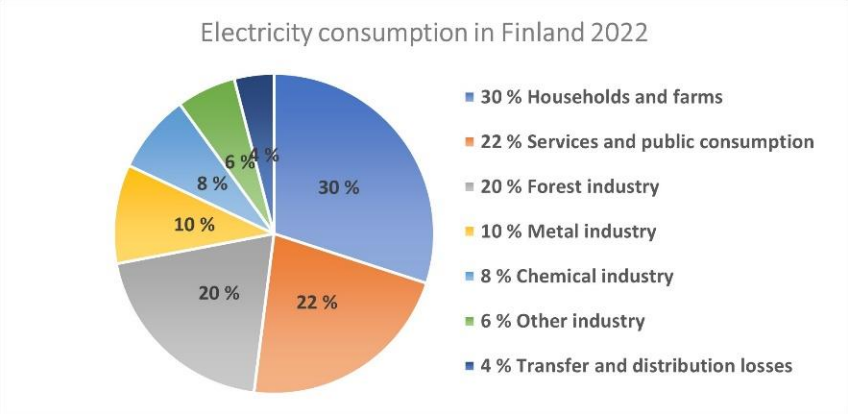


Figure 9 Consumption ratio of electricity in Finland in 2022 [21]

In total about 60 tons of low-radiation nuclear fuel elements are imported to Finland (from Russia 38%, Germany 31% and from Sweden 31%). The nuclear fuel elements for three Olkiluoto reactors transported to Olkiluoto harbour by sea. Loviisas two Soviet VVER-reactors have their nuclear fuel elements imported from Russia by road or rail. Currently all nuclear waste is stored in Finland.

2.2.2 Natural gas

The quantity of LNG imported to Finland was on 2020 176 000 tons. Finnish natural gas consumers are industry (mostly chemical and forest industry) 58% and electricity and distant heat power plants 42% [22]. Households do not use gas in Finland. The share of natural gas is about 5% of the total energy consumption. The consumption has dropped from 25 TWh to mere 13 TWh within one year, mostly because of the Ukraine war and the cancellation of Russia gas import on 21st of May 2022 from Russia. The only operational gas pipeline Baltic Connector between Finland and Estonia was closed 8th of October 2023 because of an external damage. The Finnish gas network company Gasgrid Finland Oy an US-gas company Excelerate Energy, Inc. agreed on May 2022 on renting a 2022 LNG terminal ship Exemplar to ensure gas supply. The terminal ship is moored on Inkoo harbor and it is connected to Finnish gas infrastructure. Despite the Baltic Connector pipeline damage the gas supply is therefore secured.

Currently, because of the Baltic Connector pipeline damage, all the natural gas is imported to Finland by sea with LNG tankers. In addition to Exemplar gas terminal ship moored in Inkoo also harbors of Hamina and Kokkola have gas terminals. Inland transportation of gas is done by gas pipeline network and LNG lorries.

2.2.3 Oil

The imported quantity of oil was 9.8 million tons in 2022, which was about 20% of the total primary energy consumption [23]. The amount of crude oil imports already started to decline in 2020 before the war in Ukraine, which is related to the sharp drop in the export of petroleum products in 2021. The crude oil import ban imposed by the EU regarding Russia entered into force on December 5, 2022. However, the import of crude oil from Russia to Finland stopped as early as August 2022. Russian crude oil has been replaced by imports from Norway. The EU has also banned the import of refined oil products from Russia to EU countries as of February 5, 2023. Oil products were still imported to Finland in December. Russia's share in the import of refined oil products has been significantly smaller than that of crude oil. Sweden was already the most important importing country (transiting oil from Norway) with a share of just under 50 percent. It seems that importing countries replacing Russia are relatively easy to find [24].

All crude oil is imported to Finland (Sköldvik oil harbor) by sea with oil tankers and the crude oil is refined in Sköldvik oil refinery complex, which is operated by the semi-national Neste Plc. Distribution of oil products is organized with small tanker ships to coastal oil distribution centers and countrywide inland distribution is organized with oil product lorries.

2.2.4 Black coal

In year 2022 total quantity 2 015 000 tons of black coal was used in Finland, which equals to 14.4 TWh primary energy. This is 10% more than year 2021, because coal was used to replace Russian gas import, therefore there was an increment of 26% during the Q2 of 2022. The black coal use trend has been declining and also the number of black coal power plants has continuously declined. In 2022 the black coal consumption was 50% less than the average consumption during 2000 – 2020. Black coal was mainly used in electricity and heat production plants. Black coal inventories were at the end of 2022 1 493 000 tons which is 23% more than the previous year [25].

Finland has no own coal resources, so all the coal used is imported. Earlier, about half of the coal imports came from Russia. Coal imports from Russia ended mid-august 2022 and after that the coal has been imported to Finland mainly from USA, Australia and Poland. Coal imports are today 100% sea transportation and most of the coal power plants are located on coast with their own coal harbors.

2.2.5 Peat

Finland has 9.08 million hectares of peat land, or about a third of Finland's land area. Of that, 0.6 percent is the area used for peat production. Due to the rapid decrease in the demand for energy peat, the active peat production area has decreased rapidly in recent years because of CO_2 emissions (peat is considered as fossil fuel) and was only about 30 000 ha in 2021. Energy peat used mainly for electricity and heat production covered about 10 TWh which equals to couple of percent of Finland's total energy consumption in 2021. Because of the energy crisis caused by Ukraine war and excusion of Russia from energy import the share of peat energy has slightly increased 2033 and 2023 [26]. Peat is transported mainly by road with lorries from production sites to power plants.

2.2.6 Wind power

In total, there is in Finland 1 468 wind turbines in operation at the end of June 2023, with a total maximal capacity of 6 116 MW. Finland's wind turbines produced 11.6 TWh of electricity in 2022 (look **Figure 8**), which accounted for just over 14 percent of Finland's electricity consumption [27]. Wind power production capacity has grown very rapidly in Finland, and despite it has become an irreplaceable energy resource helping the whole country to meet its energy needs in these challenging times it is also causing problems because of the instability of the wind conditions. In many cases when it is windy, it pushes the electricity price to zero and when it is calm, the electricity can cost hundreds of € per MWh.

2.2.7 Bioenergy

Bioenergy is renewable energy that is obtained from various biomasses: for example, wood, field crops and bio-derived waste. Bioenergy is classified as carbon dioxide neutral, i.e. it is not calculated to increase carbon dioxide emissions. This is based on the fact that the carbon released during the burning of biomass is bound back into the growing biomass in the long term. Bioenergy includes wood-based fuels, field biomasses, biogas and the biodegradable part of recycled and waste fuels [28].

In Finland, the share of biomass in the total energy consumption is the highest among industrialized countries, and the importance of wood is central. In 2022, the share of renewable energy in Finland's total energy consumption was a total of 42 percent (150 TWh), with the share of wood fuels being 29 percent (10.2 million m^3, which equals to 105 TWh) of the total consumption. The share of wood fuels in the use of renewable energy in Finland was about two-thirds [29].

The largest user of wood energy is the forest industry, which utilizes wood chips and wood-based by-products and waste liquids generated in its processes, such as black liquor, in its energy production. In the forest industry, by-products are also created, from which together with logging residue, biofuels suitable for transport fuels can be produced with the forest industry's biorefinery concept, which is currently being intensively developed [29].

Before Ukraine war 70 – 80% of the wood-based fuel imports (4 – 5 million m^3 of chipped wood) came from Russia [29]. Since march 2022 imports from Russia has stopped completely. Currently the importing of chipped wood as energy fuel has dropped about 30% and is only partially replaced by increasing domestic production. Currently the wood-based fuel imports are coming to Finland by sea and distributed inlands mostly by road transportation and by smaller scale rail transportation.

3. CONCLUSION

Slovakia is gradually adapting to the situation so that it will be not so strongly dependent on energy sources from the east, i.e. from Russia. This process cannot be done from day to day, but it is systematically worked on. These are mainly supplies of natural gas, nuclear fuel for nuclear power plants, black coal for industry, etc. However, it is surprising, despite the high demand for energy resources in the EU, the end of lignite (brown coal) mining in Slovakia in the main mines in the Horná Nitra region, which is currently an irreversible process. The trend towards self-sufficiency in demand for electricity is positive progress in Slovakia. The expansion of wind power plants over the course of two years will also be interesting and certainly much discussed topic in Slovakia.

Finland has very rapidly changed the energy portfolio from Russia-dependent to Russia-independent. The stoppage of energy imports (oil, electricity, gas, black coal, energy wood) from Russia of course has affected the energy markets and reality in Finland, but all these have been managed quite successfully. Luckily the decisions to strongly invest on wind power and the completion of Olkiluoto 3 nuclear power plant and the acquisition of the LNG terminal ship Exemplar have helped Finland tremendously. Especially the quick replacement of Russian oil with other sources has enabled our economy and industry to operate almost normally. The only energy source from Russia is nowadays the nuclear fuel bundles for Loviisa 1 and 2 reactors, but also those can be replaced, if necessary. Of course, replacing Russia as energy source has changed the energy logistics, but also this change has been successfully conducted.

The biggest difference between the energy portfolio and logistics between Slovakia and Finland is the fact, that in Finland the significance of natural gas as energy source for industry and especially for households has been mere marginal comparing to the Slovakia. One remarkable similarity between Slovakia and Finland is the fact, that in electricity production both countries are nowadays basically self-sufficient. However, due to the much higher share of wind power plant in electricity sources compared to Slovakia, there even may be some imports of electricity in Finland in case of windless days.

ACKNOWLEDGEMENTS

This research was funded by the Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences as part of the research project KEGA 010TUKE-4/2023.

REFERENCES

[1] European Commission (2023) *Trans-European Transport Network (TEN-T)*. [on line] 2022. [viewed: 2023-09-19]. Available from: https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

[2] AUTORIDAD PORTUARIA DE LA BAHIA DE ALGERICAS. *TEN-T – Connecting Europe*. [on line] 2022. [viewed: 2023-09-19]. Available from: https://www.apba.es/en/ten-t-connecting-europe#

[3] Debt and Liquidity Management Agency. *Základné informácie o SR.* [on line] 2023. [viewed: 2023-10-19]. Available from: https://www.ardal.sk/sk/ekonomicke-informacie/zakladne-informacie-o-sr

[4] Statistical Office of the Slovak Republic. *Macroeconomic Statistics*. [on line] 2023. [viewed: 2023-10-20]. Available from: https://slovak.statistics.sk/wps/portal/ext/themes/macroeconomic/

[5] POTOČÁR, Radovan. *Väčšina elektriny je z jadra, štvrtina z OZE, zvyšok z uhlia a plynu. OKTE ukázal najnovší energetický mix*. [on line] 2023. [viewed: 2023-09-19]. Available from: https://www.energie-portal.sk/Dokument/vyroba-elektriny-slovensko-elektrarne-okte-110053.aspx

[6] EURACTIVE. *Spotreba elektriny je v európskych domácnostiach na vzostupe*. [on line] 2012. [viewed: 2023-09-19]. Available from: https://euractiv.sk/section/energeticka-ucinnost/news/spotreba-elektriny-v-domacnostiach-je-v-eu-na-vzostupe-020464

[7] TREND. *Návrh klimatického plánu počíta s 250-násobným rastom výroby veternej energie.* [on line] 2023. [viewed: 2023-09-19]. Available from: https://www.trend.sk/spravy/navrh-klimatickeho-planu-pocita-250-nasobnym-rastom-vyroby-veternej-energie

[8] SLOVENSKÉ ELEKTRÁRNE. *Slovenské elektrárne dnes začali uvádzať 3. blok Mochoviec do prevádzky* [on line] 2022. [viewed: 2023-09-19]. Available from: https://www.seas.sk/tlacove-spravy/slovenske-elektrarne-mochovce-3-uvadzanie-do-prevadzky

[9] SLOVAK FOREIGN POLICY ASSOCIATIONS. *Slovensko má možnosti nahrádzať ruský plyn z iných zdrojov.* [on line] 2022. [viewed: 2023-09-19]. Available from: https://www.sfpa.sk/zppost/slovensko-ma-moznosti-nahradzat-rusky-plyn-z-inych-zdrojov

[10] ENERGIE PORTAL. *Zastavil sa pokles. Spotreba plynu už rastie, hlásia plynári.* [on line] 2023. [viewed: 2023-09-19]. Available from: https://www.energie-portal.sk/Dokument/spotreba-plynu-slovensko-2023-110069.aspx

[11] RTVS. *Slovensko od júna zníži závislosť od ruského plynu o 65 percent, oznámil Sulík.* [on line] 2023. [viewed: 2023-09-20]. Available from: https://spravy.rtvs.sk/2022/05/slovensko-od-juna-znizi-zavislost-od-ruskeho-plynu-o-65-percent-oznamil-sulik

[12] TREND. *Hornonitrianske bane Prievidza pozastavili ťažbu v bani Čáry, ohlásili i hromadné prepúšťanie.* [on line] 2022. [viewed: 2023-09-20]. Available from: https://www.trend.sk/spravy/hornonitrianske-bane-prievidza-pozastavili-tazbu-bani-cary-ohlasili-hromadne-prepustanie

[13] TREND. *Problémy Siemens Energy môžu ohroziť budúci rast veterných elektrární.* [on line] 2023. [viewed: 2023-09-20]. Available from: https://www.trend.sk/nazory-a-komentare/problemy-siemens-energy-mozu-ohrozit-buduci-rast-veternych-elektrarni

[14] EURACTIVE. *Solárna energia má tento rok prilákať viac investícií ako ropa.* [on line] 2023. [viewed: 2023-09-21]. Available from: https://euractiv.sk/section/energetika/news/solarna-energia-ma-tento-rok-prilakat-viac-investicii-ako-ropa/

[15] STARTIT UP. *Slováci si za drevo na kúrenie priplácajú aj o 200 % viac. Do zahraničia ho vyvážame celé tony*. [on line] 2022. [viewed: 2023-09-21]. Available from: https://www.startitup.sk/slovaci-si-za-drevo-na-kurenie-priplacaju-aj-o-200-viac-do-zahranicia-ho-vyvazame-cele-tony

[16] SITA WEBNOVINY. Dovoz brikiet, peliet a iných foriem palivového dreva na Slovensko poklesol. . [on line] 2022. [viewed: 2023-09-21]. Available from: https://sita.sk/nasvidiek/dovoz-brikiet-peliet-a-inych-foriem-palivoveho-dreva-na-slovensko-poklesol

[17] TILASTOKESKUS. *Bruttokansantuote markkinahintaan*. [on line] 2023. [viewed 2023-10-08]. Available from: https://www.tilastokeskus.fi/tup/suoluk/suoluk_kansantalous.html

[18] WORLD BANK. *Climate Change Knowledge Portal. Finland. Current Climate.* [on line] 2021. [viewed 2023-10-10]. Available from: https://climateknowledgeportal.worldbank.org/country/finland/climate-data-historical

[19] ENERGIATEOLLISUUS RY. *Energiamaailma. Energiantuotanto.* [on line] 2023. [viewed 2023-10-15]. Available from: https://energiamaailma.fi/energiasta/energiantuotanto/

[20] ENERGIATEOLLISUUS RY. *Energiavuosi 2022, Sähkö* [on line] 2023. [viewed 2023-10-15]. Available from: https://www.slideshare.net/energiateollisuus/sahkovuosi-2022pptx-255298490

[21] MOTIVA Ltd. *Solutions, Energy use in Finland. Electricity supply and demand.* [on line] 2023. [viewed 2023-10-16]. Available from: https://www.motiva.fi/en/solutions/energy_use_in_finland/electricity_supply_and_demand

[22] JUUSOLA, A. *Vientiteollisuus voi joutua vähentämään tuotantoa, jos maakaasu kallistuu entisestään tai jos siitä tulee pula – hinta on jo viisinkertaistunut.* [on line] 2022. [viewed 2023-10-16]. Available from: https://yle.fi/a/3-12553921

[23] MOTIVA Ltd. *Solutions, Energy use in Finland. Total energy consumption*. [on line] 2023. [viewed 2023-10-18]. Available from: https://www.motiva.fi/en/solutions/energy_use_in_finland/total_energy_consumption

[24] BENG-ANDERSSON, Birgitta. *Elinkeinoelämän tutkimuslaitos: Suhdanne. Energian tuonti Venäjältä*. [on line] 2023. [viewed 2023-10-18]. Available from: https://www.suhdanne.fi/ennusteet/suhdanne-kevat-2023/erityisteemat/energian-tuonti-venajalta/

[25] STATISTICS FINLAND. *Consumption of hard coal increased by 10 per cent in 2022.* [on line] 2023. [viewed 2023-10-17]. Available from: https://www.stat.fi/en/publication/cl8mrlrv9z36m0duket5x6w9d

[26] BIOENERGIA. *Tietopankki. Turve.* [on line] 2023. [viewed 2023-10-17]. Available from: https://www.bioenergia.fi/tietopankki/turve/

[27] TUULIVOIMAYHDISTYS. *Toiminnassa olevat & puretut voimalat*. [on line] 2023. [viewed 2023-10-17]. Available from: https://tuulivoimayhdistys.fi/tuulivoima-suomessa/toiminnassa-olevat-puretut

[28] MOTIVA. *Bioenergian käyttö.* [on line] 2023. [viewed 2023-10-17]. Available from: https://www.motiva.fi/ratkaisut/uusiutuva_energia/bioenergia/bioenergian_kaytto

[29] TULLI. *Turpeen ja puuhakkeen tuonti 2021.* [on line] 2022. [viewed 2023-10-17]. Available from: https://tulli.fi/-/turpeen-ja-puuhakkeen-tuonti-2021