POWER PRODUCTION MIX TRANSITION – CASE OF THE CZECH REPUBLIC AND GERMANY

Jakub Zezula

Abstract

Countries of the EU have to transform their power production mix in order to meet the targets of the greenhouse gas emissions of the Union. The goal of the article is to investigate two approaches to the transition of the power production mix. Germany and the Czech Republic represent an example of states with a different position in this process as well as a different approach to it. While Germany has a clear timetable for this transition and relies on renewable sources (dominantly wind), the Czech Republic sets a general target represented by a year of the planned closure of the coal utilities (2038) and will probably mostly rely on nuclear power plants. Due to the high share of unstable wind and solar sources, the German market experiences high volatility of power prices and the export of electricity. The Czech market is affected by the market conditions in Germany; however, the country is self-sufficient to cover its power demand at the moment. Nevertheless, this fact can be endangered by decreasing the availability of the conventional power sources (in combination with the absence of a clear strategy of their substitution) and potential increase of power consumption.

Keywords: energy transition, power production, energiewende, power markets, fit for 55, european green deal
JEL Classification: M00, M21, O13,

Introduction

The European Union issued the latest update of its environmental policy as a part of the Green Deal agreement on the way to carbon dioxide neutrality by 2050. The member countries with this update called Fit for 55 pledged themselves to decrease their emissions by 55% before 2030. This target was negotiated on the EU level; however, as the energy policy is a shared competence between the EU and the national states, each member state can make its strategic decisions about the production mix within the set common goals within the EU. (Hafner, Raimondi, 2020) Therefore, there are differences in the current electricity production mix and thus in the potential ways of transformation of this mix as well as in stages of the planning on the national levels. Germany and the Czech Republic represent an example of these differences. The aim of this article is to investigate different approaches to the power mix transition on an example of the two selected countries within the energy policy of the EU.

The energy supply is the most significant polluter in terms of the CO_2 emissions within the EU. In 2019 26,62% of the emissions came out of this sector, followed by 22,98% of domestic transport and 21,34% of the industry. In Germany, this share of the energy sector reached 31,06%, and in the Czech Republic, even 37,72% in the same year. (European Environmental Agency, 2021) Therefore, the power production sector must lead the transformation of the energy mix in order to be able to reach the targets set in the EU.

The trend is visible in the total installed capacity within the Union. The total installed capacity has been steadily rising. This is driven mostly by the wind and solar power plants (increase by 154 GW between 2009 and 2018), and at the same time, the capacity of the conventional utilities decreased by 15 GW. (Zezula, 2019)

Literature Review

The transition of the energy mix of the EU and within single EU countries has been currently a widely discussed topic in the media and research papers as well. The possibilities of countries across the EU are not equal in terms of the decarbonization of the energy sector, and countries seek a balance between green energy and the security of its supply. Thus two groups of countries appear – countries of the first one have a clear preference for green energy, and the second group focuses on the reliability of their energy self-sufficiency. (Pérez, Scholten, Smith, 2019)

Government roles are seen as crucial in the energy transition process as they should set the long-term vision, and they need support for that from the whole society, and Germany can be taken as an example. (Laes, Gorissen, Nevens) Moore and Gustafson analyzed the way of Germany towards low carbon economy within the Energiewende policy suggesting the country should focus not only on the construction of renewables sources but to the energy efficiency and security as well. A similar position is represented by Matthes. According to his paper, the transition of the energy mix should be based on the efficiency of the whole energy system.

Some studies focusing on the energy transition of the Czech Republic have been conducted as well; however, focused mostly on the decision-making process. Osička et al. focused on the future of coal in the central Europe area within the paradigm of coal phase-out in Germany and uncertainty of the future in the Czech Republic. They argue that due to the lack of media coverage of the topic's international context, a need for coal phase-out in connection to climate change is mitigated. Based on Ocelík et al., there are two distant coalitions in favor and against coal phase-out in the Czech Republic that complicate the whole process in the country.

Methodology

Based on the aim of the article, research questions were set:

- What are the differences in the power production mix of both countries in terms of the production from renewable sources?
- Is there a clear vision (plan) for coal exit in power production?
- What is the position of both countries within the region in terms of cross-border power flows?

The paper is based on a comparative analysis of the current status of the power production mix of both countries for the time frame of years 2019 and 2020 and installed capacity in 2020. Based on that, load factors for each kind of power source are calculated for 2020 in order

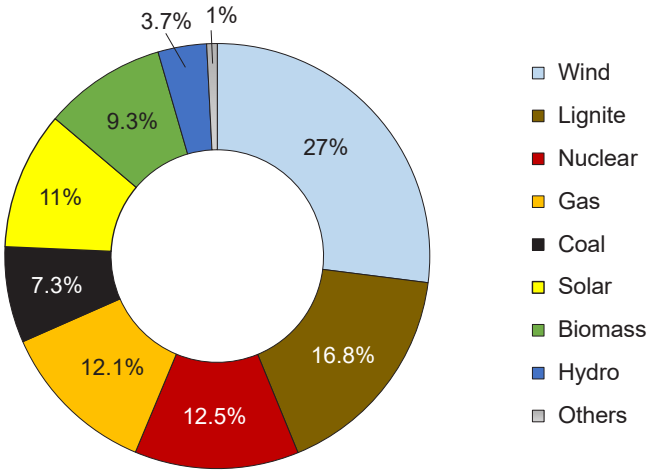
to evaluate the stability of production of the sources. Power flows between the analyzed countries and neighboring countries are presented to describe the self-sufficiency of power production and the position of the countries within their region.

In order to assess the influence of wind and solar power units on the power prices, a scatter plot for daily baseload power prices and wind and solar daily production from 2019 is used based on OTE, Epex Spot, and Energycharts data. The year 2019 is used to data distortion due to an impact of Covid-19 on power consumption and thus the prices.

Current power production

The overall power production in Germany reached 489 TWh in 2020. This represents a decline of approximately 30 TWh compared to the previous year caused predominantly by the covid measures and restrictions. Due to the lower electricity demand, a share of lignite and coal power plants on the power production decreased by three respectively two percentage points. More than a quarter of this electricity was produced by wind power plants with a total share of 50,5 % of renewables on the production. (Frauenhofer Institut, 2021) There was an increase of 31,5 percentage points compared to the year 2010 when the production of renewable reached only a level of 19 %.

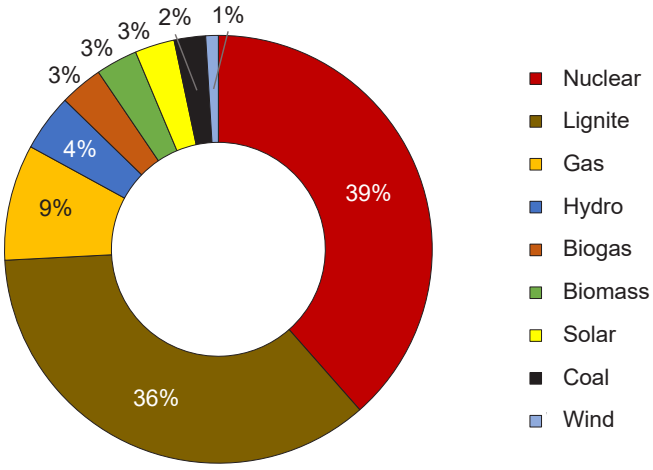
Figure 1: Power production mix Germany 2020



Source: Own compilation based on Energycharts.de

The total power production in the Czech Republic reached nearly 76 TWh decreasing from roughly 87 TWh in 2019. The decline was more significant than in Germany reaching 13 % compared to less than 6 %. Lignite share on the power production mix declined by 4 percentage points. On the other hand, the nuclear power share increased by 3 pp. The total power production in the Czech Republic represented roughly 16 % of the German value.

Figure 2: Power production mix Czech Republic 2020



Source: Own compilation based on ERU.cz

In comparison, the strategy of power production is completely different in both countries. The German production mix relies on renewable sources as the dominant power source are wind farms supported by a strong position of solar and biomass power plants building more than a half of electricity generation in the country. On the other hand, the Czech Republic is more dependent on the centralized larger production units with the significant dominance of nuclear and lignite utilities (75% of power generation). The most significant renewable power source is hydropower plants with a share of 4% on the production mix.

Power production transition

Based on the energy policy of the European Union and its targets, both countries should be on their way to adapting their power production mixes to the EU strategy. The update of the goals was published in July 2021 in a package called "Fit for 55 ". The final target of this package is reaching carbon neutrality by 2050. A partial target is represented by a commitment to reduce CO_2 emissions by 55% by 2030.

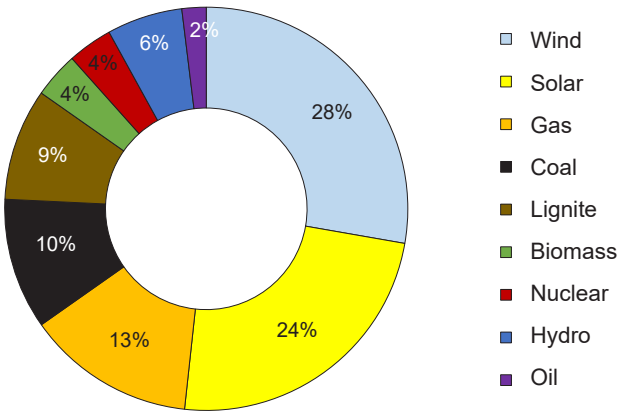
In the area of power production, there is a requirement to produce 40% of power by renewable sources before 2030, which means an increase of the current target by 8 pp. At the same time efficiency of the energy usage should improve in a way to decrease its consumption by 36 to 39% within the same timeframe. In this area, a new measure of carbon border adjustment mechanism (CBAM) was presented. CBAM should be introduced for several products in order to assure the same carbon emissions payment for companies importing to the EU as well as the domestic ones. (EUR-lex, 2021)

Germany

Germany named its plan for the transition of the energy sector Energiewende. This represents a way away from the fossil fuels towards renewables. Until 2022 all the nuclear power plants in Germany should be decommissioned. Lignite and coal power units should be closed in 2038 latest, with a planned revision in 2032 assessing the possibility of closure of all the units in 2035. With the closure of nuclear utilities, the German grid will lose 8 GW of production capacity, with lignite 20 GW and with coal 24 GW. In percentage, this means a loss of 23 % of the current installed capacity. This is given by the list of specific power units with their decommissioning plan.

Apart from the timeline of closure of the units, a system of auctions for decommissioning of coal units has been introduced. In these regular auctions with their set volumes, operators of the power plants bid a compensation (with a cap price that decreases with time) per MW for which they are willing to close their units. The auctions should take place annually till 2030. In order to encourage power utilities to bid in the auctions, the grid operator has a possibility to force closure of the units without compensation if they fail to submit bids in the auctions. (Bundesnetzagentur, 2021)

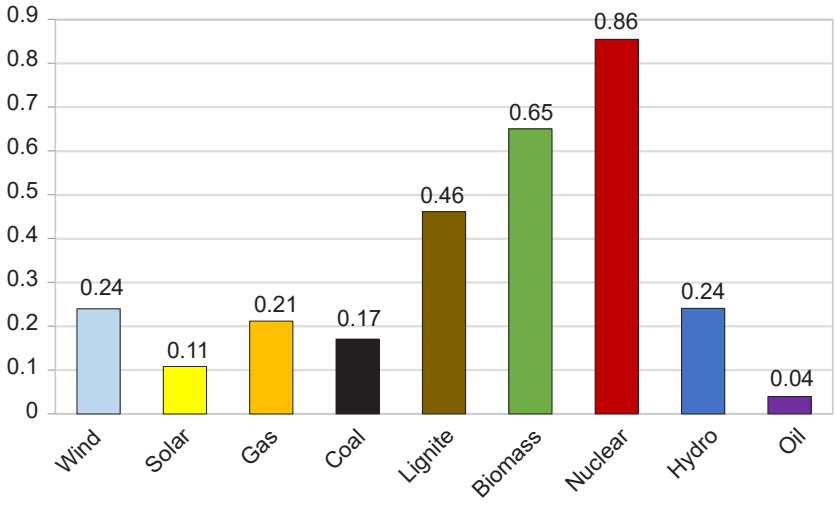
Figure 3: Installed Capacity Germany 2020



Source: Own compilation based on Energycharts.de

The load factor of the power source is given by the ratio of the total power production of the given kind of a source and its total installed capacity multiplied by the potential production hours within the year. This quantifies the relative production stability of the source.

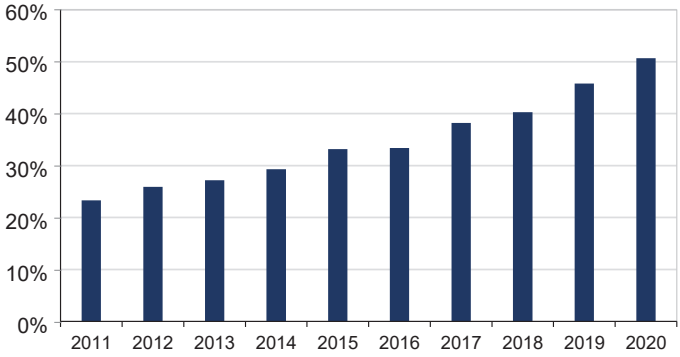
Figure 4: Load factor of each power source



Source: Own compilation based on Energycharts.de

With the decommissioning plan of the conventional power units (nuclear, coal, and lignite), the German power grid will lose very stable and flexible power plants. The load factor of nuclear power plants reached 86 % in 2020, meaning they were in operation the vast majority of the year. Lignite units were producing power slightly below half of the year. However, this fact was partially affected by the decline of power consumption due to covid restrictions in part of the year. In spite of the upcoming closure of the conventional units, the lost production capacity has to be substituted by the zero-emission (i.e. renewable) sources. In order to enhance the construction of such power sources, support for renewables has been introduced and was codified in the Renewable Energy Act (Gesetz für den Ausbau erneuerbarer Energien) for the time period before 2017. From 2017 on, a system of auctions was introduced for wind, solar, and renewable biomass sources. Each tender has its volume and capped support per KWh of power given by the law. Successful bidders from the auction then receive a total value equal to the value of their bid in the auction per KWh that consists of the price of electricity traded on the exchange and market premium that compensates potential lower earnings from the exchange. (Bundesamt für Justiz, 2021) The system of auctions should pressure the support as with the improving technologies, the construction costs of renewables decrease in time.

Figure 5: Renewables share on total power production

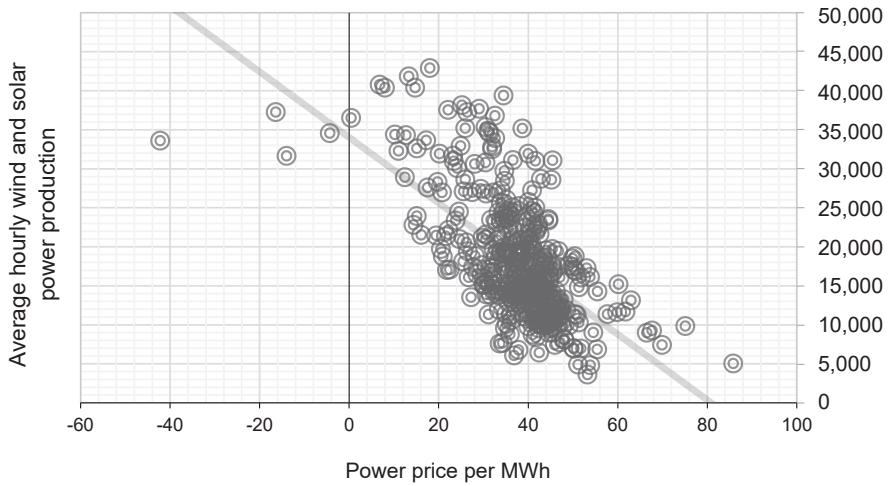


Source: Own compilation based on Energycharts.de

Over the past ten years, the share of renewable power sources on the total yearly production increased from 23 % in 2011 to a value slightly above 50 % in 2020.

From the point of view of the supported unit operator, it is reasonable to produce power when the electricity price per KWh on the power exchange exceeds the negative value of the support reduced by the variable costs per 1 KWh. As the variable costs of the renewable sources are usually lower than the support per KWh (variable costs close to zero in case of wind and solar power plants) in times of low power consumption and high production of renewable sources with low flexibility (wind and solar sources mainly) this situation leads to negative power price on the exchange.

Figure 6: Scatter Plot of the daily average power prices per MWh on EPEX Spot Exchange and the average hourly production of wind and solar power plants in Germany in 2019

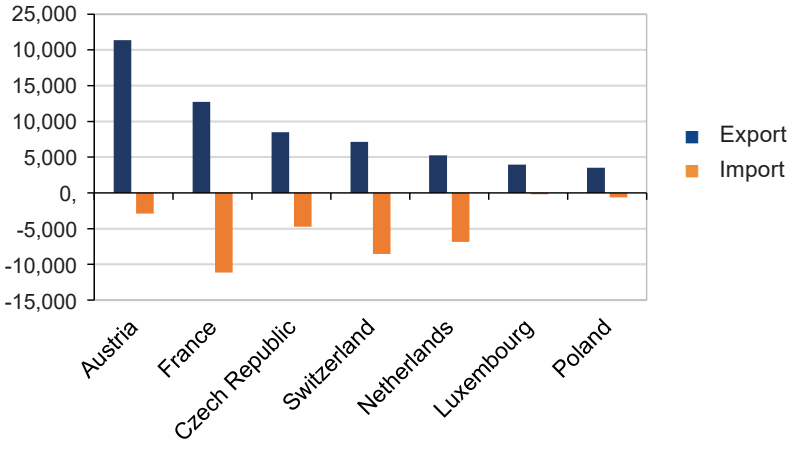


Source: Own compilation based on EPEX Spot and Energycharts data

In such a case of a surplus of power produced in Germany, part of the electricity is exported to the neighbouring markets and creates pressure on their power prices, and the price differentials between national markets are partially balanced. However, this export potential is limited by insufficient transport capacities between the national grids. Hence the remaining power must be consumed for a negative price in Germany.

Therefore, in the yearly balance in 2019, Germany was a net exporter of electricity to the neighbouring countries, i.e., it exported more power than imported. The scheduled commercial net export of power from Germany reached almost 18,5 TWh representing approximately 3,7% of the overall electricity production in the country, with a total export of more than 60 TWh. (Smard.de, 2021)

Figure 7: Scheduled Commercial Flows of Power between Germany and selected countries 2020



Source: Own compilation based on Smard.de

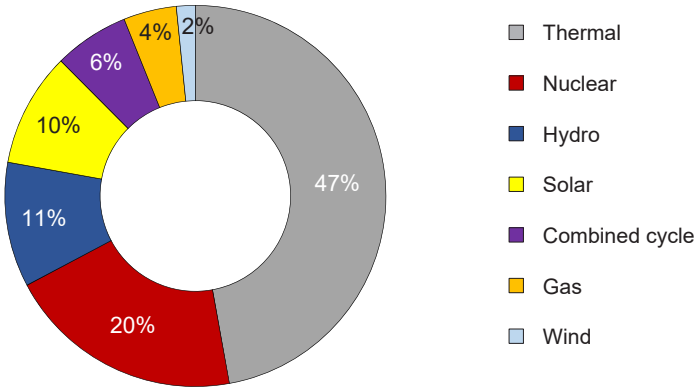
The largest part of the exported power from Germany flew to Austria. In the electricity exchange between these countries, there is a clear dominance of the flow from Germany to Austria (over 21 TWh in 2020 compared to below 3 TWh of import to Germany from Austria). The second exporting destination for Germany was France. However, the flow directions are almost balanced (over 12 TWh from Germany to France – over 11 TWh from France to Germany). In the case of the Czech Republic, Germany exported 8,5 TWh of power compared to 4,7 TWh of imported electricity. Net exports from Germany were recorded in the case of Poland and Luxembourg. On the other hand, net imports occurred from Switzerland and Netherlands.

Czech Republic

Unlike Germany, the Czech Republic represents a different approach to the power mix transition. Due to the different geographical conditions, it is not able to exploit the potential of the offshore

windmills construction. Currently, the major power sources in the country are nuclear and lignite power plants that together represent about 75% of the total production. On the other hand, renewables share on the total power production reached only 13% in 2020, that is in a strong contrast with the more than 50% in Germany. Furthermore, the dynamics of the renewables share is lower in the Czech Republic than in Germany. In Czechia, the share increased in the last decade by 4% percentage points while in Germany by 27% within the same period.

Figure 8: Installed Capacity Czech Republic 2020



Source: Own compilation based on ERU.cz

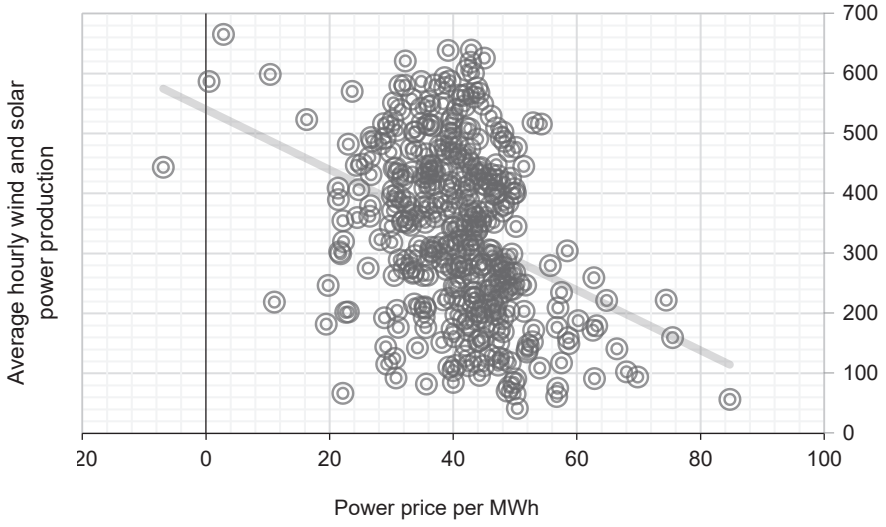
The installed capacity of the power production units in the Czech Republic is dominantly composed of thermal power plants with their share of almost half of the overall capacity. The vast majority of them are fuelled by lignite (82,5% of their power production) and coal (5,5% of the production). The rest is fuelled by biomass or other fuels. One-fifth of the capacity is secured by the nuclear units followed by renewable hydro and solar power plants with a share of around 10% each. Combined cycle utilities are fuelled by natural and other gases. Together with solely power production units, gas represents 10% of the installed capacity. Wind installations build only 2% of the total capacity.

The Czech Republic lacks a clear plan of substitution of the coal power plants with renewable (or zero-emission) sources. Based on the suggestion of the Coal Commission from the end of 2020 the coal should not be used for electricity production after 2038. However, this is based on a condition of sufficient construction of new sources that would replace the closed ones relying mostly on the expenditure of the nuclear units. This process should be evaluated every five years with the regular update of the target year.

A process of the deployment of new green power sources is supported by the subvention schemes that are represented by fixed power purchase price and green bonus. An operator of the unit is able to choose between these two support schemes. With the fixed prices scheme, the owner is able to sell the produced power for the fixed price, which allows him to plan his cash flow at the beginning of the investment in order to recover the initial costs.

In the case of the green bonus scheme, the operator has to find his own customer who would purchase the electricity and negotiate the price on his own. On top of the negotiated price, he receives the green bonus that usually yields more than the fixed price in order to compensate for increased sales risk.

Figure 9: Scatter Plot of the daily average power prices per MWh on EPEX Spot Exchange and the average hourly production of wind and solar power plants in the Czech Republic in 2019

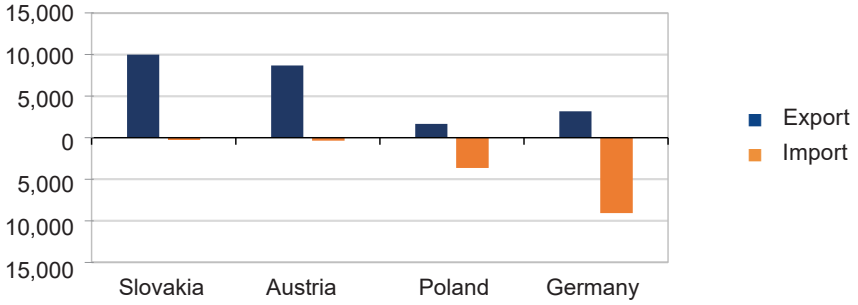


Source: Own compilation based on ote.cz

The chart above shows the distribution of daily baseload prices based on wind and solar production in the Czech Republic in 2019. For most of the followed period, the baseload price oscillated around 40 EUR per MWh. However, there were days with the price drop below 20 EUR. On the other hand, compared to Germany, the daily negative baseload price occurred only once as a combination of a relatively higher production of renewables, lower demand at the weekend, and high renewables production followed by a significant price drop in Germany.

At the moment, the Czech Republic is able to produce more power than it consumes; hence it is a net exporter. In 2020 the overall export reached 23,5 TWh with a net balance of 10,2 TWh. The exported volume of power represents around 30 % of the total electricity production. Major export destinations were Slovakia and Austria. On the other hand, the Czech Republic was the net importer of power from Germany. This would be mostly given by the overhang of power supply in times of high renewables production in Germany.

Figure 10: Real physical flows of power between the Czech Republic and the neighbouring countries



Source: Own compilation based on ERU.cz

The ground for the discussion about the transition of the power production mix is laid by the "Assessment of generation adequacy of the Czech electricity system until 2040" prepared by the Czech grid operator CEPS. The analysis expects an increase of power consumption by approximately 10 TWh within this timeframe. That should be mostly given by the increase of electricity usage in transportation mostly given by the expansion of electromobility. This would increase the necessity on the side of the power supply. In the area of renewables, there is an expected increase of installed capacity of solar units by 200 % to around 6 000 MWs, hydro units to 1 500 MWs (increase by 300 %), and a 50 % increase in biomass units installed capacity. However, in spite of the expected surging power demand and aging fleet of current utilities a need of construction of new flexible sources is foreseen. In case of decommissioning of coal units before 2038 increase of 1,1 GW of nuclear sources and 2,4 GW of gas sources should be necessary for ensuring the stability of the grid. (CEPS, 2020)

Conclusion

The European Union, with its plan Fit for 55, is on a path towards the transition to the energy sector without the production of carbon dioxide emissions. Germany and the Czech Republic represent countries with different possibilities and ways that should lead to the common goal ~~in~~ within the EU. Last year, the energy markets were influenced by the covid pandemic causing a decline in the power demand; therefore, the overall power production dropped in both followed countries.

The power production mix of both countries is different as well as the approach to its transition plan for the future. Unlike Germany, the Czech Republic lacks a clear plan of energy mix transition with steps leading towards emission-free power production. This limits the agility of the country in the changing environment.

With the current state of the production facilities, Germany is able to produce around ~~a~~ half of electricity with renewable sources. However, there is a limitation of the weather

conditions due to a dominant share of wind and solar energy. On the other hand, a significant portion of power demand has to be satisfied by lignite, nuclear, gas and coal units. In spite of the planned decommissioning of nuclear power plants before the end of 2022 and following the plan of closing of other conventional units, this volatility in the power supply could cause pressure to the stability of the whole grid in case of low renewables production in peak power demand periods and vice versa.

On the contrary, the Czech Republic relies on nuclear power, which represents a dominant share of the power production, while wind power is rather marginal. Because of that, the Czech power market does not experience significant sudden volatility with the overhang of the power supply due to changes of weather that would be created inland. Partially the volatility is imported from the German market that is a net exporter of electricity to the Czech Republic. On the other hand, for the Czech market aging fleet of the power units that could be stressed by the closure of the lignite utilities and potential increase of power demand in the future could be challenging.

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Ing. Jakub Zezula is a Ph.D. candidate at the Department of International Business at the Prague University of Economics and Business. In his research, he focuses on financial markets and the energy sector. He is working on a dissertation on the topic of financial derivatives as a hedging tool in the energy sector and teaches the course Financial Management in International Business.

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