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The energy policy of Germany and its impact on the Polish and European energy security

ABSTRACT: Intensive modernization and reconstruction of the energy sector takes place throughout the world. The EU climate and energy policy will have a huge impact on the development of the energy sector in the coming years. The European Union has adopted ambitious goals of transforming towards a low-carbon economy and the integration of the energy market. In June 2015, the G7 countries announced that they will move away from coal fired energy generation. Germany, which has adopted one of the most ambitious energy transformation programs among all industrialized countries, is leading these transformations. The long-term strategy, which has been implemented for many years, allowed for planning the fundamental transformation of the energy sector; after the Fukushima Daiichi nuclear disaster, Germany opted for a total withdrawal from nuclear energy and coal in favor of renewable energy. The German energy transformation is mainly based on wind and solar energy. Germany is the fifth economic power in the world and the largest economy in Europe. Therefore, the German energy policy affects the energy policy of the neighboring countries. The article presents the main assumptions of the German energy policy (referred to as Energiewende). It also presents the impact of changes in the German energy sector on the development of energy systems in selected European countries.

KEYWORDS: Energiewende, energy security, energy policy, power system

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Introduction

The climate policy assumptions included in the Energy Roadmap 2050 (A roadmap 2011) are a major challenge for the energy sector in many European countries. The introduction of significant emission reductions in the energy sector virtually excludes coal from the energy economy. The Industrial Emissions Directive (Directive 2010) has introduced restrictive emission standards for sulfur dioxide, nitrogen oxides, and dust. In addition, at the end of 2016, the European Commission presented a set of regulations regarding the European Union's competitiveness in the transformation of energy markets towards clean energy, the so-called Winter Package (Clean 2016). The regulations proposed in the package introduce a key CO_2 emission limit for electricity generation at a level of 550 g CO_2/kWh. The Winter Package rules out the support (payments under a capacity mechanism) for new installations, i.e. those for which a final investment decision has been made before the entry into force of the Regulation (January 1, 2020), for generation capacity emitting more than 550 grams of CO_2/kWh. Nno coal technology currently meets such requirements. In addition, the Paris Agreement of the 2015 United Nations Climate Change Conference (COP 21 2015) can contribute to changes in the European energy system. The 21st annual session of the Conference of the Parties, held in 2015 in Paris, has set several important goals aimed at reducing greenhouse gas emissions and slowing down global climate change. The key points of the agreement, negotiated by representatives of 196 countries, include: a rapid reduction of greenhouse gas emissions and keeping the global temperature increase well below 2°C and to pursue efforts to limit it to 1.5°C.

Eurostat data shows that the dependence of European Union countries on the imported energy resources and energy in 2017 amounted to almost 54% (Fig. 1). The situation of Poland is definitely better, as the dependence on imported energy sources is just over 30%, which puts Poland at the forefront of the most energy-safe EU countries. Only Denmark is less dependent on imported energy. However, the largest EU economies are in a much worse situation. The dependence on external energy resources exceeds 63% in Germany, about 47% in France, and 76% in Belgium. Countries with a relatively low level of dependence on imported energy use their natural fossil fuels, including the Czech Republic (32.7%) and Poland, or renewable sources, e.g. Denmark (around 14%).

At present, it seems that Germany is the country that has by far the largest influence on the energy policy of the remaining countries of the European Union. The German energy transformation (Energiewende 2012) initiated in 2011, proposed by the government due to the imposed pace of changes, is a new quality in Germany's energy strategy (Malko 2014). The new energy policy was initiated a few months after the Fukushima Daiichi nuclear disaster. The German government not only established the action plan and the role of the new energy policy, but also set out the assumptions, taking additional values held by the majority of citizens into account. These include: a proper response to the depletion of natural resources, an increase in the independence from energy sources imported from politically unstable countries, and a higher standard of living in the future.

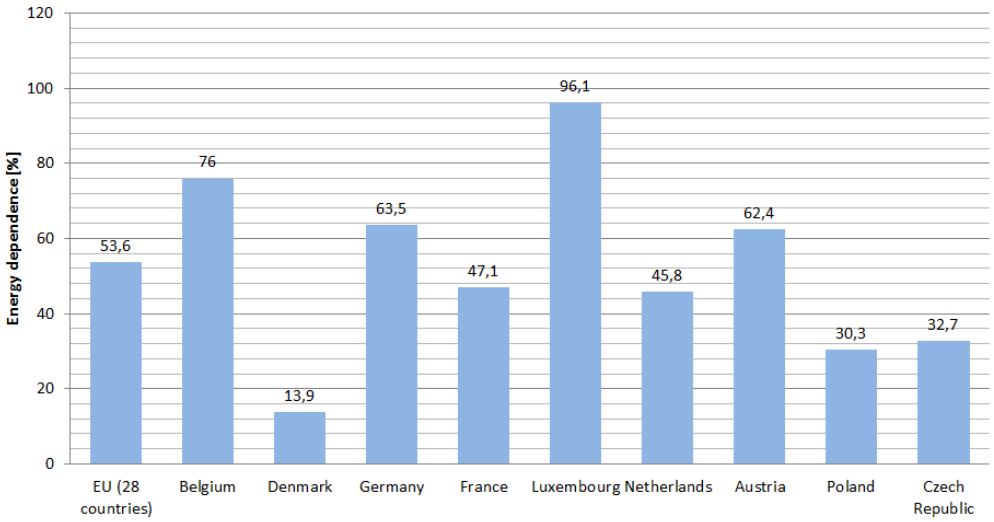

Fig. 1. The energy dependency on the import of energy resources in the total energy consumption (percentage values)
Source: own work based on data by Eurostat (Eurostat 2018)

Rys. 1. Procentowa zależność energetyczna od importu surowców energetycznych w całkowitym zużyciu energii

1. The energy policy of Germany

Analyzing the energy policy of Germany, it can be concluded that Energiewende is one of the key initiatives in Germany's policy, implemented with consistency for at least two decades. Another reason behind the acceptance of changes in the energy policy of Germany by other highly industrialized countries of Western Europe was the Kyoto Protocol, signed in 1997, supported mainly by Germany and France. France, due to the specificity of the energy balance (based on nuclear energy), is interested in cooperating with Germany on the development of EU law in this area. This is supported by the fact that the partnership of Germany and France in the EU guarantees the effective implementation and development of the climate and energy policy of both countries.

In 2000, the German government introduced the Renewable Energy Sources Act (EEG 2000), which replaced the Electricity Feed-in Act (1991). This act marked the beginning of the Energiewende policy implementation phase. From this year on, a significant increase in the installed capacity in generating sources, especially renewable ones, which received substantial support in their development, is clearly visible (Fig. 2). The rapid increase in the installed capacity has not resulted in an increase in the production and consumption of electricity. This is due to a large number of renewable sources, with significantly shorter operating hours, repla-

cing coal and nuclear power sources in the power system. In addition, the main objectives of energy policy include an increase in energy efficiency and an ambitious plan to reduce energy consumption.

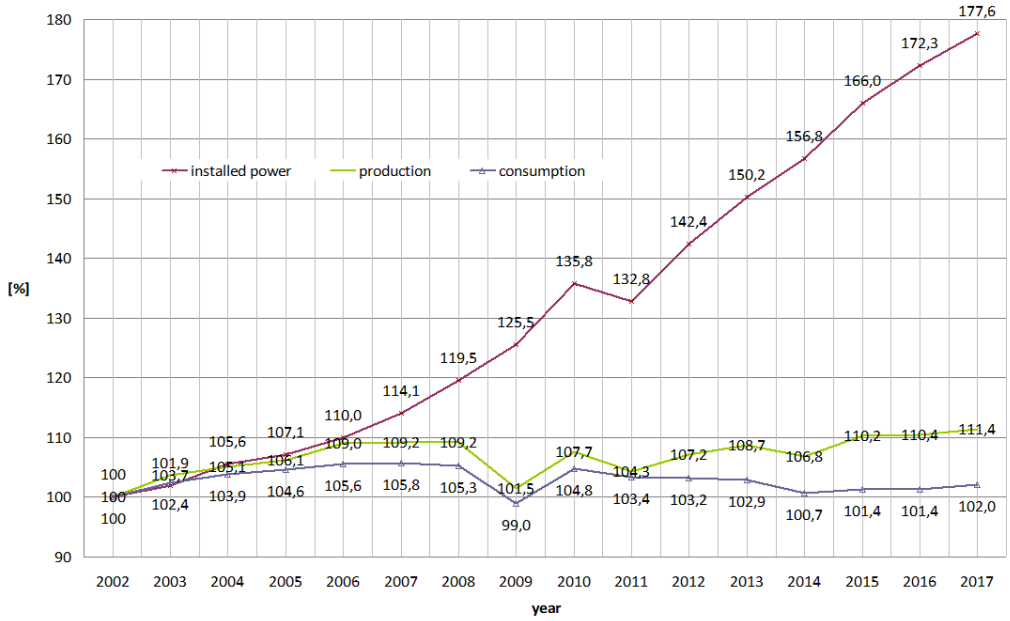

Fig. 2. The increase in installed capacity, production and consumption in Germany (percentage values)
Source: own work based on (Energy Transition 2018) and (Energy 2018)

Rys. 2. Procentowe przyrosty mocy zainstalowanej, produkcji i zużycia energii w Niemczech

The most important assumptions of the German energy policy Energiewende are:

- A complete withdrawal from nuclear energy in Germany by 2022,
- A significant reduction of carbon dioxide emissions,
- The development of a power system based on renewable energy sources.

According to the amendment of the Act, the share of renewable energy in electricity production is steadily increasing from the current 20% to about 50% in 2030 and up to 80% in 2050 (Dena 2014). The main problem in the implementation of the new energy policy (Energiewende) is the need to ensure the continuity of the energy supply after the gradual shutdown of the subsequent nuclear power plants. To achieve this objective, Germany is focusing on coal and natural gas, which is a low-carbon resource allowing for the goals of reducing carbon dioxide emissions to be maintained. Importantly, the first significant change related to the new concept of German energy policy, based on the withdrawal from nuclear power, is the development of new coal-fired power plants. This is quite surprising due to the high emissions of this fuel, but justified by

the need to replace the withdrawn nuclear power plant capacities. At the same time, subsidizing renewable sources results in lowering the level of wholesale electricity prices below the profitability threshold. This is particularly visible in the case of selected depreciated gas power plants. Therefore, gas-fired power plants are no longer used as peak sources and, as a result of their current nature of operation, the energy production from gaseous fuels has significantly decreased.

Germany is one of the countries that aims to increase the capacity of cross-border connections. One of the reasons for that is the possibility of balancing the German energy market in the case of the overproduction of energy from renewable sources and selling it to neighboring countries. The German energy system makes Germany one of the largest energy exporters to neighboring countries. This is related to the significant oversizing of the system in relation to the needs (Fig. 3).

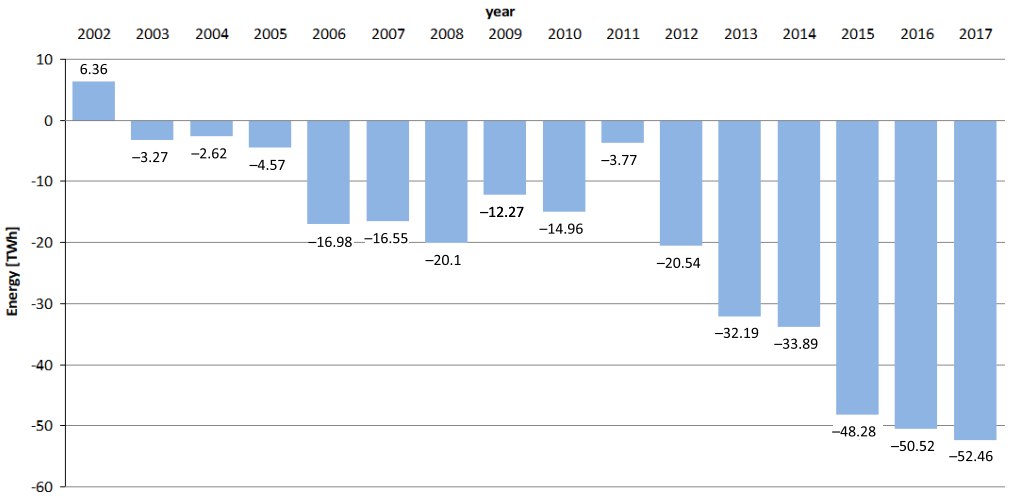

Fig. 3. The annual electric energy balance in Germany in the years 2002–2017
Source: own work based on (Energy Transition 2018) and (Energy 2018)

Rys. 3. Roczne bilanse energii elektrycznej w Niemczech w latach 2002–2017

It is clearly visible that surpluses of produced and exported electricity are associated with a significant increase in the installed capacity. A clear difference can be seen in the case of 2011, which was associated with the shutdown of nuclear power plants due to the Fukushima disaster. In 2017, Germany exported over 52 TWh of electricity to neighboring countries. The largest recipients were: Switzerland, Austria, and the Netherlands (Fig. 4). This energy was often not ordered by the neighboring countries. Therefore, there is a concern that further unplanned energy flows from Germany to neighboring countries can lead to a serious disruption in the power system in the future. As a consequence, many countries are considering, while some have already introduced, the use of phase shifters, which reduce the undesirable flows. However, such actions

are not favorable for the development of the regional electricity market in Germany and Austria, which the European Commission considers to be an important element of the EU internal market for electricity (Motowidlak 2018).

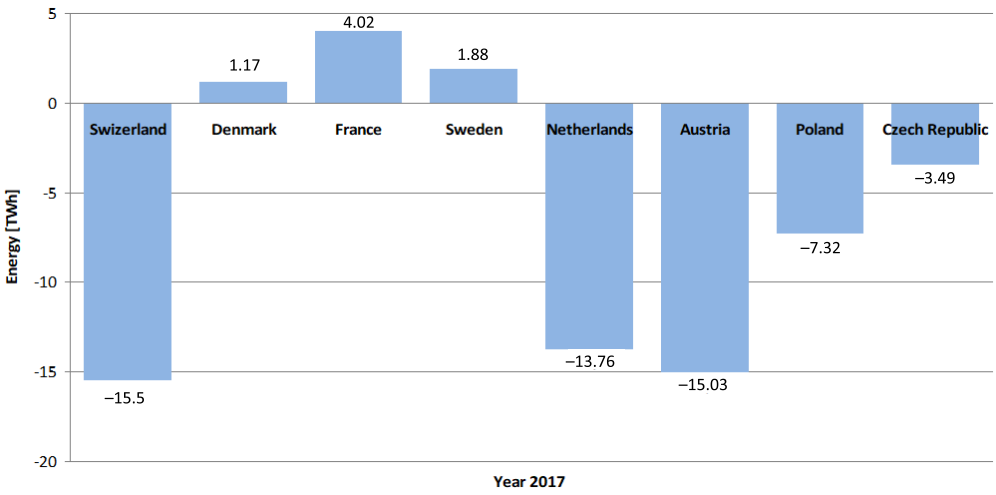

Fig. 4. Export and import of electricity in Germany in 2017
Source: own work based on (Energy Transition 2018) and (Energy 2018)

Rys. 4. Eksport i import energii elektrycznej w Niemczech w 2017

2. The German power system and its impact on neighboring countries

The German energy system has an installed capacity of over 203 GW; the annual energy production is over 650 TWh. The energy production exceeds the energy demand, which in 2017 amounted to around 600 TWh. When comparing the German energy system with the systems of neighboring countries, it can be seen that it is comparable with the combined energy systems of neighboring countries. Table 1 shows the total installed capacity in individual countries; Figures 5 and 6 present the installed capacity of various generating sources and the production of electricity from different sources.

Analyzing this data, it can be seen that the German energy system is characterized by a high degree of diversification of generation sources. In other countries, the degree of diversification is significantly lower and there is always a dominant energy source in the power system. Electricity production in France is similar to production in Germany, despite a much lower installed

capacity. This is related to the specificity of the French energy sector, which is based on nuclear sources.

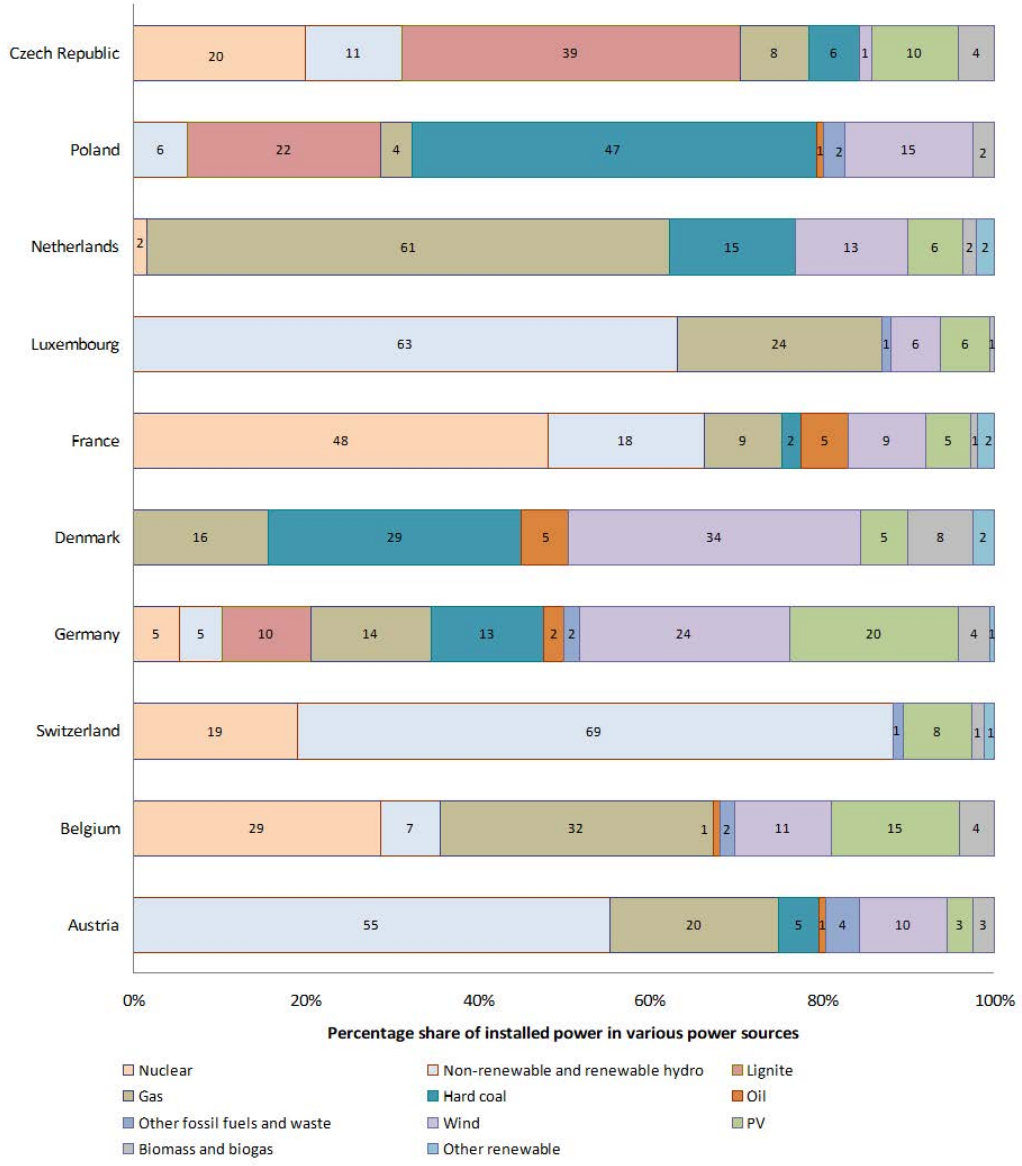

Fig. 5. The installed capacity in individual generation sources in the selected countries (percentage value)
Source: own work based on data by ENTSO-E (ENTSO-E 2018)

Rys. 5. Udział procentowy mocy zainstalowanej w poszczególnych źródłach wytwórczych w wybranych krajach

TABLE 1. The installed generating capacity in Poland and the selected European countries (data for 2016)

TABELA 1. Moc zainstalowana w źródłach wytwórczych w Polsce i wybranych krajach europejskich (dane za rok 2016)

Country	Austria	Belgium	Switzer-land	Germany	Denmark	France	Luxem-bourg	The Nether-lands	Poland	Czech Republic
Installed capacity [MW]	24,646	20,636	17,616	203,668	15,525	130,873	2,090	31,749	38,278	20,188

Source: Own work based on data by ENTSO-E (ENTSO-E 2018).

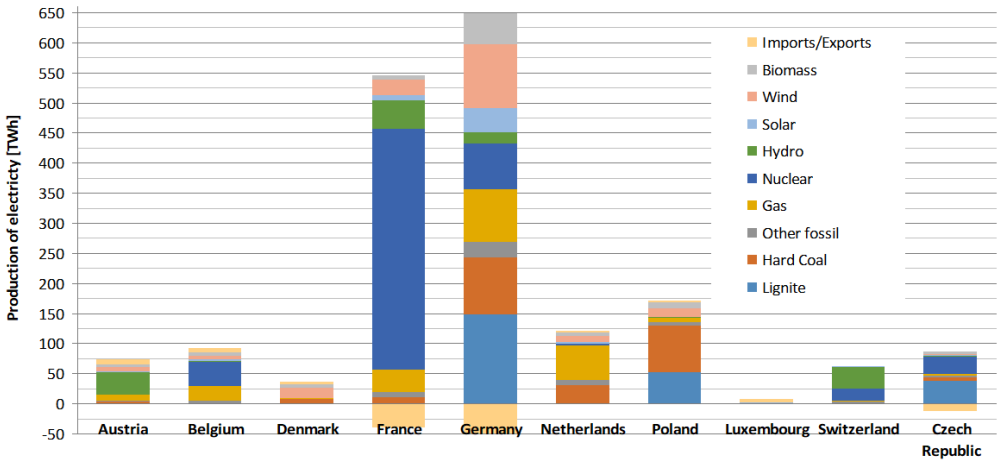

Fig. 6. The production of electricity from different sources in the selected countries
Source: own work based on Sanbag 2018; IEA 2018; Schweizerische 2016

Rys. 6. Produkcja energii elektrycznej z poszczególnych źródeł w wybranych krajach

Despite the negative German attitude towards energy, it seems that the share of both types of coal in the German energy balance of around 37% will decrease very slowly. In the German energy mix, approximately 11% of the energy demand is met by nuclear energy. According to the decisions of the German government and parliament, the last eight active nuclear power plants will be shut down by 2022. Since 2005, more than 14 GW of coal-fired power has been withdrawn from the German system. Despite this, the German energy system has the most installed capacity of coal-fired power in Europe, with a capacity of over 50 GW (Fig. 7).

In the years 2010–2017, several European countries invested in the development of new coal-fired generating capacities, which will be used for the next several years (Ruszel 2017). Nevertheless, many European countries have announced their intention to move away from coal-based energy. In total, over 40 GW, which accounts for 21% of the currently used coal-based units in Europe, of coal capacity is installed in countries which have announced their withdrawal

from coal-based electricity generation. The *Powering Past Coal Alliance: Declaration* has been signed by, inter alia: Austria, Belgium, Denmark, France, and the Netherlands, that is countries neighboring Germany. Interestingly, Germany is discussing the signing of the agreement. Table 2 presents the announcements about withdrawal from coal-fired power generation in individual European countries.

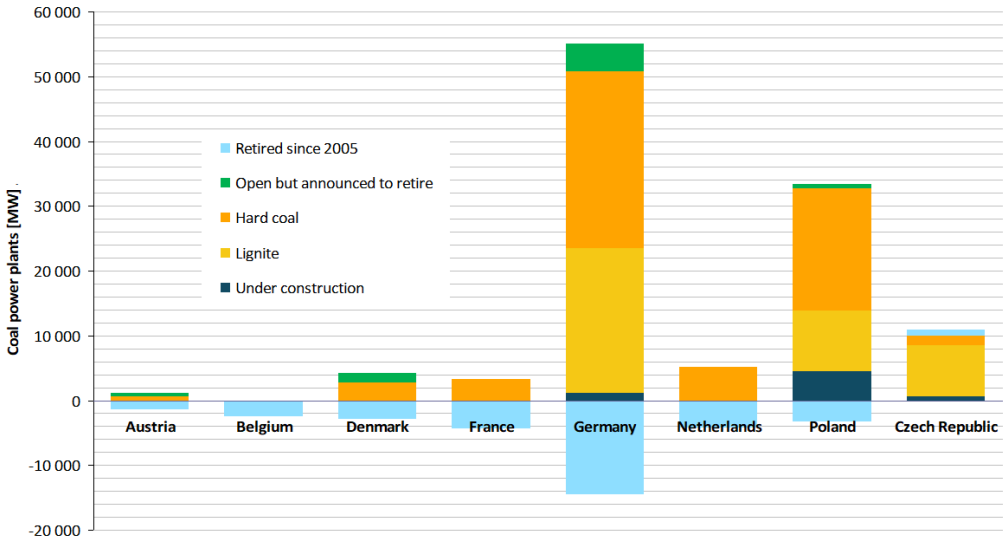

Fig. 7. The installed capacity in coal-fired power plants in the selected countries
Source: own work based on: Europe Beyond Coal: European Coal Plant Database (Europe 2018)

Rys. 7. Moc zainstalowana w elektrowniach węglowych w wybranych krajach

TABLE 2. Announcements about withdrawal from coal-fired power generation in individual European countries

TABELA 2. Zapowiedzi o wycofaniu z energetyki węglowej w poszczególnych krajach europejskich

Country	The gradual withdrawal from coal-fired power generation.
Austria	The gradual withdrawal from coal-fired power generation by 2025, taking into account the gradual withdrawal by 2020.
Belgium	Belgium is the first and until now the only EU Member State that has withdrawn from coal power. The last coal-based power plant to be closed in March 2016.
Germany	The ongoing discussion about gradual withdrawal; no specific dates set.
Denmark	Gradual withdrawal from coal by 2030.
France	France committed to withdraw from coal by 2023.
The Netherlands	Gradual withdrawal from coal by 2029.
Poland	No discussion about the gradual withdrawal from coal energy – no current energy policy.
Czech Republic	No discussion about the gradual withdrawal from coal energy

Source: Own work based on (Overview 2018).

It seems that the changes currently taking place in the energy balance of Germany reduce the energy security of the country. This is due to the increased dependence on the supply of imported energy resources, especially gas. An important threat to Germany's energy security is also the instability of energy supplies from wind and solar plants. The oversized power system based on renewable sources with a stochastic character of operation will certainly need large amounts of new capacities, namely reserve generating capacities, capable to flexibly respond to changes in the production based on renewable sources. Therefore, it seems that Germany will need strong support in the form of stable energy sources from neighboring countries.

In addition, Germany can use its energy policy in the regional dimension. In the long-term, as a result of to the implementation of the EU's climate and energy policies, Germany may gain the status of a European energy exporter. It can also become a kind of energy hub, exporting excess energy to neighboring countries. This situation will further increase the advantage of the German economy over other European countries. This may consequently lead to dependence of the neighboring countries on energy imported from Germany.

Conclusions

The further implementation of the Energiewende policy scenario by the German authorities may adversely affect the functioning of the energy sectors of some European countries. Putting pressure on rapid changes in the climate and energy policy by the German authorities may, in consequence, lead to a complete decarbonization of energy in the coming years, and thus break down the functioning of the Polish energy sector, based almost entirely on hard coal and lignite.

In the case of a significant development of renewable sources and the lack of highly efficient energy storage technologies, the need to install new flexible reserve capacities should be taken into account. Currently, gas based energy sources are the only viable option. Unfortunately, the increase in gas consumption is associated with a further deepening of the dependence on gas supplies from countries with significant gas reserves, including Russia.

The Energiewende policy is, at the same time, an effective tool for pursuing Germany's economic and political interests, both in the internal and external dimensions. The political nature of changes in Germany's energy sector is of particular importance. The successive German governments are able to implement the discussed project despite the ever-increasing financial outlays as the costs are mainly borne by the German society. European countries will not be able to suddenly move away from coal and nuclear energy and imitate the Energiewende policy. It seems that few countries can afford to finance such financial burden, as it is not always possible to subsidize renewable energy sources from the state budget. In turn, Germany is eager to reach for new norms and climate policy, because this forces technological progress, which is beneficial for the development of the industry. Therefore, when examining the problems of the German energy system related to the excessive development of renewable

sources, one should consider what the new energy mix of European countries should be, so as not to destabilize the entire system.

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Radosław SZCZERBOWSKI

Polityka energetyczna Niemiec i jej wpływ na bezpieczeństwo energetyczne Polski i Europy

Streszczenie

Na całym świecie trwa intensywna modernizacja i przebudowa sektora energetycznego. Polityka klimatyczno-energetyczna UE wywiera ogromny wpływ na rozwój sektora energetyki w perspektywie najbliższych lat. Unia Europejska przyjęła ambitne cele polegające na transformacji w kierunku gospodarki niskoemisyjnej oraz integracji rynku energii. W czerwcu 2015 r. kraje G7 ogłosiły, że będą dążyły do całkowitego odejścia od wykorzystania węgla na potrzeby krajowych systemów energetycznych. Niemcy, które przyjęły jeden z najambitniejszych programów transformacji energetycznej spośród wszystkich krajów uprzemysłowionych, należą do liderów tych przemian. Dzięki tej długoterminowej strategii, która jest realizowana już od wielu lat, planują zasadniczą transformację swojego sektora energetycznego, a po awarii w elektrowni jądrowej w Fukushimie planują całkowitą rezygnację z energii jądrowej i węgla na rzecz energii odnawialnej. Niemiecka transformacja energetyczna opiera się w głównej mierze na energetyce wiatrowej i słonecznej. Niemcy są piątą potęgą ekonomiczną na świecie i największą gospodarką w Europie. Dlatego niemiecka polityka energetyczna ma również swój wpływ na polityki energetyczne krajów sąsiednich. W artykule przedstawiono ogólne założenia niemieckiej polityki energetycznej, która określana jest jako Energiewende. Przedstawiono także, jaki może być wpływ zmian zachodzących w niemieckim sektorze energetycznym na rozwój systemów energetycznych wybranych krajów europejskich.

SŁOWA KLUCZOWE: Energiewende, bezpieczeństwo energetyczne, polityka energetyczna, system elektroenergetyczny