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In the face of the rising importance of natural gas to the Polish economy¹

Abstract

Objective: The purpose of this text is to determine ways of diversifying the sources of origin and directions for importing natural gas to Poland until the agreement for the supply of Russian gas expires in 2022. In so doing, the growth of extraction in Poland, deliveries from other countries and the partial replacement of gas in the economy with raw materials available in Poland are all analysed.

Research design and methods: A reasonable approach to energy policy, factor analysis and elements of multidimensional comparative analysis were adopted.

Findings: It is important that gas imports to the country are substantially increased in winter and it is essential that the capacity of gas storage facilities, in particular cavity facilities, is increased as well. Furthermore, it is necessary to attempt to reduce energy consumption, with different preferences that facilitate the growth of the share of renewable sources of energy (RSE) in the energy mix.

Implications / Recommendations: This article presents arrangements which may prove to be useful for implementation of Polish energy policy.

Contribution / Value Added: Considerable political changes and alterations to the gas market have superseded a number of researchers' arrangements and forecasts concerning Poland. What is missing is a comprehensive analysis, based on data from 2017 and 2018, of increasing the diversification of gas supplies to Poland.

Article Classification: research article.

Keywords: natural resource security, national security, energy policy, natural gas, pipelines, transportation investment, natural resources.

JEL classification: F520; H540; H560; L950; O130; Q340; Q470; Q480.

Introduction

In 2017 the world's demand for natural gas was 3.67 trillion m³. According to specialist predictions the economic importance of this fuel will carry on

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increasing (*International Energy*, 2017, pp. 49–53). The extraction, transportation, distribution and storage of natural gas are the most important sectors of the Polish economy with regard to national security (Lewandowski, 2016, pp. 494–495).

As most energy security definitions point out, a government should endeavor to ensure high energy performance and reliability of supply. Its

¹ The article was prepared as part of the statutory research of the Faculty of Political Science of the Pedagogical University of Cracow.

task is to take care of suitable quantity and quality thereof. The prices of energy resources (fuels) should be competitive for the economy and allow enough energy to be generated for citizens to use the facilities of modern civilization, but respect environmental protection requirements.

Diversification of supplies should therefore be considered from at least four points of view (see, for example, Tański, 2016, pp. 104–105):

- 1) economic – attempts to lower energy costs;
- 2) political – independence from one main supplier, who may suddenly suspend supplies which cannot be replaced easily;
- 3) reduction of environmental degradation; and
- 4) diversified use of energy carriers, with a view to limiting dependence on any one of them.

Substantial political changes and alterations to the gas market have superseded a number of researchers' arrangements and forecasts concerning Poland. Even one of the best Polish specialists in this field incorrectly predicted gas consumption (a year in advance), domestic extraction and extraction by Polish companies abroad (Ruszel, 2017, pp. 15–17; cf. *Krajowy dziesięcioletni plan*, 2017, p. 17. More details on price volatility and its independence from producers' decisions: Łęt, 2015).

What is missing is a comprehensive analysis, based on the data from 2017 and 2018, which enables ways of diversifying the sources of origin and directions for importing natural gas in Poland to be determined until the applicable agreement for the import of Russian gas expires in 2022.

Literature review

Since 2014 a few texts involving the issues in question have been published (among others: Janusz *et al.*, 2017, pp. 101–116; Olkusi *et al.*, 2015; Ruszel, 2017). The majority of them are narrow in their scope. For example, they encompass only: one of the listed points of view (Czech, 2017); forecasts for the gas market (e.g. Olkusi *et al.*, 2017; Szoplik & Oszczyk, 2015); gas storage

facilities (Ciechanowska, 2016; Kutyla, 2016); imports of liquefied natural gas (LNG) (Biały *et al.*, 2018; Blacharski *et al.*, 2016; Chłopińska & Gućma, 2018); the consequences of gas market liberalisation (Iwicki *et al.*, 2014; Szurlej *et al.*, 2014); or the role of gas in the electric energy market (Łaciak *et al.*, 2017).

Apart from Emelin (2013), over the last five years energy security researchers have focused on other countries than Poland in Russian journals.

Material and methods

The basis for data will be *BP Statistical*, statistical yearbooks issued by GUS (Poland's Central Statistical Office); *Sprawozdanie Prezesa* from the Energy Regulatory Office for 2017; *Skonsolidowany raport Grupy Kapitałowej Polskiego Górnictwa Naftowego i Gazownictwa* (PGNIG) for 2017; *Prezentacja wyników Grupy Kapitałowej LOTOS za czwarty kwartał 2017 i 2017 rok*; *Polityka energetyczna Polski do 2040 roku (pep2040) – projekt*; *Krajowy dziesięcioletni plan rozwoju systemu przesyłowego. Plan rozwoju w zakresie zaspokojenia obecnego i przyszłego zapotrzebowania na paliwa gazowe na lata 2018–2027 wyciąg*; the act on the change of renewable sources of energy and certain other acts, 2018; Quarterly Report Energy on European Gas Markets Market Observatory for Energy DG Energy v.11; legal acts published in the Trade Bulletin URE – Gas Fuels; data posted on the websites of the European Commission and Polish Power Systems; the Polish Geological Institute; and Gas Infrastructure Europe. Some important data for 2017 and 2018 concerning the issue in question is still unavailable (e.g. Eurostat).

The studies on establishing instruments for measuring energy security in particular countries are still far from completion (Bluszcz, 2017, pp. 1531–1548). One example is the lack of common acknowledgment for the import dependency factor. Authors adopt various criteria in the process of assessing Russian gas import volumes. Some of them maintain that Poland is safe from

the energy perspective when compared to other EU member states. Several Serbian researchers claim that in 2015 Poland was one of the last countries in the EU in terms of energy security (Filipovic *et al.*, 2018, pp. 432, 433–434). Similar differences apply to the condition of gas energy security. In 2017 a few Ukrainian researchers assigned Poland to the group of three EU countries with the lowest gas supply diversification and countries highly dependent on gas supplies controlled by Russia (Dzoba *et al.*, 2017, p. 29).

This article adopts a reasonable approach to energy policy, factor analysis and elements of multi-dimensional comparative analysis.

Results and discussion

In 2017 gas extraction in Russia reached a record level in the space of the last 10 years (see Table 1). In 2017 Russian gas was inexpensive

as compared to other supply options, and for that reason its consumption in the EU rose. Simultaneously, as in previous years, extraction in the EU dropped; it was more than five times lower than that in Russia (see Table 1). In the second quarter of 2018 gas prices rose. The same applied to imports from Russia to the EU, which reached 46% of the entire EU gas import (*Quarterly Report*, 2018b, p. 3).

As in previous years, in 2017 high-nitrogen gas accounted for more than two thirds of the total extraction in Poland (*Energia*, 2018, p. 23–24). High-methane gas dominated imports and sales. In Poland in 2017 the consumption of gas went up by 5%, while extraction fell by 2% (*BP Statistical*, 2018a, p. 28, 29). This trend remained stable in the first quarter of 2018 (*Quarterly Report*, 2018a, p. 8). PGNiG anticipates that extraction in 2018 and 2019 will go down by 5% compared to 2017 (*Skonsolidowany raport*, 2018, p. 32).

Table 1. Extraction of natural gas expressed as methane-rich gas (2007–2017) illustrated by selected examples (in billions of m³)

Country/ organisation	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Poland	4.5	4.3	4.3	4.3	4.5	4.5	4.4	4.3	4.3	4.1	4.0
Russia	601.6	611.5	536.2	598.4	616.8	601.9	614.5	591.2	584.4	589.3	635.6
Germany	15.0	13.6	12.7	11.1	10.5	9.5	8.6	8.1	7.5	6.9	6.4
EU	196.8	198.4	179.0	182.0	161.2	151.5	150.4	137.6	124.5	121.8	117.8

Source: *BP Statistical*, 2018a, p. 26, 28.

Table 2. Consumption of natural gas illustrated by selected examples in 2007–2017 expressed as high-methane gas (in billions of m³)

Country/ organisation	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Poland	14.4	15.6	15.1	16.2	16.5	17.4	17.4	17.0	17.1	18.3	19.1
Russia	428.8	422.7	399.5	422.6	435.6	429.6	423.0	423.6	409.6	420.2	424.8
Germany	88.6	89.5	84.4	88.1	80.9	81.1	85.0	73.9	77.0	84.9	90.2
EU	505.4	516.8	484.2	521.0	470.3	457.9	450.7	400.9	417.7	448.8	466.8

Source: BP 2018, p. 29. Other data: *Rocznik statystyczny*, 2018, p. 110.

As Table 2 shows, gas consumption in Poland is minor when compared to the rest of the EU. Despite differences in data, we can assume that domestic extraction was 4 billion m³; imports from Russia 11.1 billion m³; import by sea nearly 1.63 billion m³; and import from the rest of the EU 2.37 billion m³ (own calculations on the basis of *BP Statistical*, 2018, p. 34 and *Sprawozdanie prezesa*, 2018, p. 211).

At the end of 2018 the stability of gas supplies to Poland from Russia is primarily endangered by the following:

- the option of using the Nord Stream II and Turkish Stream gas pipelines, which are to be completed in 2019, for the purposes of energy-related blackmail (see, for example, Jakimowicz, 2015 and Kłaczyński, 2013, pp. 134–135);
- the use of differences between EU Member States by Russia (see Tomaszewski, 2018, pp. 138–141) to radically increase the prices of gas supplied to Poland;
- the failure to assign relevant means by Russia for the modernisation and growth of infrastructure used to deliver materials to western countries, as well as searching for and extraction of gas from new deposits (Pronińska, 2018, p. 152);
- the current economic and financial potential of geologists in Russia not corresponding to the scale and complexity of tasks to be carried out (Milovidov, 2017, p. 24);
- Russia's influence on the volume of gas exported by Kazakhstan, Azerbaijan and Turkmenistan;
- the reduction in the efficiency of the gas deposits which are currently used in Russia.

Polish authorities assume that conflict with Russia will not cause gas supply downtime to affect domestic households and entities which render basic social services (*Sprawozdanie prezesa*, 2018, p. 195). According to EU regulations, as of 2017, with regard to the supply of gas to these recipients neighbouring EU states are required to help Poland (*Sprawozdanie prezesa*, 2018, p. 215; for more detail on these EU regulations see Fleming 2019, pp. 102–110). The diverse attitudes

towards Russia inside the EU prevents us from establishing the feasibility of these assumptions.

Thanks to EU support given to the development of gas infrastructure in Poland, at the beginning of 2018 Poland was able to import 141.8 million m³ of gas per week by way of what is known as EU physical reverse (calculations based on *Sprawozdanie prezesa*, 2018, p. 190). This was equal to 50% of the gas imported weekly by Poland from abroad in 2017. By 2022 Poland intends to triple its import-related capabilities away from the east: from 12.4 billion m³ to 39.5 billion m³. The network of gas transfer pipelines in the country is to be extended by 2,200 km by 2027 (*Sprawozdanie prezesa*, 2018, pp. 183, 186, 190–191; cf. *Krajowy dziesięcioletni plan*, 2017, p. 19).

As has been aptly noted (Podraza, 2018), to create an international gas hub with a capacity of 70 billion m³ a year in Poland it is necessary to substantially expand the infrastructure, to considerably reduce the share of Russian gas in imports and to build up a significant surplus of gas in stocks.

In the process of evaluating the aforementioned plans, it is also necessary to consider the following:

- the poor progress of works on the construction of pipelines to Norwegian deposits and to Slovakia and Lithuania (*Skonsolidowany raport*, 2018, p. 3);
- the consumption of gas in winter being several times higher than the monthly average);
- the potentially much higher use of gas in the Polish economy by 2022;
- the significant delays in the construction of this kind of development in the Polish power industry (the commissioning of these gas pipelines is scheduled for 2021 and 2022) (*Polityka energetyczna Polski*, 2018, pp. 22, 31);
- the fact that no agreement has been reached for an additional link with the Czech Republic;
- the failure to carry out previous plans regarding the construction of transmission infrastructure from Scandinavia.

At the end of 2017 in Poland we knew of 295 conventional gas deposits extracted using current

technology. They had a total of 119.19 billion m³ of gas (Czapigo-Czapla & Brzeziński, 2018).

Contrary to Golarz's view (2016, p. 168), the current costs related to gas extraction from conventional deposits in Poland are high (see, for example, Bałamut, 2017, p. 23). Although new deposits are being discovered, it is impossible to substantially increase the extraction of gas in Poland, given the current prices of gas (*Polityka energetyczna Polski*, 2018, pp. 4, 10).

However, PGNiG is extracting more and more gas in Norway and Pakistan. In 2017 it extracted 0.548 billion m³ and 0.15 billion m³, respectively, in those countries. In fact, extraction in Norway accounted for two fifths of all the high-methane gas extraction by the PGNiG Corporate Group (*Skonsolidowany raport*, 2018, pp. 75–76). In 2017 the Lotos group also extracted gas in Norway (*Prezentacja wyników*, 2018, p. 7). Due to the lack of a direct pipeline the costs related to importing this gas to Poland are excessively high.

Seemingly, the solution is to make broader use of unconventional gas deposits (*Polityka energetyczna Polski*, 2018, p. 10).

At the end of 2017 the mineable methane deposits in Poland were estimated to reach 96.95 billion m³ (Malon & Tyminiński, 2018). Contrary to the expectations of some researchers (e.g. Graczyk *et al.*, 2017, p. 21), methane extraction is low: in 2017 it was 0.33 billion m³. The reasons behind this are significant expenses related to the following:

- the adoption of extraction methods which allow methane to be obtained with a touch of air;
- the provision of safety for employees and infrastructure (see Gatnar, 2016, p. 114; Wilczyński, 2015, pp. 30–31);
- the ecological consequences of the use of hydraulic fracturing methods to extract methane.

In addition, the use of what is known as shale gas is challenging. In theory Poland could extract 350 billion m³. In practice, however, the vast majority of deposits are located under urbanised areas, which prevents their extraction by way of current technology.

The key issue concerning shale gas is the investors' high costs arising from (see Lis & Stankiewicz, 2017, pp. 53, 61–68; Nizioł, 2016, pp. 75, 81; Wilczyński, 2015, pp. 29–30):

- the considerable depth of the material, which means that preparation for a 300-km²-deposit extraction costs are about PLN 35 billion, using prices from mid-2018;
- the very high income tax on extraction;
- protests by farmers (who fear substantial contamination of ground waters and local earthquakes);
- the need to expand local transmission infrastructure.

The severity of ground water contamination and the frequency of local earthquakes may cause the extraction of shale gas to be a part of political conflict in Poland.

What is known as closed gas can be found in Poland only at such depths that its extraction is considered to be unprofitable.

In 2017 Poland's share of LNG import to the EU was only 2.96%. It acquired 6.5 times less gas in this way than from Russia. The amount was below a third of the regasification capabilities of the terminal in Świnoujście (*Liquefied Natural*, 2018, pp. 34–35; *Sprawozdanie prezesa*, 2018, p. 210). At the end of 2017 the maximum capacity of LNG storage facilities in Świnoujście was 320,000 m³, and the maximum gas intake capability was 656 m³ per hour (*Sprawozdanie prezesa*, 2018, pp. 173–174).

In the first and second quarters of 2018 the growth in LNG import to Poland was among the highest in the EU. In terms of year-on-year growth for those quarters it increased by 30% and 68% (*Quarterly Report*, 2018a, p. 12; *Quarterly Report*, 2018b, p. 11). This was fostered by changes in prices in the gas market. We can estimate that in 2018 Poland will import a maximum of 3 billion m³ of gas. It would thus use at most 60% of the terminal's capabilities.

In the second quarter of 2018 supplies from Qatar accounted for 78% of the Polish LNG market (*Quarterly Report*, 2018b, p. 12; *U.S. Natural*

Gas, 2018). This small country is the world's largest supplier of LNG, but it is subject to pressure from the biggest empires of the world. In this case, the financial terms of supply security are at odds with the economic terms. Based on the November agreement for the supply of LNG from the US, in the years 2019–2022 Poland is to receive 0.7 billion m³ of gas a year, and in the years 2023–2042 1.95 billion m³ per year (*yearbook.enerdata*, 2018). Current terminal regasification capabilities make possible the full performance of that agreement on an annual basis. The prerequisite is maintaining this year's supplies from Qatar and Norway and full availability of the port during the winter.

The EU has provided considerable funds to support the expansion of the terminal's regasification capabilities by 50%, as scheduled for the years 2018–2022 (*Quarterly Report*, 2018b, p. 11). Polish plans for the years to come involve the further development of the terminal and the construction of a floating terminal in the vicinity of Gdańsk. These investments will lead to an increase in maximum regasification capabilities from 5 billion m³ per year (at present) to 14–18 billion m³ per year (calculations based on: *Sprawozdanie prezesa*, 2018, p. 186; *Krajowy dziesięcioletni plan*, 2016, p. 18). If we rely on current estimates for the growth of the Polish economy's demand for gas (Olkuski *et al.*, 2017, p. 53) with attractive LNG prices, the use of terminal capabilities in Świnoujście and the vicinity of Gdańsk will stabilise gas imports from Russia until at least 2040. These investments will, however, not be sufficient to have optimal supply diversification by 2022. Given the current prices of gas supplied through pipelines, the aforementioned investments are economically unprofitable, and the construction time needed for the related pipelines will trigger bureaucratic and legal obstacles.

In mid-2018 the major contraindications against supplying Poland with gas by sea are the following:

- the financial terms of the contract with Russia, which are still more beneficial than LNG-related agreements;

- Poland has no LNG tankers, which results in higher transportation prices;
- the high costs of terminal maintenance;
- the largest LNG tankers cannot call at the port in Świnoujście due to their size compared to the limitations of the port;
- the concentration of regasification in Świnoujście dramatically strengthens the effects of potential terrorist attacks or port blockades;
- there is sea ice in winter when the terminal is needed (see *Dopuszczalne zanurzenia*, 2018; Kaźmierczak, 2008, pp. 93–95; Sikora, 2013, p. 146; Szoplik & Oszczyk, 2015, p. 11. For an alternative point of view see Gałczyński *et al.*, 2017, pp. 110–45);
- the current capabilities of the terminal, transmission gas pipelines and road transport allow less than 0.42 billion m³ of gas to be transported a month from Świnoujście to other parts of Poland at very low temperatures.

In order to considerably limit Poland's dependence on Russian gas by 2022 we cannot use other sources of energy obtained in the territory of Poland. The share of coal in primary energy consumption in Poland is declining as coal is replaced by gas. In 2017 the difference between these materials was 48.7% to 16.5% (*BP Statistical*, 2018, p. 9). By 2022 the share of coal in primary energy consumption in Poland will be declining as coal is replaced by gas (see *Sprawozdanie Prezesa*, 2018, p. 319).

At present the best growth prospects in the Public Power System are assigned to gas stations. In fact, in 2017 they accounted for just 3% of all production of electricity (for more details see Gabryś, 2018, pp. 312–313). In terms of power installed, their capabilities grew much faster in 2017, from 1,610 to 2,341 megawatts, which was 35% of the entire annual power increase in a sector dominated by coal power plants (*Raport 2017*). The reason behind this is not an economic analysis of energy production (for more about that regarding Poland see Król & Ocloń, 2018, pp. 11–29). Poland is a net importer of hard coal and brown coal. In 2017 domestic coal extraction fell to

127 million tonnes. 13.6 million tonnes were imported (mainly hard coal), and 7.2 million tonnes were exported (*Energia*, 2018, p. 22; cf. *EU energy*, 2017, p. 216). With regard to hard coal this was a result of EU energy policy, which generated uncertainty regarding the functionality of coal plants, low coal prices on the world market, and high extraction costs in Poland. With regard to brown coal a crucial factor is local residents who disagree with extraction being started in areas in which deposits can be found. They are afraid of the severity of mining damage (Pazderski & Bandera 2017, p. 68; *Rocznik Statystyczny*, 2017, p. 102).

Large-scale coal and biomass co-firing, supported by Polish authorities, contradicts the intentions of the European Commission, generates costs related to boiler adaptation, ecological issues as and partial biomass import (see, for example, Rajczyk, 2017, pp. 15, 20, 34). Simultaneously, in the first quarter of 2018 the processing of biomass in Poland was more expensive than gas-based energy (*Sprawozdanie z działalności prezesa*, 2018, p. 286).

Climate change reduces the effectiveness of potential supply cuts by Russia. The likelihood of long periods of low temperatures in winter is getting smaller and smaller. At the same time, climate change has a negative influence. For this reason the EU Winter Package titled “Pure Energy for All Europeans” (for more details see Paska & Surma, 2017, pp. 21–28) placed an emphasis on a radical reduction of the impact of coal on the Polish power industry. Well-known CO₂ emission reduction technologies in coal plants are, in fact, unprofitable. In 2017 Poland was the fifth largest CO₂ emitter country in the EU (*BP Statistical*, 2018a, p. 49).

It is unlikely that a nuclear power station will be built in Poland by 2025. The following symptoms make that state of affairs likely: the previous delays in investments in the power industry; the substantially higher construction costs than for other kinds of plants (when calculated in terms of power produced), public opinion (Ligus, 2017,

p. 17); and the risk of Poland’s dependence upon uranium supplies (Janowski, 2016, p. 66-67) from Russia or transported through Russia (e.g. from Kazakhstan).

The major obstacles in developing RSE are the still high energy production costs (*Polityka energetyczna Polski*, 2018, p. 27), the considerable variability of the amount of energy available and serious storage-related problems. In terms of the main RSE in 2017, the largest growth was recorded by hydro-energy plants (*BP Statistical*, 2018b, p. A7). In the face of EU climate policy, Poland’s hydroenergy resources are, however, much too small to be able to hinder the growth in use of gas in the power industry.

It is too early to judge whether another RSE-concerned act will make possible the resumption of the dynamic growth of wind power. It came into effect in July 2018 (The act on changes in renewable sources of energy and some other acts, 2018).

This being the case, in the process of planning investments, firms ignore gas reduction plans set out in the Winter Package and prioritise the CO₂ emission indicators which are to be followed by power plants, as also specified in that document. According to the data given by Polish Power Grids, as of July 2018 the achievable net power of gas-powered generating facilities to be erected was 4.37 gigawatts. This is eleven times bigger

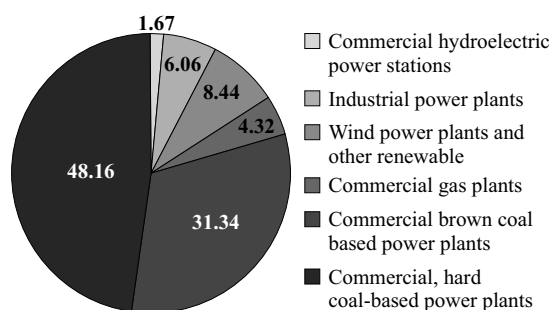


Figure 1. Percentage share in domestic electric energy production of particular groups of plants, by type of fuel, 2017

Source: *Report 2017*.

than their equivalents powered by water and wind. It slightly exceeds the net power of generating facilities powered by coal (*Rynek mocy*, 2018). The scale of potential changes is much larger. The above-stated investments in coal power result primarily from a need to replace, by 2022, a substantial number of the facilities of this sector, which are more than 25 years old (see *Polityka energetyczna Polski*, 2018, p. 5).

Perhaps it was the high cost of infrastructure maintenance that led Polish gas stores to be still smaller than Slovakian equivalents in September 2018. They could accommodate 2.985 billion m³ of gas (calculations based on: *Historical data*, 2018; *Skonsolidowany raport*, 2018, p. 155; *Sprawozdanie prezesa*, 2018, p. 171, 175). It is wrong to think that this amount is enough to ensure energy security for Poland (Janusz *et al.*, 2017, p. 115) in relation to 2018. Since 2016 there has been a substantial growth in gas consumption in Poland. In addition, Russia has threatened to suspend gas supplies to other countries in winter (Kochanek & Kazimierzak, 2015, pp. 222–237), when the consumption exceeded the yearly average considerably.

In mid-2018 in Poland only 0.735 billion m³ of gas could be stored in cavity storage facilities. They can collect gas for the transmission network quickly. Storing the remaining 2.255 billion m³ was possible only in storage facilities whose gas intake capability was “minor in relation to active capacity” (*Sprawozdanie prezesa*, 2018, p. 211). An obstacle to construction of numerous or capacious cavity storage facilities in Poland are the geological conditions (Ślizowski *et al.*, 2017, pp. 167–178). The maximum power of gas intake is when a storage facility is full (100%). This is the reason why Polish authorities wish to fill storage facilities as much as possible in 2018 (*Historical data*, 2018; *Quarterly Report*, 2018b, p. 15) and intend to enlarge them (e.g. *Polityka energetyczna Polski*, 2018, pp. 23–24).

In 2017 only seven various sized underground gas storage facilities were operating in Poland. This increases the risk of successful terrorist

attacks. Depending on the country in question, the rental by Polish companies of gas storage facilities abroad either reduces energy security or is unprofitable. In 2017 the rented gas storage facilities abroad (in the EU) had a maximum of 4.4% of all obligatory gas reserves of Polish companies (*Sprawozdanie prezesa*, 2018, pp. 200, 212). The figure for 2018 will probably be similar (see, for example, *Komunikat prezesa*, 2018, p. 23).

The increasing gas market liberalisation in certain zones year-by-year (*Sprawozdanie prezesa*, 2018, p. 181), still forced in the EU, remains dangerous from the political point of view (*Polityka energetyczna Polski*, 2018, pp. 27, 31). In spite of the attempts of Polish authorities, Russia’s impact on companies who import, extract, transmit and store gas is likely to increase.

In 2018 the prices of gas supplied to Poland determine the prices paid by recipients (see, for example, *Decyzja prezesa*, 2018, pp. 2–3). The awareness of the importance of gas energy security does not, however, translate into citizens being ready for related costs (see, for example, Mrozowska, 2018, pp. 37–39). A significant increase in gas prices, related to an improvement in energy security, may affect public support for the government.

Conclusions

Contrary to the hopes of some researchers (e.g. Tański, 2016, p. 105), the main obstacle to gas supply diversification in Poland is the contradiction between the aforementioned points of view: economic, political, ecological...

Currently Poland is able to negotiate terms with Russia, thanks to low gas prices, the moderate (according to most climatologists) likelihood of long, severe winters, and EU support for the expansion of gas infrastructure in Poland.

In March 2018 the head of the URE presented an official statement that the current gas infrastructure development “prevents rapid and effective reaction to supply disruption. It is essential that works are intensified to the benefit [...] of diversification

of roads and sources of supply” (*Sprawozdanie prezesa*, 2018, p. 209). This is relevant with respect to short-term disruption and mild winters.

If very low temperatures continue for a long time, Polish authorities have to take into consideration a potentially much more dangerous conflict with Russia. The demand for gas will increase rapidly, EU imports will reach a maximum of 141.8 million m³ of gas per week, while weather and ice in the Baltic Sea will hamper LNG importation. The situation may get even worse due to the insufficient transmission infrastructure from the terminal, declining maximum daily gas intake from storage facilities as well as the risk of successful terrorist attacks on regasification systems and the largest storage facilities. The timely supply of LNG from Qatar may be influenced by the scale of the contemporary Russian impact in the Persian Gulf. Because Poland’s EU neighbours refrain from providing assistance, it will be necessary to dramatically limit supplies for the economy and citizens.

Simultaneously, further implementation of EU energy policy helps Russia to increase its influence on the Polish gas market and may lead to substantial growth in gas consumption in Poland by 2022. Given the situation of coal power plants and RSE plants, we may predict that, by 2022, it is unlikely that the share of gas in production of electricity in Poland will remain below 16%.

Given current prices, the costs related to gas extraction from conventional deposits in Poland are high, while LNG importation is still unprofitable. It is very unlikely that by 2022 gas extraction by PNGiG and Lotos in Norway, Pakistan and Libya will have a considerable impact on diversification. This assumption is based on transportation costs and the scale of extraction in the last five years.

Significant extraction of shale gas and closed gas is unlikely in Poland during next five years. This results from the limitations of the technology currently used. To make sure that extraction is feasible at all it is necessary to reduce taxes and to assign to residents the right to deposits which are under their property. An opportunity to have

additional income will change some farmers’ attitudes towards investors.

A considerable increase in the prices of Russian gas would probably lead to profitable imports from the EU and by sea as well as an enlargement of extraction from domestic deposits and the use of RSE. However, Poland must be prepared for a rapid increase in the share of these sources of energy in supplies. This is the effect of long-term investments in the gas sector and reduced competitiveness of the Polish economy, resulting from higher prices of the material in question.

With a view to limiting the effects of a potential blockade of Świnoujście port and terrorist attacks on terminals, it is necessary to build a few small LNG handling points, as well as related pipelines. The completion of such projects by 2022 is virtually impossible. However, rapid progress of work will affect negotiations with Russia. A similar situation regarding gas pipelines negotiated with Denmark.

In the aforementioned context, in order for Poland to achieve a strong position during negotiations in 2022 the priority should be to increase the options for importing gas in winter and the capacity of gas storage facilities by 100%.

However, as aptly noted, the expansion of infrastructure by 2022 is unable to compensate for a shortage of Russian gas (Baltensperger *et al.*, p. 474). It is also necessary to strive to improve the co-ordination of actions in the EU (including a reduction in the energy consumption of economies) as well as state preferences which facilitate faster growth of the share of renewable energy sources in the energy mix.

For effective energy policy it is also crucial to keep a sense of security among citizens. It is necessary to keep on propagating the intensification of works over sources of gas supplies which are independent of Russia.

It is essential to carry out further studies on methods of limiting gas consumption by the Polish economy when temperatures are low. It is important that we continue the quest for convenient domestic venues for the erection of five

additional cavity gas storage facilities with a total capacity of 1.5 billion m³.

It is also advisable to support studies on inexpensive technologies which foster pro-ecological coal energy extraction, e.g. regarding biomass and enriched coal co-firing.

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