



The Polish Natural Gas Market – Resources, Extraction, Import and Consumption

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Abstract

Poland has been dependent on natural gas supplies from the East for many years. This dependence is a problem for our country, as it reduces the energy independence and energy security of Poland. Therefore, attempts to change this situation have been made for many years. The construction of the gas terminal in Świnoujście was the most spectacular investment in this area. It will allow covering up to half of Polish gas demand, thus limiting the dependence on supplies from the east. Domestic natural gas resources, whose deposits are located in the Polish Lowland, Permian deposits of the Fore-Sudetic and Greater Poland region, and in Carboniferous and Permian deposits of Western Pomerania, are also used. Natural gas also occurs in the Carpathian Foredeep and in the economic zone of the Baltic Sea. However, the amounts of natural gas produced in Poland are not enough to cover the demand for this raw material. In 2017, the production amounted to 3.9 billion cubic meters, which allowed to cover less than one-quarter of the demand. Poland's hopes for shale gas faded after unsatisfactory results of shale gas exploration. This is the reason for the importance of natural gas imports. In 2017 year it amounted to 11.4 billion cubic meters. To ensure stable supplies, gas pipelines and storage facilities are also needed. Recently, there have been numerous investments in this area, while the main project is the construction of the Baltic Pipe gas pipeline connecting Poland and Norway. The connections with Lithuania, the Czech Republic and Slovakia are also of strategic importance for Poland. The gas consumption in Poland is constantly increasing; this trend is likely to continue. Therefore, the current investments are of great importance.

Keywords: natural gas, shale gas, resources, extraction, import, consumption

Introduction

The demand for gas fuel is constantly increasing. This applies not only to Poland but also to other countries. Due to its numerous applications, it is used both in households and in the industry. The IEA World Energy Outlook 2017 presents three energy and fuel scenarios Stala- Szlugaj (2017). In the case of natural gas, as shown in Fig. 1, both Current Policies Scenario, assuming the continuation of current trends in the world, i.e. no actions aimed at combating climate change and New Policies Scenario, providing for certain restrictions, predict a further increase in natural gas consumption. It should be noted that only the most environmentally-friendly Sustainable Development Scenario assumes a slight decrease in gas consumption in subsequent years. The current energy policy of Poland until 2030 assumes an increase in gas consumption in the following years.

The main issues related to natural gas, that is, resources, extraction, import, transmission, storage and consumption, are presented in the following sections of the article.

The demand for natural gas fuel is constantly increasing; this trend is expected to continue regardless of the Sustainable Development Scenario adopted by the International Energy Agency until the year 2030 (Janusz 2013). The projected consumption in 2035

should amount to 4.0–5.2 billion cubic meters, with the current level of about 3.5 billion m³. It is therefore not surprising that Poland pays great attention to the development of this sector.

The development of the gas market in Poland will depend on many factors. These include the price of gas and the prices of other energy resources, the energy policy of Poland and the EU, environmental lobby striving to remove fossil fuels from the country's economy, and the domestic demand for natural gas. The demand for natural gas in Poland, forecasted according to the current energy Policy of Poland until 2030 (The energy... 2009), will amount to 17.1 billion cubic meters in 2020, 19.00 billion cubic meters in 2025, and up to 20,2 billion m³ in 2030. Analyzing the consumption of natural gas in recent years, it can be stated that the actual consumption will be higher than forecasted in the Energy Policy of Poland developed in 2009. This will be primarily influenced by the development of gas energy (Szurlej et al. 2014a).

Resources

The most important natural gas resources are found in the Polish Lowland, Permian deposits of the Fore-Sudetic and Greater Poland region, and in Carboniferous and Permian deposits of Western Pomerania. Gas also

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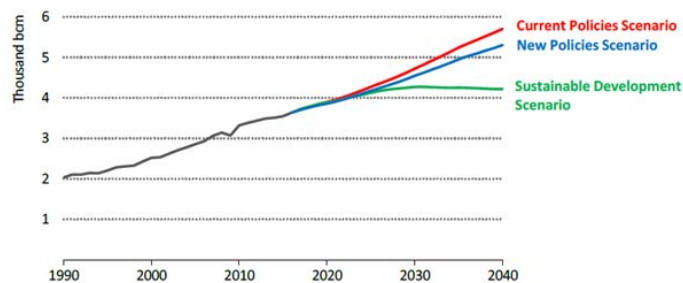


Fig. 1. The demand for natural gas by 2040 in three scenarios. Source: Outlook 2017
Rys.1. Zapotrzebowanie na gaz ziemny do 2040 roku według trzech scenariuszy



Fig. 1. Natural gas occurrence in Poland. Source: <http://www.dziennik.com/wiadomosci/artykul/gaz-lupkowy-nadziejadla-polski>
Rys. 1. Występowanie gazu ziemnego w Polsce

Tab. 1. Natural gas resources in Poland, million cubic meters. Source: Balance 2017
Tab. 1. Zasoby gazu ziemnego w Polsce, w mln m³

The number of deposits	Reserves				Industrial resources
	Anticipated economic resources („balance resources”)			Anticipated sub-economic resources („sub-balance resources”)	
	Total	A B	C		
293	119 721.34	74 696.83	45 024.51	2 219.85	52 295.08

occurs in the foothills of the Carpathians and in the economic zone of the Baltic Sea (Fig. 1). Total reserves of natural gas Poland amount to 119.7 billion cubic meters (as of the end of 2016). At the current level of production, they should last for about 30 years.

Table 1 shows natural gas resources in Poland as of 31 December 2016. Currently, there are 293 natural gas reservoirs in Poland. The total natural gas resources amount to 119 721.34 million cubic meters, including 79 785.04 million m³ of anticipated economic resources and 52 295.08 million cubic meters of industrial resources.

Shale gas

A few years ago, Poland was ranked among the countries with the highest shale gas potential. This group also included the USA, Australia and Canada. While in the above-mentioned countries, especially in the USA, exploration and exploitation of shale gas deposits was successful, shale gas exploration in Poland has brought

unsatisfactory results. Estimates of shale gas resources in Poland are highly variable. So far, 72 exploratory wells were made (as of November 30, 2017) (Ministry of the Environment 2017) and no promising results were obtained. Therefore, most of the companies – oil giants involved in the exploration of unconventional natural gas deposits, such as: ExxonMobil, Chevron, ConocoPhillips, Talisman Energy, have stopped shale gas exploration in Poland. The estimated shale gas reserves in Poland are highly variable depending on the forecasting institution. The Energy Studies Institute (ISE 2014) lists the following estimates:

Energy Information Agency (2011)

- 5.3 billion cubic meters,

Advanced Resources International (2009)

- 2.830 billion cubic meters,

EUCERS (2011)



Fig. 2. The areas of occurrence of shale gas. Source: <http://www.polskielupki.pl/artykul-gaz-lupkowy-w-polsce/74129/zasoby-gazu-lupkowego-w-polsce>
Rys. 2. Występowanie gazu łupkowego w Polsce

– 1.870 billion cubic meters,

Wood MacKenzie (2009)

– 1.370 billion cubic meters,

Lane Energy (2011)

– 1.000 billion cubic meters,

Rystad Energy (2010)

– 1.000 billion cubic meters,

PGI (2012) (maximum estimate)

– 0.865 billion cubic meters,

PGI (2012) (average estimate)

– 0.346 billion cubic meters,

USGS (2012) (max estimate)

– 0.116 billion cubic meters,

USGS (2012) (average estimate)

– 0.038 billion cubic meters.

The areas of occurrence of shale gas are marked in Fig. 2. Today, it can be stated that optimistic statements by politicians from a few years ago, heralding the transition to industrial shale gas production in 2014–2015, were misleading. Today, the prospect of shale gas extraction becomes less and less likely.

Extraction

The production of natural gas in Poland has been decreasing for the last five years since the record high of 4.34 billion m³ in 2012 to reach the level of 3.90 billion m³ in 2017. Fig. 3 shows natural gas production in Poland in the years 2006–2017.

The natural gas production in Poland was different depending on the year. The largest production, exceeding 5 billion cubic meters per year, was recorded in the 70s of the last century. In 1978, the record-high production of 6.6 billion cubic meters was recorded. Since 1989, the production of natural gas started to de-

crease and never exceeded 5 billion m³. Since 2012, the production has been gradually decreasing each year to reach the value of 3.947 billion cubic meters in 2016. In 2016, the share of natural gas in primary energy generation amounted to 5.3%, while the production in the year 2016 covered 23% of the total gas demand (Fuel and energy economy... 2017).

Import

The majority of gas consumed in Poland is imported. This fact is not surprising, given the limited resources of raw materials and a low level of production. Fig. 4 presents imports of natural gas to Poland in the years 2006–2014.

Most of the gas used in Poland is imported from abroad, mainly from the East, but the Polish government is making efforts to diversify gas supplies to Poland and increase the independence from supplies from the East. Given that the Yamal contract will expire in 2022, there is a need for investments in order to ensure gas supplies from other directions. The most important investment in recent years in Poland, aimed at increasing the energy security, was the construction of the Świnoujście LNG terminal. The construction was completed in 2015. The Świnoujście LNG terminal has a regasification capacity of 5 billion cubic meters, about one third of Polish demand. It is planned to expand the terminal's capacity to 7.5 billion m³ and eventually to 10 billion cubic meters. The construction of the second LNG terminal in the Gdańsk Bay with a capacity of 4.1–8.2 billion m³/year (Ten-Year Network Development Plan 2017). On December 11, 2015, the first delivery of liquefied natural gas to the LNG terminal in Świnoujście was completed. The gas was purchased from Qatargas Operating Company Limited and was used to fill the installations and tanks, and for start-up works. In January 2016, tests of the regasification and transmission systems were carried out. On June 17, 2016, the first commercial cargo, with a volume of about 210 000 cubic meters, was delivered. The planned Baltic Pipe gas pipeline with a regasification capacity of 10 billion m³/year is also planned.

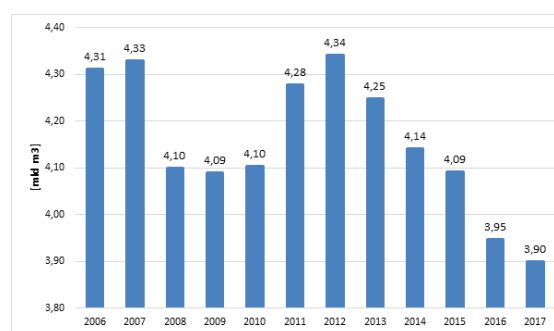


Fig. 3. The natural gas production in Poland in the years 2006–2017. Source: own study based on BP 2017 and (in the case of the last year) information from the “Bezpieczeństwo energetyczne” (Energy Security) conference in Rzeszów

Rys. 3. Wydobywanie gazu ziemnego w Polsce w latach 2006–2017

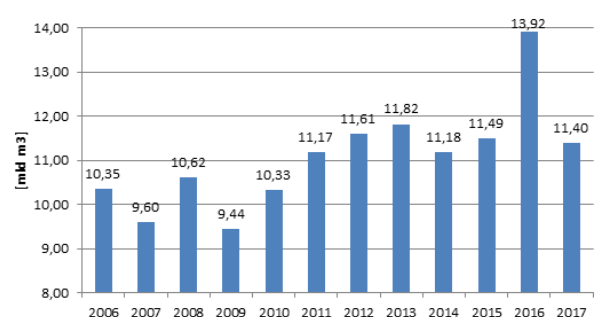


Fig. 4. Imports of natural gas to Poland in the years 2006–2017. Source: own work based on: ARE S.A bulletins... 2006–2015; Fuel and energy economy... 2017 and for the last year, information from the conference energy Security in Rzeszow

Rys. 4. Import gazu ziemnego do Polski w latach 2006–2017

In order to ensure a constant supply of gas from different sources, Poland cooperates with its neighbors within the framework of the Visegrad Group (V4 countries including Poland, Slovakia, the Czech Republic and Hungary). The development of a Roadmap towards the creation of a common regional gas market in V4 countries started in 2014.

Thanks to new investments and international cooperation, the degree of diversification of natural gas supplies from abroad will fundamentally change in the coming years. By 2023, only 31% of natural gas will be imported from the east, which is a huge difference compared to 2012 (71% of gas originating from the east).

In order to achieve this goal, GAZ-SYSTEM S.A. is planning numerous investments. They have been included in the Ten-Year Network Development Plan, including the development plan to meet the current and future demand for gaseous fuels in the years 2018–2027 (Ten-Year Network Development Plan 2017). The expansion of the transmission network has been divided into two periods, i.e. investments to be completed by 2022 and investments to be implemented by the year 2027 (Fig. 5). The modernization of the transmission network, with special emphasis on interconnections, will ensure a high degree of diversification and provide access to new markets.

The connections with Lithuania, the Czech Republic, and Slovakia are of strategic importance. The gas

interconnection between Poland and Lithuania is being implemented as part of the “Baltic Energy Market Interconnection Plan”. The gas interconnection Poland – Lithuania (GIPL) is aimed at the integration of the isolated gas markets of the Baltic States. The planned gas pipeline will have a length of 534 km and will stretch some 352 km in Poland and 177 km in Lithuania. The interconnection will have a starting capacity to deliver 2.4 billion m³ of natural gas from Poland to Lithuania and 1–1.7 billion cubic meters of gas from Lithuania to Poland each year. The Polish–Czech gas pipeline constitutes a significant element of the system which will connect Poland, the Czech Republic, Slovakia and Hungary and link LNG terminals in Poland and Croatia. The connection with Slovakia is of a key importance for the construction of the North-South Corridor. This connection will allow to deliver 4.7 billion m³ of gas from Poland to Slovakia and 5.7 billion m³ in the opposite direction (Ten-Year Network Development Plan 2017). These projects should be implemented in the years 2019–2020.

Transmission

According to the Polish energy law of 1997, gas transmission networks may be owned exclusively by joint-stock companies incorporated in Poland and wholly-owned by the Polish State Treasury. The GAZ-SYSTEM S.A. is appointed as transmission sys-

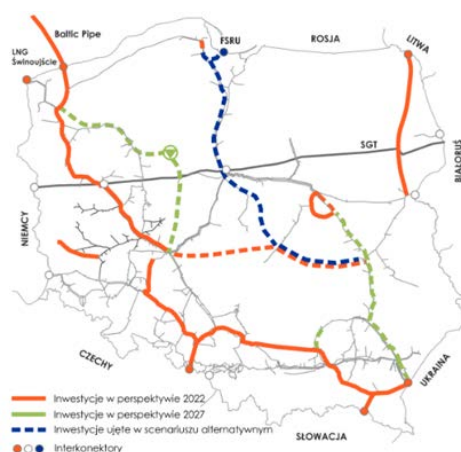


Fig. 5. Investments planned by GAZ-SYSTEM S.A. in the years 2018–2027. Source: Ten-Year Network Development Plan, 2017

Rys. 5. Planowane przez GAZ-SYSTEM inwestycje w latach 2018–2027

Tab. 2. The parameters of the cross-border entry points to the Polish transmission system. Source: Ten-Year Network Development Plan 2017

Tab. 2. Parametry punktów tranzytowych gazu na granicach Polski

Entry point	Operator	Technical capacity	
		Billion m ³ /year	GWh/year
Kondratki	Gazprom Transgaz Belarus /GAZ-SYSTEM S. A.	30,7	42,7
Drozdowicze	PJSC Ukrtransgas/GAZ-SYSTEM S. A.	4,4	5,65
Wysokoje	Gazprom Transgaz Belarus /GAZ-SYSTEM S. A.	5,5	7,04
Mallnow	GASC ADE Gastransport GmbH/GAZ-SYSTEM S. A.	6.1	7.70
GCP (grid connection point) GAS-SYSTEM/Ontras	ONTRAS/GAZ-SYSTEM S. A.	1.5	2.03
Tietierowka	Gazprom Transgaz Belarus /GAZ-SYSTEM S. A.	0.2	0.30
Cieszyn	NET4GAS/GAZ-SYSTEM S. A.	0.5	1.17
LNG terminal	Polskie LNG S. A. /GAZ-SYSTEM S. A.	5.0	7.58

tem operator for natural gas. The president of the Energy Regulatory Office issued a decision that GAZ-SYSTEM was granted the status of the Gas Transmission Operator on the territory of Poland by the 31 December 2030. The transmission system operator is responsible for the management of the transmission system, transport of gaseous fuels using the national transmission network, ensuring the security of gas supply through transmission networks, and the development of the gas transmission network. In 2017, the GAZ-SYSTEM S.A. operated its own gas transmission network with a length of 11 059 km (as of 31 December, 2017).

In 2012, the President of the Energy Regulatory Office approved the Transmission Network Code of GAZ-SYSTEM S.A. The mentioned document introduced a virtual gas trading point without a physical location in the transmission system, which enabled virtual gas trading. In addition, it established the basis for the functioning of the natural gas exchange.

Transmission system consists of two interacting systems (Ten Year Development Plan... 2017): The Transit Gas Pipeline System (TGPS) and National Transmission System, which consists of two subsystems, i.e. high-methane natural gas E and nitrogen-rich natural gas.

Gas is transmitted through the following cross border points:

- The border with Belarus: Kondratki, Wysokoje, Tietierowka (local import),
- The border with Ukraine: Drozdowicze,
- The border with Germany: Forests, Mallnow, Gubin (local import),
- The Border with the Czech Republic: Cieszyn, Branice (local import), Głuchołazy (reserve point),
- The Świnoujście LNG terminal is located in the north of Poland.

Table 2 shows the parameters of the cross-border entry points to the Polish transmission system.

Fig. 6 shows the map of the current and planned cross-border entry points into the transmission system of a strategic importance for Poland.

When it comes to natural gas transmission, the most important connection is the Yamal–Europe natural gas pipeline running through Belarus and Poland to Western Europe. The Polish section of the Yamal–Europe Transit Gas Pipeline System [TGPS] is owned by Transit Gas Pipeline System EuRoPol GAZ S.A. The length of the Polish section, from Kondratki to Górzycza, is 683.9 km.



(*) ENTSOG, The European Network of Transmission System Operators for Gas, is an association formed by gas pipeline operators in Europe.

(**) GCP – Grid Connection Point; cross border points between ONTRAS (Germany) and GAZ-SYSTEM S. A. (Poland). Gubin, Kamminke, and Lasów were connected into the GAS-SYSTEM ONTRAS (GCP GAZ-SYSTEM and ONTRAS) grid connection point on April 1, 2016.

Fig. 6. The natural gas transmission system in Poland. Source: GAZ-SYSTEM and ENTSOG 2018
Rys. 6. System przesyłu gazu ziemnego do Polski

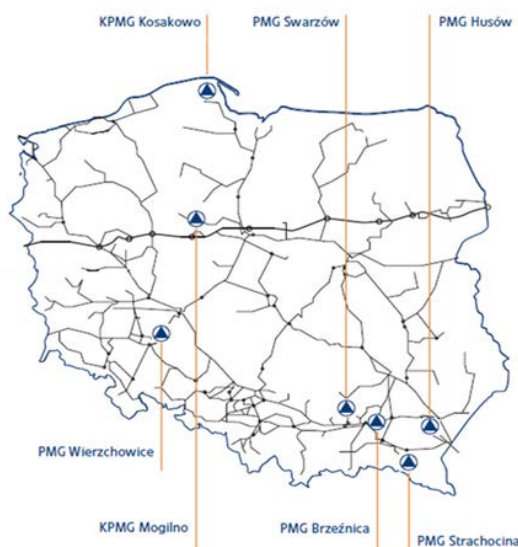


Fig. 7. Underground gas storage sites in Poland. Source: PGNiG 2018
Rys. 7. Podziemne magazyny gazu w Polsce

Storage

Underground gas storage sites are a key element of the gas safety system. Their significance is increasing with the demand for natural gas. Due to technical reasons, gas transmission system is unable to meet the customer needs during the peak winter demand period. However, underground natural gas storage sites can be used to maintain the supply.

At the end of December 2016, there were seven underground high-methane gas storage sites in Poland: PMG Husów, PMG Wierzchowice, KPMG Mogilno, KPMG Kosakowo, PMG Swarzów, PMG Brzeźnica, and PMG Strachocina (Fig. 15). Underground natural gas storage sites were located in depleted natural gas reservoirs, except for the KPMG Mogilno. The latter was built in salt caverns and thus has better parameters for injection and collection of gas. In addition, the

KPMG Kosakowo in the Pomerania Province, consisting of four storage chambers, was built in salt deposits. This is the latest investment of this type, completed in 2015. The total available capacity of high-methane gas storage sites was 2 985.35 million m³ (PGNiG 2018), while in the case of nitrogen-rich gas storage sites (UGS Daszewo and PMG Bonikowo), it amounted to 230 million m³. Operator Systemu Magazynowania Sp. z o.o., part of the PGNiG Capital Group, is authorized to store gas fuels in storage facilities. Operator Systemu Magazynowania Sp. z o.o. is responsible for the exploitation, maintenance, repairs of installations and equipment, and the design and construction of underground storage sites.

The Polish underground gas storage sites and their capacities are presented below. Fig. 7 shows their distribution across the country.

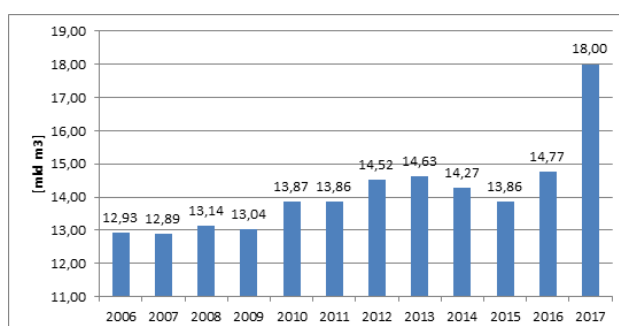


Fig. 8. Natural gas consumption in Poland in 2006–2017. Source: own work based on: ARE S.A bulletins... 2006–2015; Fuel and energy economy... 2017, and (for the last year) information from the conference energy Security in Rzeszów

Rys. 8. Zużycie gazu ziemnego w Polsce w latach 2006–2017

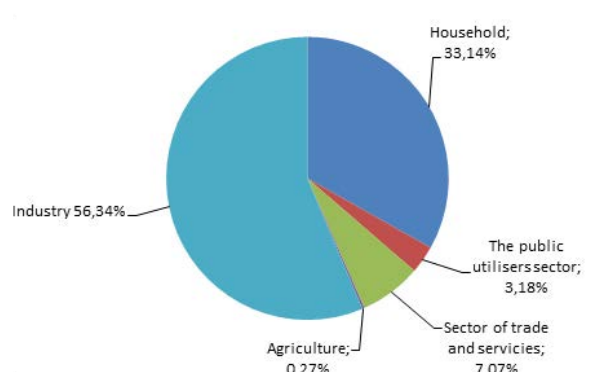


Fig. 9. Sales of natural gas to end users by PGNiG Capital Group entities in 2016. Source: own work based on Gas supply security monitoring result... 2017

Rys. 9. Sprzedaż gazu ziemnego do użytkowników końcowych przez podmioty grupy kapitałowej PGNiG w 2016 r.

The Polish underground gas storage sites and their capacities (million m³) (PGNiG 2018) ranked from the largest to the lowest:

PMG Wierzchowiec	–	1200.00
KPMG Mogilno	–	589.85
PMG Husów	–	500.00
PMG Strachocina	–	360.00
KPMG Kosakowo	–	145.00
PMG Brzeznicza	–	100.00
PMG Swarzędów	–	90.00

Consumption

The consumption of natural gas in Poland is low compared to other European countries. The per capita consumption of natural gas is 413 m³/person/year, which puts Poland on one of the last places in Europe (the average per capita gas consumption in the EU is approximately 800 m³/person/year). The countries with the highest consumption of natural gas in the EU are: Germany – 70.9 billion m³, United Kingdom – 66.7 billion m³, and Italy – 56.8 billion m³. Fig. 8 shows the natural gas consumption in Poland in the years 2006–2016.

The main consumers of natural gas are nitrogen plants and steel and energy industries, i.e. the industrial sector (about 60% of total gas sales), followed by households (around 28%), and utilities sector (10%).

The consumption of natural gas in the agriculture sector is low. However, it should be noted that supplies for the industry are also carried out by other companies. Figure 9 shows the structure of natural gas sales by the PGNiG Capital Group in 2016.

Despite the fact that the consumption of gas in Poland has been increasing since 2009, there was a significant decrease in consumption in 2014. The downward trend continued in 2015; finally, the consumption increased in the year 2016. In 2016, over 56% of natural gas was consumed by the industry, including significant quantities consumed by the chemical industry, where natural gas is used as a raw material for production and not for energy purposes (Fuel and energy economy... 2016). It should be underlined that a competitive natural gas market in Poland has been developed for several years. The entities outside the PGNiG Capital Group with the largest volume of natural gas sales to end users include: Handen Sp. z o.o., EWE Energia Sp. z o.o., ENESTA Sp. z o.o., DUON Marketing and Trading S.A., Polenergia Kogeneracja Sp. z o.o., and DUON Dystrybucja S.A. According to the recent activity report of the President of Energy Regulatory Office, the market share of the PGNiG Capital Group's share in the natural gas market has dropped from 80.2% to 73.7% in 2016. (Activity report 2017).

Conclusions

The situation on the Polish natural gas market is changing dynamically. For five years, the volume of domestic production has been decreasing while the consumption has been increasing. An increased use of gas in the economy is a positive sign, as it makes it easier to adjust to the new emission limits. Both gas and renewable energy sources are clean energy sources, which will certainly gain more and more importance in the long run, not only in the industry, but also in households (Olkuski et al. 2015). In 2017, the consumption of natural gas in Poland reached the level that was expected to be reached in the next two-three years. An increasing number of customers appear to understand the advantages of market liberalization and choose suppliers offering the lowest prices. At the end of December 2016, 78 437 customers changed their suppliers, while in December 2015 and at the end of 2013 this value amounted to 30 749 and 429, respectively (Report 2015, 2016; 2017). This is due to favorable changes in the regulatory environment, liberalization of the gas market, and the increased competition, which is a driving force behind infrastructure development (Szurlej et al. 2014b). In fact, an increase in infrastructure investments has been observed recently. The whole system is being rebuilt. The transmission network, both domestic

and international, is being developed. New connections, which will ensure higher degree of diversification of natural gas supplies, are being developed. The construction of the Baltic Pipe gas pipeline, connecting Poland and Norway, is being planned. The gas storage facilities are also being expanded. The increased interest in building new connections was caused by the unstable situation in Ukraine and the fear of possible interruptions in gas supplies to Poland. The most important investment of recent years in this industry was the construction of the Świnoujście LNG terminal, which allows for gas to be transported from any supplier. This would allow to import 5 billion m³ of gas per year (7.5 billion of m³ after the expansion). Connections with Slovakia and Lithuania will also be built. The connections with Slovakia and Lithuania are to be built by 2020 and 2023, respectively. The completion of these investments would guarantee the security of gas supplies to Poland. What is more, this would make Poland the key gas hub in the region of Central and Eastern Europe.

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Rynek gazu ziemnego w Polsce – zasoby, wydobycie, import, eksport i zużycie

Polska od wielu lat jest zależna od dostaw gazu ziemnego ze wschodu. Zależność ta jest problemem dla naszego kraju, ponieważ zmniejsza niezależność energetyczną i bezpieczeństwo energetyczne Polski. Dlatego próby zmiany tej sytuacji zostały podjęte wiele lat temu. Najbardziej spektakularną inwestycją w tym zakresie była budowa terminalu gazowego w Swinoujściu. Pozwoli to na pokrycie do połowy polskiego zapotrzebowania na gaz, ograniczając tym samym zależność od dostaw ze wschodu. Wykorzystywane są również krajowe zasoby gazu ziemnego, których złoża znajdują się na Niżu Polskim, złoża permskie w regionie przedśudeckim i wielkopolskim oraz w utworach karbońskich i permskich Pomorza Zachodniego. Gaz ziemny występuje również w zapadlisku przedkarpackim oraz w strefie ekonomicznej Morza Bałtyckiego. Jednak ilość gazu ziemnego produkowanego w Polsce nie wystarcza na pokrycie zapotrzebowania na ten surowiec. W 2017 roku produkcja wyniosła 3,9 miliarda metrów sześciennych, co pozwoliło pokryć mniej niż jedną czwartą zapotrzebowania. Polska nadzieja na wydobycie gazu łupkowego upadła po niezadowolających wynikach poszukiwań geologicznych. Import gazu ziemnego do Polski jest znaczny. W 2017 roku wyniósł on 11,4 miliarda metrów sześciennych. Aby zapewnić stabilne dostawy, potrzebne są również gazociągi i magazyny. Niedawno przeprowadzono wiele inwestycji w tym obszarze, a głównym projektem jest budowa gazociągu Baltic Pipe łączącego Polskę i Norwegię. Połączenia gazociągami z Litwą, Czechami i Słowacją mają także strategiczne znaczenie dla Polski. Zużycie gazu w Polsce stale rośnie; ten trend prawdopodobnie będzie się utrzymywał, dlatego też aktualne inwestycje mają ogromne znaczenie dla gospodarki.

Słowa kluczowe: gaz ziemny, gaz łupkowy, zasoby, wydobycie import, zużycie