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"Sea gas" inclinations for the Polish energetic system safety

ABSTRACT: The article presents the author's considerations on the significance of the investment package diversifying natural gas supplies as part of the Northern Gate in ensuring Poland's energy security. Data found in literature concerning the possibilities of importing the raw material by sea (terminals, gas pipelines) includes investments at various stages of concept development and construction. However, these documents lack cohesive information about a full investment package being implemented. The author has thus attempted at creating variants concerning the diversification capacities of the Republic of Poland in reference to several key offshore and onshore projects. A problem has therefore been formulated: To what extend will the Northern Gate investment package increase Poland's energy security as a result of increased supply of natural gas from the sea? To answer this questions, researchers were forced to verify their working hypothesis which assumed that Northern Gate investments including a comprehensive package of projects had the potential of significantly improving the level of energy security in Poland by extending the possibility of importing natural gas. To solve the problem and verify the hypothesis, the researchers applied systemic analysis, deduction and variant analysis, which were used to estimate the possible import capacities of the raw material by sea. As a result of the works, the researchers created four variants including various investment projects assuming the import of 7.75 m^3 to 30,95 B m^3 of natural gas a year by sea.

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The variant which was adopted as the most probable indicates the possibility of importing 17.75 through 22.75 B m^3 of gas a year, which is 111% of the average annual demand in Poland.

KEYWORDS: natural gas, energy security, the Northern Gate

Introduction

Energy security, understood as a state of the economy, by which the current and prospective demand for gaseous fuels and electricity with reference to current and future technical, economic and environment protection requirements (EL 1997), is one of the key elements of the independence and sovereignty of every country. Ensuring the continuity of supplies and building capacities for storing and transferring raw materials is of strategic importance to the safe functioning and further development of Poland. In turn, the degree of diversifying the sources and directions of natural gas supplies for the country is one of the most important elements which determine the security of gas supplies (Report ME 2018). The Regulation of the Council of Ministers which sets the minimum level of diversification of natural gas supplies implements an upper level of total gas imported from a single source by 2022 at 70% and declares a decrease to 33% by 2023 (Regulation CM 2017). Therefore, a series of investments pertaining to natural gas have been implemented, including the extension of production and distribution infrastructure, the optimization of own resources, and the diversification of gas supplies.

Decisions have recently been made to extend the country's potential related to accommodating natural gas supplies carried out by sea through the Northern Gate. Apart from plans to extend the LNG Terminal in Świnoujście, there were projects assuming the construction of the Baltic Pipe, successive offshore FSRU installations (Floating Storage Regasification Unit FSRU), as well as announcements concerning the construction of a "small-scale" LNG terminal within the Port of Gdynia (*Outer Port*), or the construction of a next line as part of the submarine gas pipeline connecting the B-8 oil field with Władysławowo. What is noteworthy, the three latter concepts (the independent FSRU terminal and the LNG terminal in Gdynia and the small-scale Władysławowo project) are not included in the scope of the document titled Energy Policy of Poland until 2040 (pol. PEP2040). These investments were however included in plans adopted by Gaz-System. A question therefore arises: To what extent will the Northern Gate investment package increase Poland's energy security as a result of increased supply of natural gas from the sea? To answer this questions, researchers formulated a working hypothesis which assumed that Northern Gate investments including a comprehensive package of projects had the potential of significantly improving the level of energy security in Poland by extending the possibility of importing natural gas. To solve the problem and verify the hypothesis, the researchers applied a systemic analysis, deduction and variant analysis, which were used to estimate the possible import capacities of the raw material by sea.

1. A description of the needs

78% of the domestic demand for natural gas is satisfied through imports, primarily from the East (52%) (ME 2018), whereas an increase of gas sales to domestic recipients has been recorded (an approx. 19% increase in 2017 compared to 2016), as well as an increase in the share of natural gas in the overall primary energy balance in Poland (a 3.96% increase compared to 2000). The domestic consumption of natural gas which also increased by 5.6% in 2017 compared to 2016, has also been growing. What is important, the overall rate of consumption of natural gas exceeded the anticipated limits and went beyond the 2020 forecasts (17.1 B m^3) in 2017. The current demand for natural gas in Poland is expected to reach the level of above 187 TWh by 2010 to 208 TWh by 2025, and to nearly 222 TWh by 2030 (Report ME 2018). By comparison, the technical capacity of the Świnoujście terminal is 7.58 GWh (5 B m^3 a year). Gaz System has presented similar natural gas demand forecasts (Tab. 1).

TABLE 1. Demand forecast in volume and energy units

TABELA 1. Prognozy zapotrzebowania w jednostkach objętości i energii

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Optimum forecast											
B m^3	17.8	17.8	17.9	17.9	17.9	18.0	18.0	18.1	18.1	18.1	18.2
TWh	199	200	200	200	201	201	202	202	202	203	203
Moderate forecast											
B m^3	16.5	16.5	16.6	16.6	16.6	16.7	16.7	16.7	16.8	16.8	16.8
TWh	183	185	185	185	186	186	186	187	187	188	188

Source: based on (Gaz System 2017).

A general increase in demand for natural gas is perceptible. Access to the sea opens the country up to immense opportunities in the mining and transport of raw materials going beyond the mere use of sea ports serving as "windows to the world", but including comprehensive infrastructure assuming holistically perceived sea basins. Apart from being a reservoir rich in has, crude oil or wind potential, seas are the world's blood circulation, with nearly 90% of the commodities manufactured in the world are transported by sea. Sea basins, together with their properly developed coastal infrastructure (sea ports, terminals), submarine distribution lines (gas and oil pipelines, power cables) are used to increase the security of raw material deliveries bearing strategic importance, as they contribute to the diversification of sources of their origin. Therefore, they contribute to strengthening international cooperation (Nowakowski 2016).

The Northern Gate concept which fulfills the priorities of the infrastructural policy of the European Union (the North-South Corridor) aims to connect Central European gas transfer networks with Southeastern sections, and to open markets to supplies of this raw material from other directions (diverting supplies from the East). According to official data, the Northern Gate encompasses two major investments which include the extension of the LNG terminal in Świnoujście, which was opened in 2016, and the opening of the Norwegian Corridor. Within the scope of the Ministry of Energy, the Northern Gate assumes the construction of the Norwegian Corridor, aiming to reach an import capacity of approx. 10 B m^3 of gas per annum, and the extension of the LNG terminal in Świnoujście, aiming to reach a throughput of 7.5 B m^3 per annum.

The *Strategic Gaz System development perspective for 2017–2022* specifies two scenarios, one of which is identified as basic, as it points to two investments situated on the western coast as new sources of natural gas import. One of them is the LNG terminal with an extended throughput of 7.5 to 10 B m^3 a year. The other is the Baltic Pipe, which could be used to import up to 10 B m^3 of gas a year in the future. The scenario encompasses the LNG terminal in Świnoujście and a new installation in the Gulf of Gdańsk area, with a throughput of 4.1 to 8.2 B m^3 a year. Despite the successful completion of the primary scenario, we can reach an impressive value of 20 B m^3 of the raw material a year. The alternative variant offers an opportunity to increase the transfer capacity from 14.2 to 18.2 B m^3 a year, provided however that gas will be entirely imported on the board of LNG tankers, and that the time of sailing to Gdańsk/Gdynia will be extended, compared to the current lines leading to Świnoujście (a cost increase) (Strategic 2017). The 2025 *Gaz System* perspective strategy presents the value of 10 B m^3 LNG transported onboard of cryogenic tankers to the terminal in the Gulf of Gdańsk (Strategy 2016).

2. A description of Northern Gate elements

The LNG terminal in Świnoujście is an optimal investment location-wise, aiming to diversify gas supplies and increase the storage capacity of this raw material (shortening the navigation distance by 360 nautical miles, compared to the Gdańsk location). Every year, the terminal has contributed to increasing the energy security of the country. On the one hand, this is the result of increased handling capacities (5 to 7.5 B m^3 of the raw material, up to the forecast 10 B m^3), which included Poland in a group of recipients of gas supplied from various directions and by various suppliers (in the past, these were Qatar, Norway and the US). On the other hand, an increase in the inland storage capacity and its further distribution inside the country or further, at sea, is also important (Miętkiewicz 2018).

In turn, the Baltic Pipe is recognized as a strategic infrastructural facility, the purpose of which is to open a new corridor for raw material supplies to the European market. Gas received from Norwegian deposits will contribute to increasing the independence of the Polish, Danish and neighboring markets. The pipeline is to be launched within four years (2022) (Oksiuta 2018).

TABLE 2. Basic technical data for the Baltic Pipe

TABELA 2. Podstawowe dane techniczne gazociągu Baltic Pipe

Planned length [km]	ca. 275	Pipe section length [m]	12
Gas pipeline diameter [mm]	900	Planned service life [years]	50
Operating pressure [MPa]	6.7 to 12	Throughput [B m3/year]	10

Source: based on data obtained from: www.baltic-pipe.eu.

The estimated expenditure involved in the project is EUR 1.6 billion, whereas the Polish operator is responsible for activities valued at EUR 800 million.

Energinet and Gaz-System undertook to construct a gas pipeline of 900 km in total length, laid on the ground and routed on the seabed within the territorial limits of Denmark, Sweden and Poland. Environmental, geophysical and geotechnical studies carried out since 2017 led to the routing of the so-called "northern corridor", i.e. a 275 km long gas pipeline section crossing the territorial waters of Denmark and Poland, and the Swedish Exclusive Economic Zone (EEZ). Two variants of the pipeline's routing were initially considered, i.e. crossing through the Danish and Polish territories (territorial waters and exclusive economic zones), and through the German (variant I) or Swedish (variant II) exclusive economic zone (Baltic Pipe 2018).

On the Danish side, the pipeline was to reach the Faxe South area, whereas in Poland, the authorities analyzed the possibility of routing the submarine pipeline to the Niechorze – Pogorzelica area (Dragan and Krzyczkowski 2018). The absence of an explicit indication of the landing site stems from the fact that conclusions from environmental analyses of the impact of the investment on the coastline have not yet been developed. The project will allow to import approx. 10 B m^3 of natural gas a year. According to data from 2016, the Danish consumption was approx. 2.5 B m^3. For the Danish market including approx. 400 thousand recipients, the Baltic Pipe is a major investment.

The project includes five counterparts, among which are (Energinet 2018):

- Routing of the gas pipeline on the seabed to connect the sources with the Danish transfer system (the project assumes a 105 to110 km section of a new gas pipeline passing from the Norwegian Europipe II gas pipeline to the Danish terminal in Varde, the North Sea);
- Increase of the throughput of Danish systems through their extension, which will contribute to reducing the overall transfer costs (a total section of 210 to 230 km between Egtved in Jutland to the southeastern regions of Zeland);
- Construction of a state of the art gas pumping station on the Danish side, supporting the transfer of gas to the Danish market and further, to Poland;
- Foundation of the submarine gas pipeline as a bidirectional connection of Danish and Polish systems (260 to 310 km in length, Baltic Sea);
- Extension of the transfer system to facilitate the transport of gas on the one side, and to create the possibility of building a Polish regional commerce center for neighboring countries.

The project will open a possibility of importing gas mined in the Norwegian Continental Shelf area, where PGNiG holds 20 concessions (being an operator as part of two of them). For the purposes of ensuring ongoing supplies, in 2017, the company reserved a Baltic Pipe throughput from October 1, 2022 to September 30, 2037 (Dragan 2018). PGNiG Upstream Norway AS proceeded to studies aiming at selecting the drill site in the Shrek prospect (PL838 concession, 40% of the shares are owned by PGNiG Upstream Norway AS). The drilling itself is to be carried out in the second half of 2019, and commercial mining is to reach 2.5 B m^3 a year, starting with 2022. The documented volume of natural gas deposited in the Norwegian Continental Shelf area, available to PGNiG as of 2018, is ca. 83 boe (barrel of oil equivalent) (PGNiG 2018).

A new situation therefore arose, where the LNG terminal in Świnoujście handles strategically sized gas deliveries, and the current offer is likely to change (construction of a new tank, extension of handling quays to accommodate smaller LNG vessels, extension of car and railway terminals). In turn, the Baltic Pipe is to guarantee natural gas deliveries at competitive prices. This will allow to partially or completely substitute the long-term Yamal contract with a long-term contract with the Norwegians, for instance (PAP 2018).

3. FSRU Gdańsk, small-scale LNG terminal and Baltic deposits

The Floating Storage and Regasification Unit (FSRU) situated on the waters of the Gulf of Gdańsk is to allow for importing from 4.1 to 8.2 B m^3 of liquefied natural gas a year. Apart from being introduced into the onshore transfer network (basic service), the raw material will be also loaded onto smaller vessels and bunkered for the purpose of sea ships powered by LNG. The purpose of the system was to supplement the submarine gas pipeline of 40 km in length, connecting the onshore tanks in Kosakowo with a reduction and measurement station. The handling point was planned for an offshore location situated 7 km from Mechelinki (Miętkiewicz 2017a).

TABLE 3. Handling capacities of designed FSRU terminals

TABELA 3. Zestawienie możliwości przeładunkowych projektowanych terminali FSRU

Feature	Gdańsk	Inner Port
Minimum handling capacity [B m^3]	4.1	–
Maximum handling capacity [B m^3]	8.2	2.5
Handling volume [K m^3]	170	170

Source: own study, based on numbers indicated in the text (see References).

In 2017, Gaz System completed a procedure assuming the selection of a Feasibility Study contractor. Initially, the terminal would reach its full handling capacity in 2021, joining a group of similar investments in the Baltic Sea (Miętkiewicz 2017b).

An LNG handling and regasification station – a so-called "small-scale" LNG terminal is to be built in the northeastern part of the designed Outer Port's breakwater. According to the designs, the unit will be capable of accommodating Qmax tankers as the largest reference vessels (the maximum vessel adopted is 345 m long, 55 m wide, with a 12.5 m draft and of 266 000 m^3 in capacity). The main purpose of the terminal will be to unload the raw material from LNG tankers and load it onto smaller vessels, on tanker trucks and railway tankers, or into cryogenic vessels (LNG powered vessel bunkering in the port). A dedicated port basin will be separated for the purpose of servicing LNG vessels (the Gas Basin). At the second stage of the project, a FSRU terminal (station) will be built on an insular (outer) breakwater. A vessel serving as a FSRU (LNG tanker with a regasification module). Transported by sea, natural gas would pass through the port of Gdynia (cavern storages in Kosakowo), and would be pumped into smaller tankers for further distribution, or fed into smaller LNG-powered vessels*. An important feature of the project is that the FSRU terminal will be connected to the National Gas System. This solution will be based on an submarine gas main founded on the bottom of the Gulf of Gdańsk (Tri-City Gas Ring), connecting the terminal with a Lotos sp. z o.o. receipt point (Gdańsk) and with the aforementioned Kosakowo tanks. If the option of building the gas pipeline is abandoned, as part of a spare variant, the raw material will be used to power the CHP facility in Gdynia, provided that it is converted to accept LNG (Wuprohyd 2018). Additionally, the coolant produced as a by-product could be used in cooling processes carried out as part of the port's normal operations. An LNG tanker serving as a FSRU would, by assumption, transport and store up to 170 K m^3 of liquefied gas (a vessel of 270 to 300 m in length, of 43 to 47 m in width and with a draft of 12 to 13 m). A terminal this large would be capable of importing and processing ca. 2.5 B m^3 of natural gas a year. A QFlex to QMax LNG tanker (280 to 345 m long, 43 to 55 m wide, and 12 to 13 m in draft) would dock to the FSRU terminal (feeding the raw material to the FSRU installations). The raw material will be conveyed "ship to ship".

Optionally, extension plans assume the construction of an LNG power plant. The proposed power plant will be situated in the direct vicinity of the terminal, and the energy produced there is to power the container terminal. The heat produced will, in turn, power the port and municipal buildings situated in its vicinity. The Port of Gdynia is currently available to ships with a maximum draft of up to 13 m (considering the average water level at the port). The investment will allow for the accommodation of the first ships by 2026.

The last of the investments entails the construction of a second underwater gas pipeline of ca. 75 m in length and of 11.5 cm in external diameter, connecting a production center built on a Baltic oil field with an onshore recipient (Władysławowo). So far, LOTOS Petrobaltic has operated one

* Ships powered by LNG will become increasingly popular for vessels of 1500 GT *Gross Tonnage*) and more, due to the reduction in exhaust emissions and economic savings. In 2017, 11% of the global portfolio of new ship production commissions were LNG-powered ships.

gas pipeline connecting the B8 oil field (an independently confirmed deposit of 484 million m^3 of gas) with the Energobaltic CHP facility (operating since 2003). Running on blue fuel, the CHP facility has eliminated the consumption of 36 thousand tons of coal a year in the electricity production process, or 32 tons of coal in the production of propane-butane (Lotos 2018).

4. Investment variants

The following conditions were adopted as the main variables determining the development of gas supply diversification possibilities:

- Government decisions concerning the adoption of successive developmental stages of existing investments (LNG terminal in Świnoujście);
- International conditions (Russian protests, lack of agreement with German, Danish, Norwegian partners);
- Government decisions concerning the construction of successive elements of the regasification infrastructure on the Polish section of the Baltic coast.

Numbers presented in the variants, together with suggested Times to complete base on the official data. Four concepts represents the author's opinion and corresponds with the surveys on LNG market development in the maritime domain. Moreover, variants presents differentia and wide purview of elements. The land based LNG terminal (Świnoujście), and as well as the FSRU (incoming options) and international gas pipeline (Baltic Pipe), together with national sea bottom natural gas mining (oil/natural gas rig) can be recognized in the distinct scenarios.

The first variant assumes the extension of the LNG terminal in Świnoujście to a level capable of handling 7.5 B m^3 of gas a year by 2021 and the construction of a third tank (180 K m^3) with a railway terminal by 2023. 10 B m^3 are planned to be achieved by 2025, if delays in the construction of the Baltic Pipe are incurred (Ruszel 2017). Therefore, the first scenario itself creates an opportunity of reaching nearly half of the annual demand for natural gas of the entire country by employing the sea transport of gas from foreign sources. As soon as the last investment (the *Outer Port*) is completed, Poland would increase its import capacity from 7.5 to 10.25 billion m^3 of gas, through 12.25 billion m^3 if the LNG terminal in Świnoujście is further extended.

The second variant assumes the extension of the LNG terminal in the above presented perspectives, the finalization of investments related to the construction of the Baltic Pipe (carrying up to 10 B m^3 of natural gas a year), and the construction of another onshore terminal (a "small-scale" terminal) as part of the Port of Gdynia extension project and providing a capacity to handle 2.5 B m^3 a year. This variant displays the capacity of importing up to 17.75 B m^3 through 2.25 B m^3 of gas a year, through to 22.75 B m^3.

The next variant entails the assumptions of the second variant, except that the "small-scale" terminal is substituted with an investment in a FSRU terminal as an independent offshore installation situated outside the sea port of Gdynia. This plan is characterized by a significantly higher

reception capacity, which has a direct impact on the final result of the overall activities for the variant in question (19.35 to 25.95, even to 28.45 B m^3 of gas).

The last variant is characterized by a high level of import from 21.85 to 28.45 through 30.95 B m^3 of gas a year, assuming that all of the planned investments will be completed and will reach the anticipated maximum processing power.

Variant II should currently be adopted as the most likely in the opinion of the author.

TABLE 4. Variants

TABELA 4. Warianty

Variant	Set	Capabilities [B m^3/year]	Time to complete	Total capabilities [B m^3/year]
Variant I	LNG terminal in Świnoujście	5 to 7.5 (through to 10)	7.5 in 2021	7.7 to 10.25 (through to 12.25)
	B8-władysławowo gas pipeline	0.25	2019	
	"Small-scale" terminal Gdynia *Outer Port*	2.5	2026	
Variant II:	LNG terminal in Świnoujście	5 to 7.5 (through to 10)	7.5 in 2021	17.75 to 20.25 (through to 22.75)
	"Baltic Pipe"	10	2022	
	B8-władysławowo gas pipeline	0.25	2019	
	"Small-scale" terminal Gdynia *Outer Port*	2.5	2026	
Variant III	LNG terminal in Świnoujście	5 to 7.5 (through to 10)	7.5 in 2021	19.35 to 25.95 (through to 28.45)
	"Baltic Pipe"	10	2022	
	B8-władysławowo gas pipeline	0.25	2019	
	FSRU Gulf of Gdańsk	4.1 to 8.2	2021	
Variant IV:	LNG terminal in Świnoujście	5 to 7.5 (through to 10)	7.5 in 2021	21.85 to 28.45 (through to 30.95)
	"Baltic Pipe"	10	2022	
	B8-władysławowo gas pipeline	0.25	2019	
	"Small-scale" terminal Gdynia *Outer Port*	2.5	2026	
	FSRU Gulf of Gdańsk	4.1 to 8.2	2021	

Source: own study, based on numbers indicated in the text (see References).

Conclusions

The variants described do not exhaust all of the possible diversification scenarios, and their accurate definition is understandably a difficult task. However, what all of these variants share is a promise that, within a few years, Poland will be able to build a substantial potential having positive impact on the diversification of supplies of raw material which is considered to be strategic in ensuring the country's energy security. Assuming a domestic demand for natural gas at approx. 18 B m^3, the capacities used to import gas by sea, as presented in variant I (the least optimistic from 7.75 to 10.25, through 12.25 B m^3), exceed 55% of this demand at their average level. The capacity to diversify deliveries by sea can be estimated for this minimum value. A full answer to a research problem thus defined requires the upper limit of maximum deliveries carried out through the Northern Gate to be formulated. The second variant which was adopted as the most probable indicates the possibility of importing 17.75 through 22.75 B m^3 of gas a year, which is 111% of the average annual demand for natural gas. This creates a new quality for the energy security of the country and the region. Maintaining own production at 4.5 B m^3 of natural gas a year, combined with the extension of onshore interconnectors will result in the possibility of building a hub for the neighboring countries. It should therefore be concluded that completing the package of investments as part of the Northern Gate will have an excellent impact on improving the energy security of the country.

Therefore, it should be concluded that the working hypothesis concerning the Northern Gate, construed as an extensive investment package, is capable of significantly raising the level of energy security in Poland, including in terms of raw material import capabilities. They point to the total capabilities of individual participants of successive variants. What is noteworthy, the national transfer system responsible for further distribution of the raw material in the country and internationally, plays an important role in diversification as well. Without sufficiently developed distribution capacities, even a well-developed receiving infrastructure will not reach the anticipated volumes. The following conclusions were formulated in the course of analyses:

- The projects described above undoubtedly contribute to the integration and strengthening of the European natural gas market (Baltic Pipe);
- Considering both the source and the direction, successful investments ending in diversification will have a significant impact on the change (improvement) of Poland's position in possible negotiations for raw material deliveries with the Russian Gazprom;
- These projects contribute to an overall reduction in the level of emissions generated by the national economy, and can contribute to stabilizing the power system in the case of changing electricity production from renewable sources (particularly important for Poland's northern regions in the context of announced projects to build large wind farms in the open sea);
- After the Baltic Pipe is constructed, PGNiG will receive direct access to deposits in the Norwegian Shelf, and thus Poland will join a group of countries which have mined these deposits, and the commencement of deliveries from the Norwegian Shelf may cause a revo-

lution in contracts on the gas market in the country by ensuring a high competitiveness of supply prices;

- Different principles of operation of such investments as the Baltic Pipe, compared to the LNG terminal in Świnoujście, the FSRU terminal or the "small-scale" terminal, will guarantee competition on the market of gas supply contracts;
- Similarly to the construction of LNG tanker service terminals and the routing of successive gas pipelines on the seabed, the observed revival of the sea domain as a convenient path to transport strategic raw materials will have a positive impact on building the energy independence of the country;
- Thanks to the investment, the resilience of Poland and potentially other countries of Central-Eastern Europe to the use of energetic material supplies in geopolitical play (gas blackmail) will increase, and stable supplies to recipients in countries from the so-called old Union (as an element of distorting European integrity) will be guaranteed;
- Implementing initiatives aiming to create new paths and acquire new natural gas suppliers (Africa, North America, Asia) and creating interconnectors increase the country's immunity to disturbances in deliveries;
- Import of key primary energy carriers to a country which has no sources which would satisfy its demand is elevated to the rank of a matter of national security. The uninterrupted inflow of energetic raw materials determines the correct functioning of the economy and the citizens' lives;
- It is also noteworthy that these projects have a positive impact on the climate policy of the Old Continent. Since the availability of new sources for Central-Eastern Europe will increase, we can speak of a significant impact on reducing the emission levels of the domestic economy.

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Rafał Andrzej MIĘTKIEWICZ

„Gaz z morza" – inklinacje dla bezpieczeństwa energetycznego Polski

Streszczenie

Artykuł prezentuje rozważania autora na temat znaczenia pakietu inwestycji dywersyfikujących dostawy gazu ziemnego, w ramach Bramy Północnej, dla bezpieczeństwa energetycznego Polski. Pojawiające się w literaturze przedmiotu dane dotyczące możliwości importowych surowca drogą morską (terminale, gazociągi) obejmują inwestycje będące na różnym poziomie koncepcji i realizacji. Brak przy tym w dokumentach spójnych informacji na temat pełnego pakietu inwestycji. Autor tym samym podjął próbę stworzenia wariantów dotyczących zdolności dywersyfikacyjnych Rzeczypospolitej w odniesieniu do kilku kluczowych projektów usytuowanych na morzu i polskim wybrzeżu. Tym samym postawiono pytanie problemowe:w jakim stopniu pełen pakiet inwestycji Bramy Północnej zwiększy bezpieczeństwo energetyczne Polski w związku z rozwojem możliwości sprowadzenia gazu z kierunku morskiego? Odpowiedz na sformułowany problem badawczy wymagała weryfikacji hipotezy roboczej, w której założono, iż inwestycje Bramy Północnej, obejmujące szeroki pakiet inwestycji, są w stanie w znaczący sposób podnieść poziom bezpieczeństwa energetycznego Polski poprzez rozbudowę możliwości sprowadzania gazu ziemnego. Rozwiązaniu sytuacji problemowej i weryfikacji hipotezy posłużyła metoda analizy systemowej, dedukcji oraz wariantowanie, które umożliwiło oszacowanie potencjalnych zdolności importowych surowca drogą morską. W wyniku przeprowadzonych prac udało się stworzyć cztery warianty obejmujące różne projekty inwestycyjne umożliwiające sprowadzenie drogą morską od 7,75 mld m^3 po 30,95 mld m^3 gazu ziemnego rocznie. Przyjęty za najbardziej prawdopodobny wariant wskazuje na możliwości sprowadzania od 17,75 do 20,25, nawet po 22,75 mld m^3 gazu rocznie, co dla średniej wartości stanowi 111% rocznego zapotrzebowania Polski.

SŁOWA KLUCZOWE: bezpieczeństwo energetyczne, gaz naturalny, Brama Północna