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ENTREPRENEURIAL, LEGAL AND LOGISTICS ASPECTS OF GAS IN NIGERIA**Anya Kingsley Anya,¹ Gaga Wilson Ekakite,² Esther Chinenye Anya,³ Anatolijs Krivins,⁴
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Abstract. The current situation in global gas trade indicates a redistribution of suppliers and consumers - solvent markets are opening that diversify gas purchases (mainly the European Union), and sellers are appearing who are more active in expressing themselves and have significant gas reserves. Moreover, pipeline gas and LNG flows are redistributed. In this context, special attention should be paid to Nigeria, which has both the opportunity and the desire to become one of the major players in the global gas market. This article aims to analyze the current situation in the Nigerian gas market and consider the probable development of events in Nigeria's gas production and transportation industry. The methods employed in the study include statistical analysis and descriptive approach. Our findings indicate that the modern economic and political context opens up broad prospects for Nigeria in pipeline gas logistics and LNG projects. This development of events could be favourable for all interested parties - buyers will receive the necessary volumes of gas, and Nigeria will be able to make a profit, reduce unemployment and develop its country's economy. Against this background, the paper evaluated the evolution of gas development and utilization in Nigeria with respect to the Nigerian Gas Master plan and the gas development and utilization measures. The authors, therefore, concluded that the proper exploitation and exploration of gas, barring any other odds, could be the game changer of the Nigerian economy.

Keywords: natural gas; hydrocarbon; global market; industry; logistics

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JEL Classifications: L32, L53, L95

Additional disciplines: law, logistics

1. Introduction

Nigeria has abundant natural resources and is blessed with a large hydrocarbon resource endowment, both in absolute terms and relative to other petroleum-producing countries (Plan, 2004). The oil and gas sector is the backbone and mainstay of Nigeria's economy. Value of energy goods exported from Nigeria has a sharp increase tendency (see Figure 1).

Value of energy goods exported from Nigeria from 2018 to 2021 (in million Nigerian naira)

Value of energy goods exported from Nigeria 2018 -2021

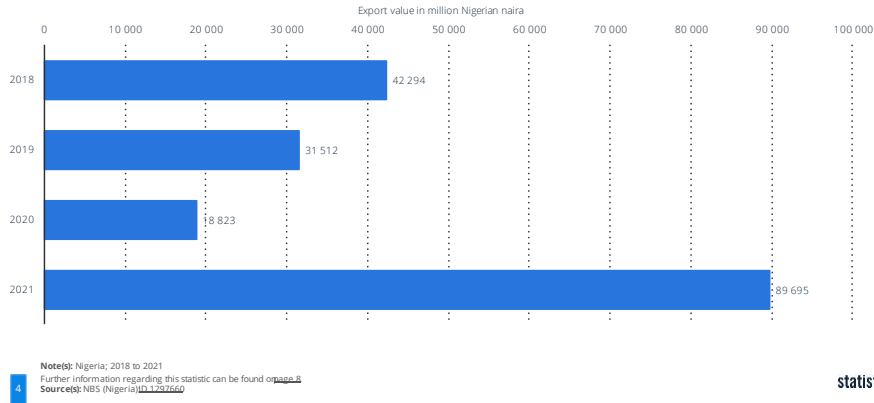


Figure 1. Value of energy goods exported from Nigeria during 2018-2021

Source: NBS (Nigeria), (March 1, 2022). Value of energy goods exported from Nigeria from 2018 to 2021 (in million Nigerian naira), provided by Statista

Natural gas is a "cleaner energy" than crude oil in the energy sector and regime. It has attracted more investors than petroleum, mineral ores, and other valuable extractive products, especially in developing nations like Nigeria.

Nigeria has a vast gas reserve. This resource is of growing benefit as gas has become, and continues to be, the fuel of choice in developed and developing countries (World Bank, 2004). Natural gas reserves in Africa totaled over 620 trillion cubic feet in 2021. Nigeria housed the largest reserves in the continent, around 200 trillion cubic feet – equivalent to roughly three percent of the proved global natural gas reserves (Galal, 2024).

Nigeria is among major gas exporting countries (see Figure 2).

Leading gas exporting countries in 2022, by export type (in billion cubic meters)

Global gas exporting countries 2022

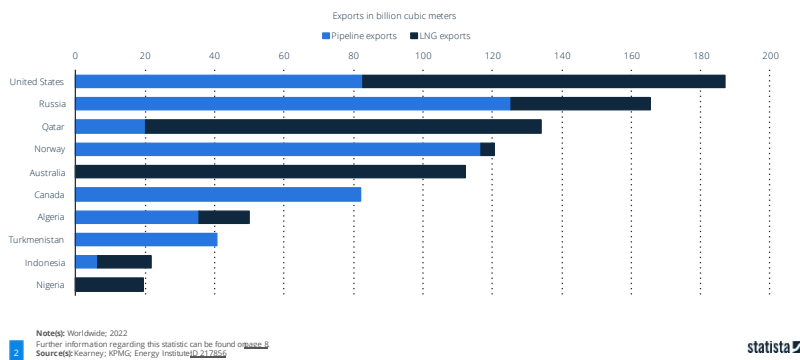


Figure 2. Leading gas exporting countries
Source: Energy institute, provided by Statista

Natural gas exported from Nigeria grows (see Figure 3)

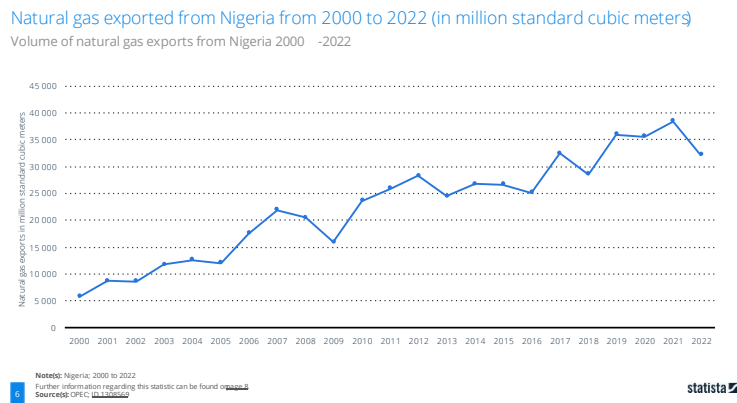


Figure 3. Natural gas export from Nigeria

Source: OPEC, provided by Statista

However, due to flaring during crude oil exploration, Nigeria loses most of its gas. Today, the government pays great attention to the development of exploration, production and marketing of natural gas. To achieve this goal, it is necessary to create adequate infrastructure and improve natural resource management in Nigeria. There are initiatives to increase transparency in the extractive industries, including, for example, a national resource management strategy, a clear legal framework and competent institutions to ensure maximum benefit to its citizens, transparency and accountability, private sector investment to diversify the economy, improved accounting systems to reduce the number of thefts to reduce emissions from gas combustion. The Nigerian gas sector has many players involved in exploration and production, including international and local companies.

2. Theoretical background

Many scientific articles are devoted to Nigeria's gas sector problem. Current trends in the aggravation of energy issues in the global economy have led to increased struggle between countries, including on energy exchange markets (Zhu et al., 2021; Amuda et al., 2023; Androniceanu et al., 2023).

Nigeria, possessing enormous energy potential, including gas generation potential (Akintola et al., 2021), today continues to be a leader in the West African region and lays claim to leadership within the entire continent. The Nigerian foreign policy strategy aims to expand international trade relations, including in the energy sector. The leading role is economic diplomacy, the policy aimed at attracting external assistance and foreign investment. This approach gives Nigeria a more optimistic view of possible economic growth (Galadima et al., 2022).

The problem of gas flaring in Nigeria has remained relevant for many decades. About 40 years ago, a new economic development strategy was adopted; the program aimed to extract oil, ore, and coal and sell these raw materials on the world market. Further, the government carried out several necessary economic measures, which resulted in the state's share in the assets of foreign companies expanding. But even in the 20s of the 21st century, alternatives to gas flaring are being discussed in Nigeria (Elehinafe et al., 2022) and the Economic Impact of Gas Flaring in Nigeria (Okoro et al., 2021) is emphasized.

For example, the issue of producing electricity from gas (Ihejirika et al., 2022) is being discussed, a technical and economic analysis is being carried out (Adewuyi et al., 2023), Project Life Cycle Costing is calculated (Oruwari & Ogbuikwe, 2023). However, the complexity of the problem is that it is necessary to create conditions for freedom of international economic activity on the territory of the country with the state's regulatory role. In the context of the globalization of world energy, the impact of gas legislation on the local economy (Adegun et al., 2022) can be pretty significant.

The role of Nigeria's international trade in the global economy is small due to low levels of exports and imports compared to other developed market economies in the world. The legal and contractual terms of transactions with international gas production companies are the basis for expanding the volume of attracted foreign investment and improving the organizational forms of the oil business in the state. Over the past few years, oil and gas production in Nigeria has been hampered by militant attacks on infrastructure. The growth in exploration and production volumes on the Nigerian shelf was mainly due to the government's efforts to develop the hydrocarbon component of the country's economy. The domestic market expansion is also hampered by the need for more infrastructure, unresolved security problems, and transportation problems (Osuaquwu et al., 2021).

It should be noted that in a global context, the topic of natural gas is often associated with an environmental issue. The most significant negative impact on the environment occurs within the territories of gas and oil fields, as well as in nearby populated areas and along trunk pipelines. Vegetation, soil, and microrelief are directly affected.

Oil and gas production leads to changes in deep-lying horizons of the geological environment, which can lead to irreversible deformations of the earth's surface and, in some cases, can contribute to earthquakes (Zhang et al., 2024). Pipeline transport can be considered an environmentally friendly mode of transport of hydrocarbons only if strict environmental discipline is observed in the design, construction and operation of gas pipelines. The operation of compressor stations (Luo et al., 2024) has a technogenic impact on the environment. The negative effects of air pollutants are due to their toxic and irritant properties (Nsaif et al., 2024), since natural gas from specific fields may contain very poisonous substances.

The large-scale construction of trunk pipelines has a negative impact on the state of wildlife. Drilling and other gas extraction activities can lead to soil degradation, compaction and loss of vegetation. Environmental problems can also arise during the production of liquefied natural gas, transportation, and regasification (Jung, 2024; Yang et al., 2024). Dredging and erosion can have a negative impact on the habitats of aquatic organisms. Direct impacts may include physical destruction of habitats, and indirect impacts may occur through changes in water quality. Wastes commonly generated at LNG facilities (Yu et al., 2024) include packaging waste, used oils, hydraulic fluids, used batteries, and chemical containers. The main sources of noise at LNG facilities are pumps, compressors, generators and engines, compressor discharge and suction lines, recirculation system piping, air drying units, heaters, gas coolers in gas liquefaction plants, evaporators, unloading and unloading of tankers and gas carriers.

Finally, the third area of scientific research activity was the problem of corruption in the gas sector. The need to intensify the processes of Nigeria's integration into the world economic system (including attracting foreign direct investment) is associated with an attempt to ensure the acceleration of the country's economic growth.

Of course, government effectiveness (Adabor, 2023) and institutional quality (Akbar et al., 2022) are of great importance here. To enhance the Nigerian gas industry's attractiveness to regional and global investors, Nigeria has expanded its existing incentives for private investors. This is indirectly related to "Mobilising Rents" (Irrarázaval, 2022), but in Nigeria, the level of such investment is still not high enough. Researchers often note that economic success in such situations requires an intensified fight against corruption (Krivins et al., 2023) and a reduction in crime (Remeikiene et al., 2022). It has been established that when making strategic investment decisions (Karim et al., 2020), investors also take into account the socio-cultural (Kipane et al., 2023; Tsheola et al., 2023; Ntshangase et al., 2023) aspect.

Among the laws aimed at improving the conditions for attracting investment in the gas sector of the Nigerian economy, it is necessary to highlight those related to structural adjustment and liberalization reform to ensure greater openness and support (Mahmood et al., 2021) in the privatization process. Today, many enterprises in the country are state-owned, but a privatization program is being actively implemented here, which causes corruption risks (Gani, 2021). Thus, critical changes in the regulatory environment for foreign direct investment in Nigeria relate to foreign ownership of businesses, issues of expropriation and compensation, dispute resolution, transparency (Vasić et al., 2023) and protection of property rights. Nigeria has joined international

institutions that regulate economic cooperation with foreign investors, so it is impossible to ignore the ethical component.

3. Research methodology

The research methods are statistical analysis, analysis of regulatory legal acts, Qualitative Document Analysis (QDA) and content analysis. These research methods make it possible to ensure systematic and reliable recording of some aspects of the content of documents and qualitatively process the data obtained. This allows us to establish the characteristics of documentary sources and the features of the entire process: social orientations and attitudes of Nigeria as a gas producer, values and norms replicated in documents. Non-quantitative content analysis records the presence of a text content element - an indicator corresponding to the content category. This approach allows us to identify types of qualitative content models - regardless of the frequency of occurrence of each type. This approach made it possible to implement the content of the analyzed document into a social context and to comprehend it as a manifestation of social life. Before examining the established data, categories of analysis were determined - fundamental concepts and semantic units - available in the text and corresponding to those definitions and their empirical indicators recorded in the research program.

4. Research data

The first part of the research base consists of information related to Gas Utilization and Concomitant Options in Nigeria. Nigerian domestic and regional demand from the greater West Africa region may push annual gas production in Nigeria beyond the 10 BSCF/D mark by 2020. The global population is expected to rise to nearly 10 billion by 2050, spurring global energy demand to almost 60% higher than today by 2060 (Plan, 2004).

Gas utilization in Nigeria, as earlier discussed, has been through a chequered history as phased below (Table 1):

Table 1. Characteristics of historical periods of development of the gas sector in Nigeria

Phase	Historical period	Characteristic
Phase 1	Pre-1999, The Demand Constraint Era	<ul style="list-style-type: none"> • Era marked by intense flaring • Fiscal incentives to stimulate demand • Focus on exports (LNG) as a most promising source of demand, hence the birth of an export-oriented gas sector • Proliferation of fiscal incentives and absence of a legal framework to regulate the sub-sector
Phase 2	Between 1999 and 2005, that is, the Nigerian Liquefied Natural Gas Era	<ul style="list-style-type: none"> • Kick-off and subsequent growth of LNG • Beginning of steady decline in flares • Initiation of new export projects – Gas to Liquid, etc. • Commencement of fiscal and legal regime consolidation to incentivize and regulate operations in the sub-sector.
Phase 3	2005: The Demand Boom/Supply Constraint Er	<ul style="list-style-type: none"> • Sudden boom in demand from both domestic and export sectors • Sudden shift from demand to supply constraint • Birth of the Gas Master Plan initiative • The Gas Master-Plan initiative was born in response to the sudden boom in gas demand in Nigeria.

Source: authors created based on research data (NTUFAM, 2013).

The second part of the research base consists of information related to the typical Gas Utilization Projects. Available and commercially priced gas can initiate a real expansion in many domestic and export-based projects - excluding Pipelines (Plan (2004). These options will include a cross-section of facilities that can support that growth over a long period once the more extensive and strategic options have been implemented (World Bank, 2004). Options relevant to Nigeria include (see Table 2):

Table 2. Characteristics of historical periods of development of the gas sector in Nigeria

Priority 1	Priority 2	Priority 3
<ul style="list-style-type: none"> • Power Generation • Gas to Liquids (GTL) manufacture 	<ul style="list-style-type: none"> • LPG processing • Cement manufacture • Steel (DRI) manufacture • Fertilizer (Ammonia/Urea) 	<ul style="list-style-type: none"> • Further Liquefied Natural Gas (LNG) • Methanol • Aluminium smelting

Source: authors created based on research data (NTUFAM, 2013).

There was a concentration of market power in a few dominant joint ventures (JVs), and these core IOC operators typically focused their gas activities on the export of LNG rather than on the domestic market (NTUFAM, 2013). Pressure to reduce flaring, desire for economic growth and general enhancement of populace quality of life, and desire for industrial development are the principal drivers for developing natural gas (Ojijiagwo, 2017). The development of the Nigerian LNG project was pivotal to increased gas utilization in Nigeria and to create a position in the international market.

Concerning the domestic market, the NNPC, through its subsidiary, Nigerian Gas Company (NGC), supplies gas for power generation, either as a source of fuel or as feedstock (Ojide et al. 2012) to cement and fertilizer plants, glass, food and beverages, manufacturing industries and so on. More local industries are now aware of the advantages and benefits of using gas; hence, the demand for gas is increasing. The Nigerian gas market is a profit-oriented market awaiting potential investors.

For the international market, NNPC and its Joint Venture partners are currently embarking on several gas utilization projects (Export- Oriented Gas Projects), which include the following: 1) Escravos Gas Project, 2) OSO NGL Project, 3) LNG Projects, 4) Ekpe Gas Compression Projects, 5) OSO 2Y2 Project, 6) Belema Gas Injection Project, 7) Odigbo Node Gas Project, 8) Odidi AGG Project, 9) Cawthorne Channel Gas Injection Project, 10) The West African Gas Pipeline Project.

The third data group summarizes the following themes: Economic/Fiscal Incentives Associated with the Nigerian Oil and Gas Industry; Midstream and Downstream (M&D) Gas Operations; Administration of Midstream and Downstream Gas Operations; and Domestic Response to Demand Growth.

The Petroleum Industry Act (PIA, 2021) establishes 7 new gas operations licensees. The Nigerian Gas Company a subsidiary of the Nigerian National Petroleum Company, engages in the transmission, distribution and marketing of natural gas and operates most of the gas transportation network alongside other pipeline system owners granted an operator license/authorization by the Department of Petroleum Resources under the Nigerian Gas Transportation Network Code, 2020 (Opsng, 2021). The newly created midstream and downstream licensees created under the Petroleum Industry Act relating to gas are license for: 1) "Natural Gas Processing"; 2) "Bulk Gas Storage License (BGSL) - bulk storage of natural gas"; 3) "Gas Transportation Pipeline License: (GTPL) - exclusive right to own, construct, operate and maintain gas transportation pipeline"; 4) "Wholesale Gas Supply License (WGSL) - sell and deliver wholesale gas to wholesale customers and gas distributors" (5); "Retail Gas Supply"; 6) "Natural Gas Distribution"; 7) "Domestic Gas Aggregation".

The Petroleum Industry Act requires that a holder of an existing lease, license, or permit involved in midstream or downstream gas operations before the Act's effective date must apply to the Authority within 24 months of the effective date. The Authority may issue the relevant license or permit if, according to Section 125, involvement in midstream and downstream or downstream gas operations without a license or authorization commits an offence and faces a penalty of: (a) 1 year in prison or a fine imposed by regulation in the case of a license-required Activity; or (b) 6 months in prison or a fine imposed by regulation in the case of a permit-required Activity. The Act in Section 314 proposes that employees of the Department of Petroleum Resources, Petroleum Pricing and Product Regulatory Agency, the Petroleum Equalization Fund (Management Board) and Petroleum Inspectorate be transferred to their respective regulators. Section 52 of the Petroleum Industry Act creates a Midstream Gas Infrastructure Fund to 'make equity investments of Government-owned participating or shareholder interests in infrastructure related to midstream gas operations aimed at: (a) increasing the

domestic consumption of Natural Gas in Nigeria in projects which are financed in part by private investment, and (b) encouraging private investment. The source of the Midstream Gas Infrastructure Fund shall be a 0.5% levy on the wholesale price of petroleum products sold in Nigeria and natural gas produced and sold (PIA, 2021). The objectives of the Gas Master Plan are summarized below (see Table 3).

Table 3. The Objectives of the Gas Master Plan

[1] Maximize the Multiplier Effect of Gas in the Domestic Economy	[2] Optimize Nigeria's Share and Competitiveness in High-Value Export Markets	[3] Balancing the trans-generational needs-managed exploitation.
[1.1.] Facilitate gas to power, fertilizer, etc. [1.2.] Domestic LPG [1.3.] Stimulate broad gas-based industrialization-methanol, fertilizer, etc.	[2.1.] Selective participation in high-value markets [2.2.] Strategic positioning for growth [2.3.] Assure long-term energy (gas) security for Nigeria	[3.1.] Balancing the trans-generational needs [3.2.] Managed exploitation

Source: authors created based on research data (Ubani, 2016).

It should be noted that in January 2020, the Government of Nigeria passed the Finance Bill. This act amends several tax laws and aims to improve tax participation and collection and modernize the tax system. For example, the tax on profits from oil production (which abolishes the tax exemption on dividends paid from after-tax profits) and the value-added tax were changed. In addition, this law, which is also an amendment to the 1999 Law on Production Sharing Contracts in Deep-Sea and Inland Basins, changed the royalty rates for deep-sea (water depth more than 200 meters) and inland basins. Since international oil companies primarily operate in Nigeria's deepwater fields, the law has increased the government's share of revenue generated from these fields. It will force investors to reconsider their investment plans for currently developing fields as well as new ones. There is still a pressing need to eliminate technical shortcomings and increase production, profit, and safety on construction sites while minimizing the environmental impact to make the work of relatively small enterprises more formalized by law and trustworthy.

In this part of the article, we will summarize the main events of the last three years that have occurred in the gas transport sector in Nigeria:

On June 30, 2020, the Federal Government of Nigeria announced the commencement of construction of the 614-kilometer Ayaokuta-Kaduna-Kano natural gas pipeline. The pipeline will supply gas for power generation and stimulate new industries in the cities of Kogi, Niger, Kaduna and Abuja. Construction is being carried out within the framework of the Chinese "New Silk Road" project. The pipeline will connect to the Trans-Saharan gas pipeline, which will export natural gas to Europe. Nigeria's oil reserves are expected to last for 30-40 years, and its vast gas reserves will allow it to diversify the economy.

In 2021, a plan was unveiled to transition the Nigerian economy to the widespread use of gas - Nigeria intends to radically change the situation by using its vast gas fields to become one of the leading gas-consuming countries. By 2030, Nigeria will be one of the world's largest gas consumers.

In 2023, China National Electrical Equipment Corporation commissioned the last of the four units of the Zungeru hydroelectric power station in Nigeria. The new facility, with a total capacity of 700 megawatts, will generate 2.64 terawatt-hours of electricity per year, equivalent to 10% of Nigeria's annual electricity consumption.

In October 2023, it became apparent that Nigeria and Algeria were speeding up the Trans-Saharan Gas Pipeline (TSGP) construction to export Nigerian gas to Europe. The TSGP gas pipeline project cost is estimated at \$13 billion, and the gas pipeline length will be 4,128 kilometres.

On November 21, 2023, The Nigerian gas company Riverside LNG and the German Johannes Schuetze Energy Import AG entered a deal for liquefied natural gas (LNG) supply. The first gas deliveries from Nigeria to Germany will begin in 2026. According to the agreement, Nigeria will annually supply 850 thousand tons of LNG to Germany, with a planned increase in exports to 1.2 million tons. Under the new deal, Nigeria will provide 2% of the total imports of liquefied natural gas into Germany. In turn, Germany will increase investment in renewable energy in Nigeria (Deutsche Welle, 2023).

In January 2024, it became known that the Nigerian company NIGUS International and the Chinese company Zhongmin Xinjunlong signed a \$1 billion agreement involving the use of associated gas. The gas is assumed to be processed into synthetic diesel fuel and liquefied gas for domestic needs. The partnership will bring the latest technologies to commercialize flare gas and develop green energy in Nigeria.

At the same time, the Nigerian company Riverside LNG is negotiating gas supplies to South Africa, and the company is also exploring opportunities in Liberia and Cameroon. Currently, South Africa cannot receive LNG, so deliveries under the project will begin by 2027.

Thus, today, logistics transportation of Nigerian gas is planned in three main ways: 1) TSGP pipeline, 2) WAGP pipeline, and 3) liquefied natural gas (LNG). Let us briefly summarize the basic information that is available for each of these options today.

TSGP pipeline. The Trans-Saharan Gas Pipeline (TSGP) appeared in the 1970s but still needs to be implemented due to high costs and specific risks. However, on June 21, 2022, the energy ministers of Algeria, Niger and Nigeria agreed to lay the foundations for the implementation of the TSGP project and a memorandum of understanding was signed on July 28, 2022. This project benefits all interested parties - Europe will receive additional gas volumes; Algeria will increase gas supplies to Europe without significant investments in its gas production; Nigeria will gain a new market. It is planned that this gas pipeline with a capacity of 30 billion cubic meters (initially, it is intended to send 20 billion cubic meters of gas annually) could be launched in 2026. An increase in pumping from other West African countries, including Ghana, Senegal and Equatorial Guinea, is not excluded. Some Asian and Eurasian gas-exporting countries considered this idea utopian; however, in May 2023, the African Development Bank took over the financing of this project, and already in March 2024, the Algerian authorities announced the completion of more than half of the gas pipeline: 2,200 kilometres of pipes with associated infrastructure out of the planned 4,100 kilometres. It remains to lay 100 km of pipes in Nigeria, 1000 km in Niger and 700 in Algeria. In technical terms, specialists from Italy, Germany and France are actively assisting in the implementation of the project; construction is proceeding at a rapid pace, so it is possible that the first volumes of gas could flow through the pipeline in 2025 or even in December 2024.

WAGP pipeline. On September 15, 2022, Nigeria, Morocco and the Economic Community of West African States (an economic union of 15 countries) agreed to build the 5,600-kilometer West African Gas Pipeline (WAGP) along the West African coast from Nigeria to Europe. Because the TSGP Pipeline may be vulnerable, Europe is also supporting the construction of the alternative Nigeria–Morocco Gas Pipeline (WAGP). The construction of a gas pipeline from Nigeria to Morocco is planned from 2024 to 2026 - there are both technical and financial possibilities for this. The Islamic Development Bank and the OPEC Fund for International Development have already committed about \$60 million to finance feasibility and engineering studies.

Liquefied natural gas (LNG) is the third working option for Nigerian gas logistics. Europe is developing LNG projects at an accelerated pace; now, the capacity for receiving LNG is already available in Europe. However, Nigeria has many strong competitors, such as the United States and Qatar, which plan to significantly increase the volume of their LNG production in 2025 and 2026—countries such as Nigeria, Angola, and Senegal offer untapped potential in liquefied natural gas. Nigeria seeks to increase gas supplies to foreign markets, and the European Commission can certainly conclude an agreement to cooperate on fuel imports.

Thus, two new gas pipelines (TSGP and WAGP) will appear in the coming years. In the first stage, they will supply Europe with at least 50 billion cubic meters of gas and, later, 66 billion cubic meters. Gas reserves allow Nigeria to ensure the operation of both gas pipelines for 80 years. In addition, the LNG development direction

is quite realistic. Nigeria can earn up to 800 billion euros from gas projects. (Deutsche Welle, 2022). This aligns well with Nigeria's ambition to become a top 10 global economy by 2050.

5. Results and discussion

During the study, 17 countries were considered, which for 20 years have provided the most significant volumes of natural gas on the world market (Algeria, Australia, Canada, China, Egypt, Indonesia, Iran, Malaysia, Netherlands, Nigeria, Norway, Qatar, Russia, Saudi Arabia, , United Kingdom, United States, Uzbekistan). Global gas production (unit - bcm) in 2022 was as follows: United States 1027, Russia 699, Iran 244, China 219, Canada 205, Qatar 170, Australia 162, Norway 128, Saudi Arabia 105, Algeria 102, Malaysia 76, Egypt 68, Indonesia 57; Uzbekistan 52, Nigeria 41, United Kingdom 38; Netherlands 18. It must be taken into account that global gas production (unit - bcm) in 2002 was as follows: Russia 584, United States 536, Canada 187, United Kingdom 109, Algeria 80, Netherlands 76, Indonesia 74, Iran 70, Norway 69, Uzbekistan 54, Malaysia 51, Saudi Arabia 46; Australia 35; China 33; Qatar 29; Egypt 26; Nigeria 14. We summarized the data obtained in a comparative Table 4.

Table 4. Global gas production (bcm) in 17 countries

	Gas production 2022 (bcm)	Gas production % of 17 analyzed countries	Gas production 2002 (bcm)	Gas production % of 17 analyzed countries	Increase/decrease in the analyzed group of countries, %	Volume increase/decrease from 2002 to 2022 (times)
United States	1027	30.10847	536	25.85625	4.25222	1.916045
Russia	699	20.49252	584	28.17173	-7.67921	1.196918
Iran	244	7.153327	70	3.376749	3.776578	3.485714
China	219	6.420405	33	1.591896	4.828509	6.636364
Canada	205	6.009968	187	9.020743	-3.01078	1.096257
Qatar	170	4.983876	29	1.398939	3.584937	5.862069
Australia	162	4.74934	35	1.688374	3.060966	4.628571
Norway	128	3.752565	69	3.328509	0.424056	1.855072
Saudi Arabia	105	3.078276	46	2.219006	0.85927	2.282609
Algeria	102	2.990325	80	3.859141	-0.86882	1.275
Malaysia	76	2.228086	51	2.460203	-0.23212	1.490196
Egypt	68	1.99355	26	1.254221	0.739329	2.615385
Indonesia	57	1.671064	74	3.569706	-1.89864	0.77027
Uzbekistan	52	1.52448	54	2.60492	-1.08044	0.962963
Nigeria	41	1.201994	14	0.67535	0.526644	2.928571
United Kingdom	38	1.114043	109	5.25808	-4.14404	0.348624
Netherlands	18	0.527704	76	3.666184	-3.13848	0.236842
	3411	100	2073	100		1.645441

Source: authors created based on <https://yearbook.enerdata.net>, 2024

Important conclusions can be drawn by comparing these volumes with those of 20 years ago. The changes in the global natural gas market will unevenly impact individual markets across different continents. The main indicators of these differences will be delivery speed and transaction volume. In the European Union, natural gas production in the North Sea is declining, but demand remains significant. Monopolistic tendencies are gradually disappearing - growing competition will take their place. New projects (e.g. Brazil, Mexico, Iran, Angola, Egypt, Trinidad, Nigeria, Oman, Qatar) will increase supply. Increasing the number of services offered will provide more options for buyers.

During the analyzed period (from 2002 to 2022), Nigeria entered the top five countries with a multiple increase in gas production - over the years, the volume has almost tripled. However, we noted that gas supplies from Nigeria to the European Union have remained relatively high. In this regard, our analysis highlights the main problematic issues.

Nigeria has declared the 2020s a "decade of gas"; however, Nigeria has found itself unable to satisfy increased gas demand from the European continent, which is moving away from Russian gas, just as Nigerian oil production falls due to limited gas projects and export infrastructure, underinvestment and technical issues. Nigeria's LNG exports to Europe fell 22.7% in 2023, according to S&P Global Commodity Insights data, due partly to insufficient deepwater gas projects and export infrastructure (Spglobal, 2024). Nigeria is looking to fast-track the construction of a 5,600-km gas pipeline to Morocco (the 3 Bcf/d Nigeria-Morocco pipeline snaking across 13 West African countries), capable of supplying Europe, after a breakdown in diplomatic relations with Niger scuttled the Trans-Sahara pipeline to Algeria (Spglobal, 2024).

Our analysis shows that Nigeria needs to focus not on gas pipelines but on the transportation of liquefied gas. The liquefied gas transportation method dominates international trade due to the technological challenges of producing very long pipelines (especially subsea gas pipelines at great depths). In addition, in today's world, buyers no longer want to commit themselves to long-term contracts with a fixed price. Maritime trade can provide a more flexible system of agreements, including long-term and short-term contracts. Additional use of liquefied natural gas can meet global energy needs during peak demand periods. Of course, the production and liquefaction of natural gas should be based on an analysis of many factors, including natural gas reserves in the ground, which should provide contracts for at least 15-20 years. Sufficient gas volume means reserves should be approximately 30 times greater than the estimated annual mining capacity. The equipped liquefaction plant includes plants for separating natural gas from impurities, a main liquefaction plant, storage tanks for liquefied natural gas, quay and ship loading facilities for liquefied natural gas, sufficient supply of electricity and water, and proper transport logistics planning. The country's entry into the liquefied natural gas trade in practice requires installing installations and specialized terminals with tanks and docks for unloading ships and storing gas. It is also necessary to build a network of pipelines to distribute gas to end consumers.

Carriers can be either government fleets or independent ships. Still, the costs of building and maintaining such a fleet are exceptionally high due to the absolute specialization for this type of trade. The required number of ships directly depends on the distance between the importing and exporting countries. The construction of gas liquefaction plants requires significant investments; this construction must be carried out in a region with a natural harbour, flat terrain and a short distance from the gas source. However, in practice, these conditions are challenging to satisfy, significantly increasing the project's overall cost. Thus, before the importing country carries out the necessary construction of infrastructure for receiving liquefied gas, it must be justified (a significant number of consumers, the absence of more reliable alternative sources, etc.). Finally, the country's market must be willing to receive natural gas as fuel. Otherwise, the enterprise will fail, and the infrastructure costs will not be recouped. Five main factors assess the success of an LNG project: 1) gas reserves, 2) infrastructure, 3) capital, 4) cooperation between trading countries, and 5) market conditions.

The analysis of data (including Gas Utilization and Concomitant Options in Nigeria, a list of international projects, The Petroleum Industry Act, The Nigerian Gas Master Plan, etc.) indicates that the problems of corruption and environmental protection issues remain very important. The danger of corruption in the Nigerian gas industry, in our opinion, is caused by the following factors: 1) competition for access to natural resources (lack of transparency in negotiations, incomplete legislative regulation of the process, extremely high barriers

to entry into the relevant market); 2) diversity of legal frameworks for the activities of actors in the extractive sector; 3) the international nature of the extractive sector; 4) gaps in the legislative system (Teivans-Treinovskis et al., 2022); 5) highly politicized decision-making on the development of mineral resources; 6) incorrect distribution of government functions in the industry; 7) lack of monitoring systems at the firm level; 8) opacity of beneficial ownership; 8) possible bribery for the sake of providing a more favourable tax regime (Krivins, 2018); 9) possible bribery (Krivins, 2014) in the distribution of subsidies between national firms and foreign partner companies (Krivins, 2019). These risks must be reduced by improving decision-making transparency, legal regulation, and law enforcement practice. The environmental protection problem was considered a completely independent context and an aspect interconnected with corruption.

6. Conclusions

The gas market is gradually expanding, demonstrating a tendency towards balancing. Full liberalization of national gas markets could help attract private capital, increase transactions, and develop healthy competition conditions for entrepreneurs. Technological progress and experience significantly reduce the cost of constructing plants to extract, liquefy and return liquefied natural gas to gaseous form.

The global gas trade context, which has changed markedly since 2022, opens up new prospects for Nigeria. Nigeria has significant advantages when the European Union is interested in establishing trade relations with new, stable, secure gas suppliers to the EU market.

Firstly, the volume of gas in Nigeria is very significant, and Nigeria has the opportunity to increase the volume of liquefied gas supplies to different countries worldwide. Secondly, the emergence of a new supplier will help the European Union diversify gas supplies (at the same time, due to objective reasons, the volume of supplies from Nigeria will not be huge, and Nigeria will not be able to become a monopolist in the EU market). Thirdly, the European Union has significant investment and technological and innovation capital. The excellent solvency and sustainable development of the European Union, on the one hand, and the capabilities of Nigeria, on the other hand, create a unique combination in the global gas market. In this way, both parties can mutually benefit from cooperation.

The main obstacles (which are pretty surmountable) may be: 1) the problem of corruption - the European Union, the USA and Western countries traditionally pay increased attention to fair trade agreements. The primary method for concluding such contracts is an open tender, which best corresponds to the principle of free competition between entrepreneurs; 2) special attention should be paid to environmental protection, which may become the second most significant aspect of cooperation between the European Union and Nigeria; 3) the problem of political instability, especially characteristic of the continent of Africa and Nigeria in particular; 4) problems of long distances and logistics; 5) risks of a possible global decline in gas prices due to the discovery of new fields and increased competition; the likelihood that gas buyers will eventually turn to other forms of energy that replace natural gas in efficiency.

Having compared two competing types of gas transportation in Nigeria, the authors emphasize that pipelines have advantages and disadvantages. Difficulties associated with soil deformation, terrorism, and political differences can actualize traditional methods of maritime trade, which inspires confidence in supplies. The main recommendation for Nigeria could be more active construction and use of LNG terminals.

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