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Are there enough resources to make a new turn in the domestic gas industry towards the East?

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Abstract
This article presents the results of the analysis of the economic situation in the domestic gas industry, including the activities of the flagship of the country's fuel and energy complex, the Public Joint Stock Company Gazprom Group of Companies, in terms of the sufficiency of financial resources for the implementation of the national programme of social gasification/pre-gasification of Russian territories. Problems of reorientation of gas raw material exports to the East, issues of creating a liquefied natural gas complex, fleet of icebreakers for transportation of LNG to old and new areas and sales points are considered. A separate research issue is the difficulties of implementing the state target programme of social gasification and pre-gasification of Russian territories. The purpose of this subject study is a comprehensive economic assessment of the implementation of state programmes for regional development based on the use of hydrocarbon raw materials, including the social gasification/pre-gasification programme in the constituent entities of the Russian Federation. The results of the research carried out by the authors of the article are limited to the analysis of non-public departmental information on the problems identified in the gas industry. The methods of comparative activity studies and economic statistics were used as research tools. The conceptual approaches involved are discussed. The article concludes with three tentative conclusions.
Keywords: pre-gasification, global market, gas standoff, supply routes, logistics connections, gas chemistry, ESG principles.

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是否有足够的资源形成国内天然气工业向东部的新转向?

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简介
文章介绍了对国内天然气工业经济状况的分析结果，其中包括国家旗舰燃料和能源综合体--俄罗斯天然气工业股份公司的活动，以及完成俄罗斯领土社会气化/天然气化国家计划所需的充足资金。该报告审议了向东出口天然气原料的调整问题、建立液化天然气联合企业的问题、向新老地区和销售地运输天然气的破冰船队问题。实施俄罗斯领土社会气化和预气化国家目标计划的困难是本研究的一个单独问题。本案例研究的目的是对以碳氢化合物原料利用为基础的地区发展国家计划（包括联邦主体的社会气化/预气化计划）的实施情况进行全面的经济评估。文章作者取得的研究成果主要是通过分析部门非公开信息发现的天然气行业问题。研究工具采用了行动比较法和统计学方法。对所采用的概念方法进行了讨论。本文最后得出了三个中间结论。
关键词：预气化、全球市场、天然气对抗、供应路线、联动物流、天然气化学、ESG 原则。

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本文是根据合著者在 2024 年 4 月 25-26 日于俄罗斯总统国民经济与国家行政学院西北分院（圣彼得堡）举行的第十五届国际科学与实践会议 "国家与企业。俄罗斯经济发展中的现代风险、问题和趋势"国际科学实践会议和在2024 年 11 月 1-2 日于圣彼得堡彼得大帝圣彼得堡理工大学举行的第十一届 "智能工程经济与工业 5.0 (ECOPROM) "国际科学实践会议。合著者的科研活动部分反映在这些会议发表的成果（摘要）中。合著者进行的课题研究没有获得任何资助或任何外部资金支持。

Introduction

At present, the Russian gas industry is faced with the need to quickly develop a concept for reorienting the development strategy of the entire domestic gas complex and implementing the global gasification of the country, while at the same time implementing many national projects. Thus, at the plenary session of the International Forum 'Russian Energy Week' on 26 September, Russian President Vladimir Putin devoted a significant part of his report to these problems. He made it clear that the country is expanding the geography and scope of energy cooperation, while at the same time building new routes to dynamically growing and attractive markets, including the countries of the Eurasian Economic Community, the CIS and southern Eurasia. Accordingly, supplies through the Power of Siberia gas pipeline are increasing. Exports of liquefied natural gas (hereafter LNG [Tsatsulin, Bykov, 2023]) continue to grow. For our part, we note that in the conditions of gas confrontation on the European market, in 2024 the share of LNG in global gas consumption will increase from 30% to 48%[1], and the prospect of oversupply of the global LNG market is even looming.

In particular, the President emphasised: 'LNG from the Russian Arctic has become one of the anchor and main cargoes of the Northern Sea Route. We will certainly continue to develop our own services and technologies in the LNG sector, create LNG transhipment, storage and trading centres, offer gas carrier projects and, of course, increase the capacity of our Arctic and Eastern sea ports, strengthen communications and the infrastructure of the Northern Sea Route'[2]. According to the authors of the article, this is all the more important as the Arctic routes cross nine regions of the Russian Federation and the country's maritime border coastline exceeds 20 thousand kilometres.

During the aforementioned Russian Energy Week, the President of the Russian Federation noted that important strategic changes are being implemented in the gas industry, which are not so much related to the shift of export gas supplies from the West (the European market alone consumes up to 155 bcm per year) to the East, but to a significant increase in supplies to the domestic market, including the social gasification/pre-gasification programme, which has been in full swing since the beginning of 2021. The recognised leader in the implementation of this state programme is PJSC Gazprom, which together with the Government of the Russian Federation has developed a ten-year plan for the development of the gas industry.

Such a long-term plan, if fully implemented, will allow not only to ensure the sustainable development of the gas company itself, but also to create a new, modern infrastructure adapted to the changing vectors of supply geography, and will also provide an opportunity to improve the existing gas networks, It will also provide an opportunity to improve existing gas networks, organise the logistics of new connections, rationalise transport routes, and significantly increase the volume of processing of gas raw materials by Russian capacities of a high level in accordance with the established scale of production processes in favour of the creation of high-quality, innovative and high-tech products for the open domestic market and the somewhat tight foreign market. It is true that the successful implementation of all these urgent and useful projects will, in the authors' estimation, require a radical institutional restructuring of the country's export-oriented complex.

1. Clarifying the problem and purpose of the research

Here, of course, a delicate question arises: are there real opportunities to solve such important declared tasks, which presuppose the actual availability of our own high-tech machinery and sufficient financial resources on the part of those structures that are responsible for their solution today? After all, after the beginning of the EEV, the conventional West introduced many sanctions restrictions, more than 18 thousand items in the composition of 14 packages against our country (at the time of writing), including the sphere of LNG promotion to foreign markets.

[1] Plenary Session of the XIII International Gas Forum St. Petersburg 'Gas Market-2024: Contours of the New World Order'. https://rutube.ru/video/6e3c439c68e13e7020eecc70069ac0b7/.
[2] http://kremlin.ru/events/president/news/75185.

Moreover, judging by fragmentary information from the Russian oil and gas market analyst - foreign agent M.I. Krutikhin, which needs to be verified, the European Commission has decided to impose a complete ban on gas supplies to EU countries from 01.01.2027[3]. Taken together, these massive Western sanctions pressures, which have already been felt by the Russian economy, have resulted in a 7-8% reduction in gas production and a 16% reduction in gas exports by the end of 2024[4]. Although last year friendly countries still accounted for over 90% of Russia's energy exports.

Thus, in June this year, the promising projects Arctic LNG-1 and Arctic LNG-3, Murmansk LNG, Gazprom Invest, Rusgazdobycha, Murmansk-Transgaz, and Ob Gas Chemical Complex fell under such sensitive sanctions and restrictions for the domestic gas transportation complex. In addition, our former pseudo and quasi-market business partners in the globalised economy declared their intention to limit the energy revenues of the Russian budget and hinder the development of already launched energy projects in the Fuel and Energy Complex (FEC).

How does the government of the country plan to overcome the problems caused by global instability and solve the tasks formulated by the President of the country? Are these problems surmountable when even in the draft State Budget of the Russian Federation for 2025-2027 the oil and gas revenues from the export of raw materials will not exceed 27%, and multiple types of tax pressure on the core sector will increase from 1 January 2025, along with the corporate income tax updated to 25%? At the same time, the government is also discussing the immediate stability of the VAT.

Russia's Cabinet of Ministers has approved an updated strategy for the development of the country's mineral resources base up to 2050. This was announced by Russian Prime Minister M.V. Mishustin at the opening of a working session with his deputies. 'The government has approved an updated Strategy for the Development of the Mineral Resources Base and has also extended the planning in this important area by 15 years, until 2050,' the Prime Minister said, adding that the document has updated the forecast technical and economic indicators and the target scenario has formulated the main objectives. These include the discovery of new hydrocarbon deposits, for which it is necessary to step up efforts to comprehensively explore and develop explored territories, especially in hard-to-reach areas, including the Arctic and the Far East, despite the new risks and threats that have emerged [Imanov, 2023]. Today, there are 153 officially explored gas fields in the country.

The mineral resource base is a natural basis for many manufacturing industries, such as metallurgy, chemicals, mechanical engineering, etc. The development of this base ensures the creation of new jobs, despite the extremely low unemployment rate in 2024, measured at the end of August at 2.4% for the three previous months[5] (a record low), and stimulates further economic growth, which is so necessary in the current difficult conditions, which have given rise to many new problems, not always foreseeable and sometimes not obvious in terms of their identification.

Raw materials are also necessary to meet the country's internal needs in the field of construction, energy, industrial production, to ensure comprehensive economic security and to maintain a reasonable export potential, including gas supplies of all types and forms. It is necessary to determine the range of real possibilities of the gas industry in order to form a new strategy for its development and/or to modernise the old strategy with elements of significant transformation of its vectors, but in any case taking into account the assessed risks, threats and the level of necessary sufficiency of financial resources. All this is the aim of the long-term research of the authors of the article.

The development of a strategy 'with a new geographical face' is extremely relevant, firstly, because it is necessary to overcome the main uncertainties in the development of the oil and gas sector/complex of the Russian Federation for the next 20-25 years [Fomin et al., 2024]. Secondly, it is natural gas - today the most environmentally friendly, acceptably efficient and still accessible hydrocarbon - which accounts for 48% of the country's energy balance. Together with nuclear power (NPP), hydroelectric power (HPP) and wind power (WPP), which have a minimal carbon footprint, this share is 85.2%.

2. Obtained results

Given the seriousness of these problems, the financial capacity of Russia's gas majors to undertake such significant transformations in the gas industry and implement truly large-scale projects comes to the fore. For example, in 2023, according to the RAS report, Gazprom had a net loss of 639 billion roubles and produced 156 billion m3 less natural gas than in the previous year. In the first half of 2024, Gazprom reported a net loss of 480 billion roubles in its financial statements according to Russian accounting standards, twice as much as in the same period of the previous year.

This loss of the corporation, which has almost 500,000 employees, is covered by the revenues of various structural divisions of the parent organisation Gazpromneft (a significant profitable asset of the holding, the management of which must be concerned about preserving the subsidiary) and Gazprombank. In general, according to consolidated IFRS reporting, the PJSC's net profit has tripled over the same period, but it is technically difficult for analysts to isolate the financial component for gas, and a reliable factorology is not always available.

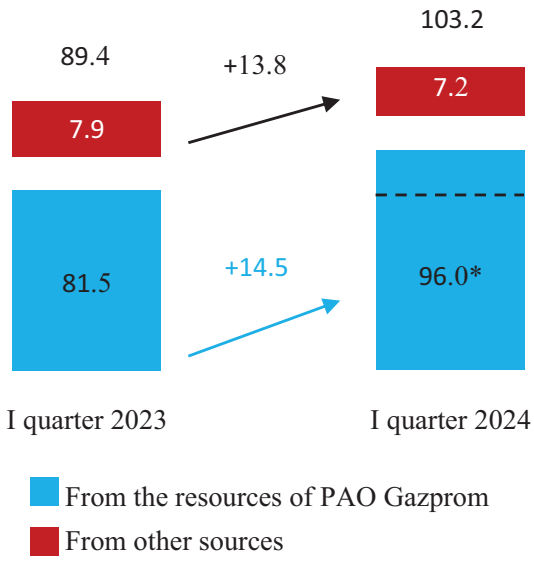
Nevertheless, in all analytical estimates for the half-year by quantitative discrepancies, it is necessary to take into account the seasonality factors associated with the injection of gas into storage facilities for future sales. In

[3] https://www.youtube.com/watch?v=vGN-X2VjB90.
[4] https://rutube.ru/video/6e3c439c68e13e7020eecc70069ac0b7/.
[5] https://vk.com/fnprru.

addition to the traditional seasonality, there are imbalance factors due to the uneven production of environmentally friendly renewable energy sources (solar, wind, hydro, biomass, geothermal). There is also the constant factor of currency revaluation of the company's tangible and intangible assets. All this promises very high volatility in gas prices on the spot market[6] and the so-called contractual obligations market in the coming months of 2024 and the first half of 2025. However, the authors of the article believe that the RAS methodology, from the point of view of the principles of its balance sheet consolidation, more accurately takes into account the profit and loss of PJSC Gazprom according to the presented official financial statements.

However, despite this unfortunate circumstance, which is reflected in the RAS reporting and the quarterly statistical reports, the plans for the implementation of the gasification programme have not been disrupted. Thus, the volume of gas supplies after the commercial closure in the first quarter of 2024 amounted to 96 bcm, which is 11.2 bcm higher than Gazprom's target (84.8 bcm) and 17.79% higher than a year ago, as shown in Figure 1. On the other hand, deliveries from other gas sources for the implementation of this programme decreased by 8.86%, but in general the quarterly gas volumes involved in the programme together increased by 15.44% over the year.

Fig. 1. Gas supplies of Gazprom Mezhregiongaz Group in the first quarter of 2023–2024 (bcm)



Note. The target for the first quarter of 2024 is 84.8 billion m³.
Source: compiled by the authors on the basis of the report of the head of Gazprom Mezhregiongaz dated 01.07.2024.

PJSC Gazprom's resource potential is truly vast. For example, the Kovyktinskoye field[7] estimated at 1.8 trillion cubic metres of gas and 65.7 million tonnes of oil and gas condensate, and the Chayandinskoye field[8] in the Yakutsk region, estimated at 1.2 trillion cubic metres and 61.2 million tonnes, are the largest explored underground gas reserves in Eastern Siberia. Yamburg, in Yamal, also has significant gas reserves: when the explored fields are added together, the gas deposits there are the fifth largest in the world outside the Arctic Circle in terms of reserves. They are already planned to be connected via Yelets (as the final point of the Yamburg-Yelets gas route) to pipelines extending to the western borders of the Russian Federation.

However, there is virtually no domestic consumer demand in the country for such significant volumes of potentially extracted gas raw materials, which is constrained in particular by insufficiently branched traffic, as the first two fields are located on the Power of Siberia route to Blagoveshchensk. Accordingly, the operation of the aforementioned Yamburg field has encountered its own technical difficulties, caused by the effect of diminishing returns against a background of rising production costs. As a result, the most important indicator of the efficiency of the activity - the internal rate of return (IRR), one of the profitability indicators in the oil and gas industry, which should not fall below 16.0%[9]. is decreasing. In addition, there are no real opportunities to ensure the gasification of the pipeline routes used to each house and to fully implement social gasification.

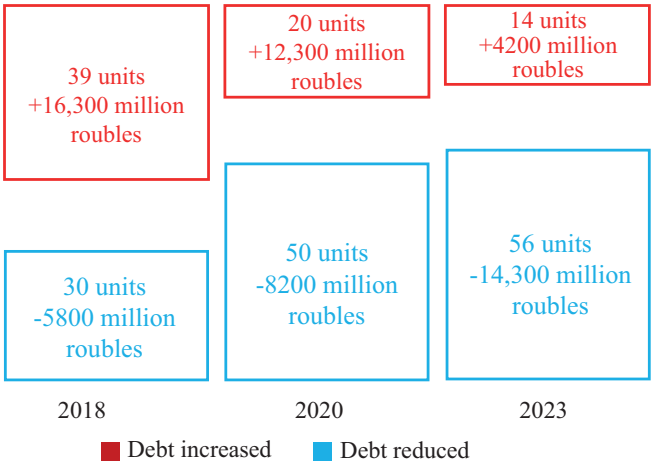
There are also no real possibilities of providing gas supply plans for the pipeline routes used to each home and to fully implement social gas supply.

Another obvious reason for the occurrence of the noted losses were overdue debts for gas supplied to end consumers, as evidenced by the data for individual subjects of the Russian Federation for the results of 2023. If we talk about the volume of gas supplied by regional gas sales companies (hereinafter referred to as RGCs) and gas distribution organisations (hereinafter referred to as GDOs), it is actually carried out in most subjects of the Russian Federation - more than 70. For most of these recipients, for various reasons, troublesome payment arrears have arisen, which are partly reflected in the graphs in Fig. 2.

In five years to the end of 2023, the debt was reduced in 56 subjects of the Russian Federation, i.e. in 2018-2023, the number of regions that reduced their debt to Gazprom Group almost doubled. In 14 subjects of the Russian Federation by the beginning of 2024, despite the satisfactory dynamics of its repayment, the debt remains in the amount of 4,200 million roubles, which reduces the standards of the required mobility of the holding's working capital.

[6] As a result, global gas prices fell in July-August compared to the previous year, amid growing global reserves and declining demand forecasts. This has had a corresponding impact on the profitability of gas producers (declining margins), such as the US company Cheniere Energy, whose third-quarter net income fell by half - to $893 million - due to a decline in margins, and quarterly revenue from the gas segment fell by 12% - to $3.55 billion.
[7] One of the priority facilities constructed at the field is the Integrated Gas Processing Plant No. 2 9UKPG-2.
[8] The natural gas from this reservoir has a complex composition, including significant amounts of helium.
[9] IRR (internal rate of return) – the interest rate at which the present (discounted) value of a company's future cash flows equals the value of the initial investment.

Fig. 2. Dynamics of overdue debts for gas supplied to end users by constituent entities of the Russian Federation for 2018–2023



Source: compiled by the authors on the basis of the report of the head of Gazprom Mezhregiongaz dated 01.07.2024.

A more detailed picture of debt volatility for the top 5 constituent entities of the Federation according to the grouping indicator of increase/decrease is presented in Table 1; the general trend of the regional 'fives' indicates a certain repayment of the incurred debt of +3400 mln roubles against -2600 mln roubles. At the same time, the implementation of the state programme of social gasification/pre-gasification in the country, supervised by Gazprom's specialised structure Mezhregiongaz, is in full swing [Tsatsulin, Bykov, 2024]. Thus, on 10 October 2024, the head of Mezhregiongaz S.V. Gustov launched via teleconference at the International Forum 'Gas Market-2024: 16 new regional networks of social gasification/pre-gasification: Contours of the New World Order' in St. Petersburg[10].

The dynamics of the implementation of the adopted plan and the prescribed forecast for 2024 for the implementation of the contractual discipline for the connection of households on the territory of the Russian Federation are shown in Fig. 3: the graph reflects the growing number of business contracts executed within the framework of the pre-gasification procedure up to the borders of the applicants' plots, the cumulative total, the dotted line indicates the forecast values of the main indicators for 2024.

The large-scale and widespread gasification of the country, which has been planned for many decades, has received additional incentives in recent years and new benchmarks have been set for the gas industry, which has had a positive impact not only on the availability of gas, but also on the overall development of the country's regions and the environmental situation developing in them, as fuels with a high carbon footprint, i.e. carbon emissions (CO_2 and other formations) into the atmosphere, are displaced. Russia is one of the world's most active countries in terms of contributing to the reduction of greenhouse gas emissions, and its energy balance is one of the greenest in the world. According to the head of state, by the end of 2024, the share of environmentally friendly gas, nuclear, hydroelectric and other more modest sources of conditionally clean energy in the Russian Federation will approach 85%.

However, in the near future, along with the implementation of gasification/pre-gasification plans, it is necessary to move on to solving the problems of sustainable and affordable energy supply, based on the use of the most rational options for such solutions among all available alternatives, taking into account the effectiveness of technological progress and regional characteristics of territories, breakthrough innovative achievements of scientific and technological progress, the pace of digitalisation of the economy, and even special promising developments in the field of artificial

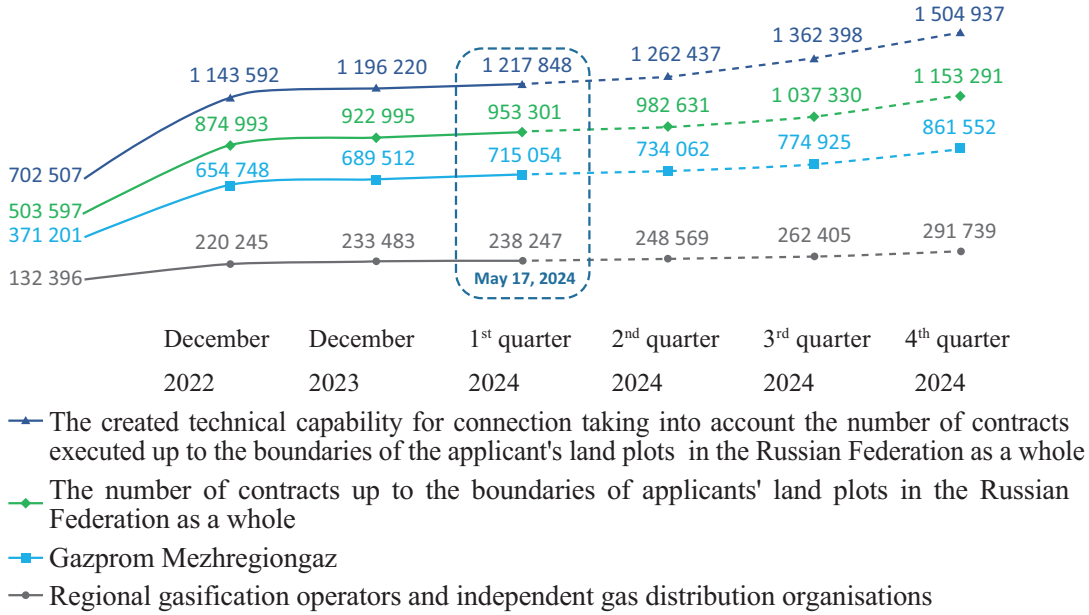
Table 1
Type of overdue debt in the regions of the Russian Federation
(mln rub.)

Subjects of the Federation with the largest annual increase in overdue debt	Debt increased	Subjects of the Federation with the largest annual reduction in overdue debt	Debt reduced
Tver region	+900	Krasnodar region	–800
Archangelsk region	+800	Moscow Region	–700
Yaroslavl region	+700	Perm region	–500
North Ossetia - Alania	+600	Vladimir region	–300
Primorsky Krai	+400	Samara region	–300
Total	+3400	Total	–2600

Source: compiled by the authors on the basis of the report of the head of Gazprom Mezhregiongaz dated 01.07.2024.

[10] https://musinlc.ru/peterburgskij-mezhdunarodnyj-gazovyj-forum-pmgf-2024/.

Fig. 3. Plan and forecast for 2024 for the execution of contracts
for the connection of households within the framework of pre-gasification as of 17th May 2024



Source: compiled by the authors based on the report by the Head of Gazprom Mezhregiongaz on 1 July 2024.

intelligence in relation to the gas industry [Bogatyrev, Tsatsulin, 2024].

However, it is important to recognise that the gasification and additional gasification of small towns and rural settlements in Western and Eastern Siberia is becoming extremely expensive under inflationary conditions. The population may simply not demand the services offered by PJSC Gazprom for the installation of relatively expensive gas equipment due to the predicted decline in purchasing power, unfavourable inflation expectations, the accelerated spending of limited National Welfare Fund funds, and the threat of devaluation of the national currency. The entire social gasification/additional gasification project may turn out to be unprofitable, or even critically unprofitable, in the near future in cases of force majeure. The lack of financial resources, even if only felt remotely, indirectly affects the level of geological exploration and survey activity of gas companies.

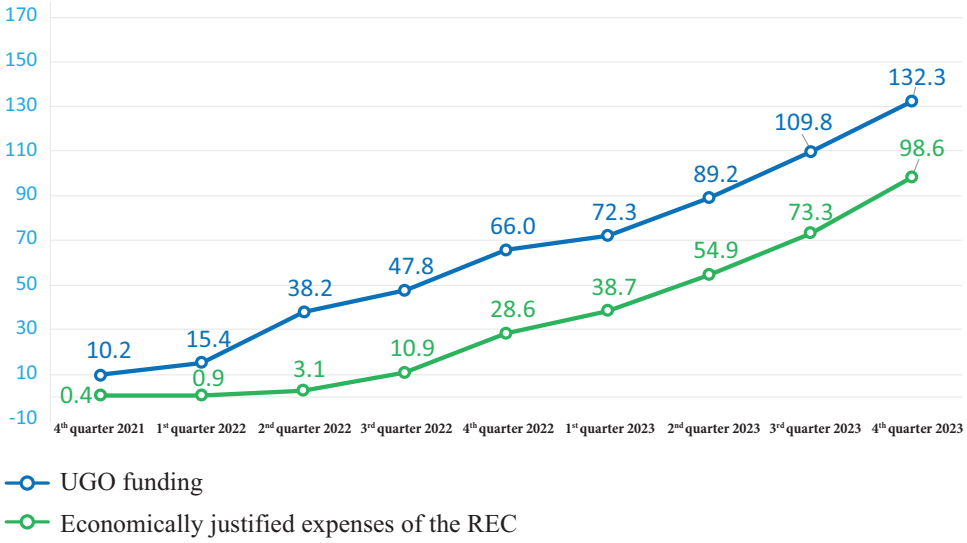
Thus, for purely economic reasons, the development of new fields in the Laptev Sea region has been suspended, with exploratory drilling postponed for five years. The ultra-fast development of fields explored in the 1960s and 1970s - such as Samotlor in the Tyumen Region and Urengoy in the Yamal-Nenets Autonomous District - was, to a certain extent, the main reason for their barbaric exploitation during the period of the international 'pipe-for-gas' deal. Consequently, some of the fields were damaged by the forced injection of water into the formations, as well as by the spontaneous flow of water from underground sources into formations that had been rapidly emptied of gas [Yalaletdinov et al., 2024].

The sad fate of many oil and gas fields cannot be justified by the 'fat years' of an economy based on unrestrained consumption, which then fell into a period of stagnation. We must recall the miscalculations of the previous country leadership, not to refute the attractive pragmatism of the toxic 'After us, at least later' meme, popular in the minds of many, by turning to the scientific heritage of the great scientist Academician V.M. Bekhterev [Bekhterev, 1990], but to highlight the absolutely irresponsible manifestation of this complex, behavioural and toxic meme. However, we must recognise that global challenges in the international hydrocarbon markets and the uncertain state of the global fuel and energy sector have paradoxically created favourable opportunities for the rational transformation of Russia's oil and gas development strategy for the next two to three decades. It is here that we should recall the first Russian turn to the East, which was formalised at the time (1905–1906) through the efforts of the first chairman of the Council of Ministers of the Russian Empire, S. Yu. Witte[11].

Nevertheless, in 2023, the current financing processes under the Unified Gasification Operator (hereafter referred to as the UGO, the official responsibility centre) scheme, and the careful control of expenditure as economically justified regional energy commission (hereafter referred to as REC) expenses, were carried out steadily and systematically, without any sporadic disruptions. This is reflected in the curves of Fig. 4. At the same time, the financing rates of UGO events are consistent with the REC expenditure rates, and the statistical summary indicator of the analysed technical and economic characteristics in the form of the

[11] https://russiancouncil.ru/analytics-and-comments/analytics/sergey-vitte-i-pervyy-povorot-rossii-na-vostok/.

Fig. 4. Dynamics of financing and economically justified expenses according to the decisions of the REC based on the results of 2023 (bln rub.)



Source: compiled by the authors based on the report by the Head of Gazprom Mezhregiongaz on 1 July 2024.

distribution ratio (DR) was assessed as favourable at the end of the year:

$$DR_{REC/UGO} = 98.6 / 132.3 = 0.74528 \sim 74.53\%.$$

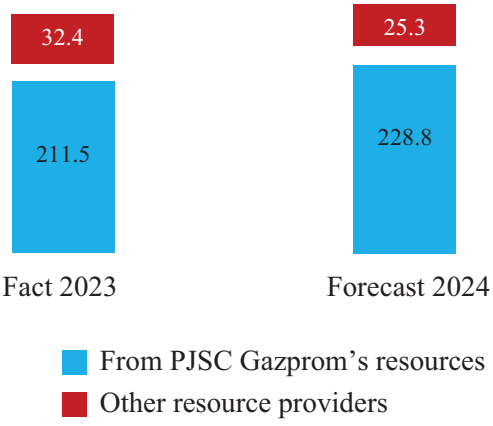
However, we cannot ignore the various problems with the transportation of hydrocarbon raw materials by pipeline that have recently become much worse. While the transport sector of the economy is gradually leaving the era of oil dominance, the fuel and energy sector is entering a new era of active interspecific fuel competition based on the targeted use of gas raw materials. It is noteworthy that the scope of LNG application is expanding rapidly in gas-powered transport, including public transport (for example, municipal buses in Volgograd are fuelled with LNG), agriculture (in particular, tractors and combines), and road transport, where hydrogen is even used as a motor fuel [Kulagin & Grushevenko, 2020][12].

Other promising areas for the use of LNG include rail and water transport and industrial rolling stock. New domestic models of specialised automobiles and construction equipment that use compressed and liquefied natural gas have already been developed.

In addition to LNG, ammonia and methanol will be in demand for sea and river transport. There are independent, highly favourable and completely non-fuel prospects for various inert gases, also known as noble gases, such as helium, krypton, neon, argon, xenon and radon. These gases, when used as additives in natural gas, significantly alter its calorific value and consumer properties, while retaining their own value in various consumer markets.

Given the scale of the domestic supply of gas raw materials to consumers, Gazprom continued to increase its natural gas supplies in 2024, provided that the official target supply indicator for 2023 was approved by the Board of Directors of PJSC Gazprom on 20 December 2022 (No. 3868), amounting to 209.9 billion m³, which was exceeded by 0.76%. This is happening against the background of a projected decrease in supplies from other market suppliers by 21.08%, as illustrated by Fig. 5.

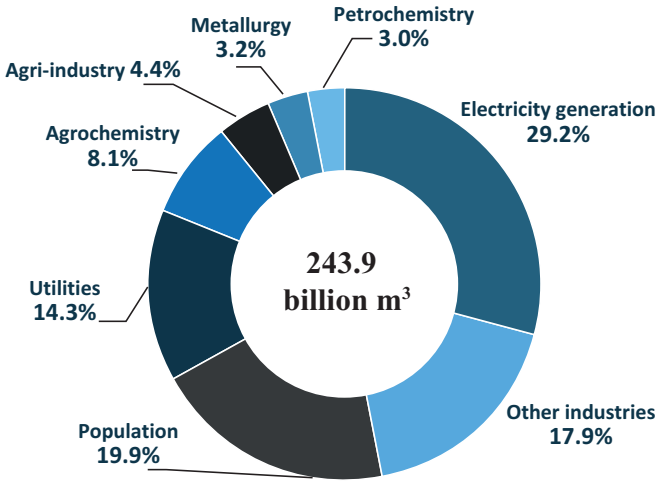
Fig. 5. Natural gas supplies of Gazprom Mezhregiongaz Group in 2023–2024 (bcm)



Note. The target for 2023 is 209.9 billion cubic metres.
Source: compiled by the authors based on the report by the Head of Gazprom Mezhregiongaz on 1 July 2024.

[12] Although hydrogen energy has been considered an attractive option for developing the fuel and energy complex since the mid-20th century and research into producing and combusting hydrogen has been conducted for around 200 years, as of 2024, its use as an energy source worldwide is still extremely limited. Almost all of its consumption occurs in the production of ammonia and methanol, as well as in metallurgy, oil refining, and petrochemistry. Typically, hydrogen is an intermediate element in production chains — it is produced in some processes and consumed in others within the same site [Global Hydrogen Trade, 2022]. The use of hydrogen as an automobile fuel was actively studied in the USSR during the Great Patriotic War, particularly by specialists from besieged Leningrad. One such specialist was the inventor B.I. Shelishche [Brodsky, 1975].

Fig. 6. Reported industry structure of Gazprom Mezhregiongaz Group gas supplies in 2023 (%)



Source: compiled by the authors based on the report by the Head of Gazprom Mezhregiongaz on 1 July 2024.

Of particular interest is the consumption structure of gas raw materials for industrial and social sectors in relation to the total volume of 243.9 billion m³ for 2023 as a whole. The role of gas raw materials in industrial processing schemes, including primary processing, and in end-use products in real-sector industries looks relatively modest. This is reflected in Fig. 6, which shows that only about 18.7% of all supplied gas is consumed when gas raw materials are used separately as fuel for the electric power complex of the national economy in metallurgy, petrochemistry, agro-industry and agrochemistry.

3. Cross-discussion

Industry experts and analysts assert that gas fields launched in the 1960s and 1970s are now significantly depleted, a claim that is not disputed. In order to revive them, it is necessary to drill through the Earth's crust to the gas-bearing strata at a depth of over 2,000 metres. However, these efforts will require more costly and science-intensive breakthrough technologies that the domestic oil and gas industry does not yet possess [Plis et al., 2024].

In Russia, hydrocarbon volumes are distributed unevenly across a large area of the country, from the Riphean to the Cretaceous stratigraphic ranges, at depths of 1,500–4,500 metres.

The southern territories of the Siberian Platform, covering an area of about 750 thousand square kilometres, include the southern part of the Krasnoyarsk Territory, the Republic of Sakha (Yakutia) and the Irkutsk Region. These territories have significant gas-bearing potential. Large gas fields have been discovered, explored and developed there, and the Kovyktinskoye and Chayandinskoye fields, which stand out for their reserves, are notable examples of this. Industrial development of these fields began in the mid-1980s.

The shift in production emphasis in the practice of territorial movement of gaseous hydrocarbons began during the period of establishing a gas confrontation with the collective West, beginning with the North-Eastern Front. Currently, eight small-tonnage LNG production complexes belonging to PJSC Gazprom are already operating in the eastern part of the country (in the Tomsk and Tyumen regions, among others), and the corporation's short-term operational plans provide for the construction of more than 60 mini-LNG complexes across Russia[13].

The products of small-tonnage LNG production are primarily intended for the autonomous gasification of consumers located far from the main gas infrastructure, as well as for the refuelling of vehicles. At the same time, Gazprom is establishing medium-tonnage LNG production facilities, such as the one in the Portovaya compressor station area and the one in the Ust-Luga area of the Leningrad Region. The latter facility involves the deep processing of ethane-containing gas on the basis of a standard gas chemical plant. Several such new standard enterprises have opened recently.

The implementation of new projects is also at risk of failure due to the impact of existing and developing sanctions packages. Currently, sanctions are being imposed on unfinished LNG vessels and fleet facilities that have already been launched, including those in the gas carrier series. However, the environmental characteristics of Arctic LNG-2 are very attractive since it operates using the cleanest ecological fuel[14]. Accordingly, the Yamal LNG plants, the Arctic LNG-2 company's process lines and plants, and even Gazprom's LNG plants in Tatarstan – mini-complexes representing a new format of gas assets – are capable of bunkering various classes of river and sea vessels. They are also forced to operate under special, commercially flexible regimes that are not always market-based.

[13] https://nangs.org/news/downstream/lng/gazprom-postroit-tretij-mini-kompleks-pro-proizvodstvu-spg-v-tatarstane.
[14] https://arcticspg.ru/.

There have also recently been a number of difficulties with land transportation of gas. The 1,000 km long Soyuz-Vostok gas pipeline runs through Mongolia to China and is essentially an extension of the 6,500 km long Power of Siberia 2 pipeline. Previous projects in Mongolia's economy and civil sector had envisaged using gas instead of coal, an extremely dirty and traditional fuel in Mongolia. It is well known that combustion of coal produces the main component of carbon emissions, making it difficult to implement the concept of a low-carbon green economy in Mongolia. This also leads to stricter requirements from observers and experts in international organisations for reducing CO_2 emissions.

Nevertheless, Mongolia has postponed its government's decision to switch to Russian gas until 2028. In the meantime, the political and economic project 'Power of Siberia-2' is not paying for itself within the planned parameters due to the unexpected position taken by the Chinese leadership. The option of merging it with Russian gas pipelines in a westerly direction is already being considered. Analysts believe that, as China slowly moves towards a green economy, it will not consume as much gas as was prescribed in intergovernmental agreements and medium-term plans (on behalf of PJSC Gazprom).

According to a team of highly qualified specialists and analysts from the Institute of Energy Research of the Russian Academy of Sciences, headed by the authoritative scientist Academician A.A. Makarov, the active revival of the specified project for these two countries can only take place on the predicted horizon of the intermediate cutoff in 2035, when the PRC will consume more natural gas than all European countries combined. The total consumption of Asian countries not belonging to the Organisation for Economic Co-operation and Development (OECD) will equal the volumes consumed in North America and exceed them by 2050. According to futurologists at the Institute of Energy Research of the Russian Academy of Sciences, countries in South and Central America, including Guyana, which became a major hydrocarbon producer after 2015, will surpass Asian OECD countries in terms of consumption by 2050 [Forecast for the Development of Energy, 2024]. In terms of the principles that will shape the future oil and gas market by 2050, it is reasonable to assume that the market will continue to be based on the 'three pillars': North America (including Canada), CIS countries, and the Middle East. These regions will together provide over 70% of the world's hydrocarbon production. The authors of this article also examined the structural forecasts of the gas component of the hydrocarbon market for three classic scenarios of the development of the global fuel and energy complex by 2050: pessimistic ('fog' in the terminology of the ERI compilers), optimal ('split') and optimistic ('key'). These were analysed in terms of both global primary energy consumption and global electricity production by type of energy resource, compared with 2021 [Forecast for the Development of Energy..., 2024]. This year obviously served as the initial base, i.e. the starting point, for implementing procedures involving either intricate extrapolation or econometric correlation-regression modelling.

The consumption and production structures projected over a 25-year horizon and presented in Tables 2 and 3 were determined according to the named scenarios, possibly taking into account a set of partial and pure elasticity coefficients of the factorial influence of a group of preliminarily selected, most significant causal features and factors on effective features and indicators[15]. Notably, the share of gas as an environmentally friendly natural consumption asset remains at a stable 23% in all structural development scenarios recorded in the presented diagrams (Table 2).

Table 2
Forecast structure of global consumption by primary energy source for 2050 in three scenarios for the development of the global fuel and energy complex (%)

Type of primary energy resource	Baseline extrapolation 2021	Forecast development scenario for 2050		
		Pessimistic	Optimal	Optimistic
Oil	29	29	27	25
Gas	24	23	23	23
Coal	27	21	21	17
Nuclear	5	6	6	6
Hydro	3	3	3	3
Bioenergy	9	11	11	11
Other RES	3	7	9	15
Total	100	100	100	100

Source: compiled by the authors and partly based on calculations [Forecast for the Development of Energy, 2024].

[15] This ERI report does not present the modelling procedures, methods and tools of analytical calculations, nor the author's forecasting concept, which is considered a generally accepted practice. Expert futurologists rarely specify the techniques and details of their econometric modelling for the forecast horizon.

Table 3
Predicted structure of world electricity production by source of origin in 2050
in three scenarios for the development of the global fuel and energy complex (%)

Source of electrical energy	Baseline extrapolation level 2021	Forecast development scenario for 2050		
		Pessimistic	Optimal	Optimistic
Oil products	2.5	1.5	1	1
Gas	22.5	16	16	15
Coal	36	25	23.5	14
Nuclear energy	10	9.5	9	8
Hydro energy	14.5	13	12	11
Bioenergy	3	4	3.5	3
Solar energy	4	16	18	24
Wind energy	7	14	16	23
Other renewable energy sources	0.5	1	1	1
Total	100	100	100	100

Source: compiled by the authors and partly based on calculations [Forecast for the Development of Energy, 2024].

In the interests of correcting the calculations shown in the work Forecast of Energy Development... (2024) by ERI RAS specialists, it should be noted that, in most of the initial forecast characteristics for the structural scenarios included in the report, the final calculation of the 'Structural Ratio (SR)' indicators by summation does not equate to 100% of total energy resources, which should naturally have been eliminated by the authors of this article in relation to both Table 2 and Table 3.

The ERI RAS team's forecast calculations of the structure of electricity generation in the global fuel and energy complex for 2050, by energy resource type, demonstrate a significantly lower gas share, ranging from 15-16% with a 1% variability level (Table 3), comparable to the statistical error margin. The authors of the article suggest that this downward trend is most likely associated with the gradual depletion of gas fields everywhere, as well as the expected growth of market prices (up to 500 dollars per thousand m³ according to the Chairman of the Management Board and Deputy Chairman of the Board of Directors of PJSC Gazprom, A. B. Miller[16]). It is also associated with the promotion of the green agenda amid long-term sanctions and global geopolitical and economic instability.

A comparative analysis can be used to interpret the INEI forecast of electricity production from petroleum products, which decreased from 2.5% to 1% in all scenarios (Table 3). It seems that the developers of the forecast have assumed that some types of fuel oil will be used indefinitely to power small mobile objects in the future. The accomplishment at a level of statistical significance of only 1%, expected in 2050, only serves to confirm and strengthen the validity of the aphorism of the eminent scientist Academician D.I. Mendeleyev: 'Burning oil is like heating a stove with banknotes.'[17].

In addition to the forecast situation on the world market, which may naturally be subject to adjustment and/or distortion by future decisions of the Forum of Gas Exporting Countries, the work 'Forecast of Energy Development... 2024' contains development scenarios for our country. In all the considered scenarios, gas consumption in the Russian Federation increases slightly, reaching 520–574 billion m³ by 2050 depending on the scenario selected.

The highest figures are, of course, found in the optimistic scenario ('key'), where increased efforts in energy efficiency and conservation are offset by faster economic growth, particularly in eastern regions, leading to higher gas consumption. The forecast can also be interpreted as indicating increased consumption of raw materials for internal use, including for the operation of LNG plants, greater use of gas fuels in electricity generation due to the partial replacement of coal, and increased electricity demand. We note that the actual range of variation of predicted gas consumption in the Russian Federation, estimated by the ERI RAS developers to be 54 billion m³ per year for the strategising period 2021–2050, coincides with the capacity of just one 'Power of Siberia-2' pipeline from PJSC Gazprom to China, at 50 billion m³ per year.

Another unfortunate misunderstanding has come to light, this time of a legal and technical nature. Rosnedra analysts[18], have drawn attention to alarming appeals to the relevant authorities from many private companies wishing to develop

[16] https://musinlc.ru/peterburgskij-mezhdunarodnyj-gazovyj-forum-pmgf-2024/.
[17] https://www.kron.spb.ru/press-center/likbez/neftepererabotka/.
[18] Head of Rosnedra https://rosnedra.gov.ru/.

subsoil resources containing sought-after and scarce minerals in a civilised and fair manner. This is due to extremely high starting payments, reaching several billion rubles, in the auction trade of lots for subsoil plots. This creates an insurmountable obstacle for companies that base their business on developing already explored subsoil, including hydrocarbon deposits, and wish to enter the market. The authorities introduced a decreasing coefficient mechanism with some delay, which is designed to streamline starting payments. However, the authors of this article believe that it will not solve the current problem.

Conclusions

1. The average annual growth rate of the national economy, as measured by the GDP macrostatistics indicator, is within the acceptable range of 3.7–3.9%. The implementation of the social gasification/pre-gasification programme, the active creation of a new pipeline infrastructure in the east of the country, the development of gas-powered transport, the development of corresponding innovative gas production technologies and plans to switch from coal to gas for the production of electricity and heat in certain regions, while strictly adhering to the principles of the green agenda (ESG), can create the appropriate conditions for expanding the range of production capabilities for the use of gas raw materials for domestic needs[19]), can create the appropriate conditions for expanding the range of production capabilities for the use of gas raw materials for domestic needs.

The planned launch of new export projects will also require an increase in gas consumption to meet the industry's own needs. At the same time, the Russian Federation has significant potential for energy savings. Even partial implementation of these savings could significantly reduce gas costs. However, it is important to bear in mind that weather conditions can cause annual gas consumption volumes to deviate by up to ±15%.

2. In terms of finding additional sources of economic growth and ensuring the country's security, the existing resource potential suggests real prospects for developing the petrochemical industry and related sectors. It is therefore necessary to adhere to this direction and not stop at the initial production stages, but rather to enter the segments of final products with a high degree of processing and significant added value in production chains, and ultimately, the release of consumer goods, including new products. In this context, the excerpt from the aforementioned report of the President of the Russian Federation is noteworthy, in which it was proposed to pay special attention to gas chemistry, given that consumer demand for its products will only grow and prices in the processing chains can sometimes increase 12-fold.

3. A set of mandatory strategic shifts will stimulate further GDP growth, improve existing technologies and create new ones, and generate corresponding jobs. According to the IMF, the Russian economy became the fourth largest in the world in 2023, with a share of 3.5% of world GDP calculated using the purchasing power parity assessment method. Russia has thus caught up with Japan (3.5%) and overtaken Germany (3.2%). Meanwhile, the top three remain China (18.8%), the USA (15.0%) and India (7.9%). Russia's position in the world ranking is also confirmed by World Bank data[20].

In addition to export markets, many types of derivative product have their own large domestic market, which is currently largely dependent on imports. Nevertheless, energy consumption volumes continue to grow worldwide, and the automation and digitalisation of fuel and energy complex facilities is being actively implemented. The solution to specific problems of increasing the competitiveness and energy security of the state is beginning to play a special role, which will certainly help to strengthen state sovereignty and overcome strategic uncertainty in the development of the domestic gas industry.

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[19] The abbreviation 'ESG' traditionally stands for environmental conservation (E), social responsibility (S), and quality of corporate governance (G) [Koryakin et al., 2024].
[20] https://spb.ranepa.ru/news/tema-dnya-reshetnikov-ekonomika-rf-prodolzhaet-rasti-tempami-vyshe-mirovyh/.

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