Investments in Biotechnological Projects: the Way to Sustainable Development in the Oil and Gas Industry

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Abstract: In the context of global financial turmoil and high volatility of oil prices, oil and gas corporations are seeking to diversify their investment activities. The priority is not only adapting to new market conditions, but also leveling the risks of falling oil prices by investing in the most promising projects and growing innovative markets. The purpose of this article is to explore the possibilities of increasing the economic sustainability of oil and gas corporations by diversifying their investments in biotechnological projects. The paper examines the prospects for such investments in the context of reducing dependence on oil price volatility. The main focus of the research is aimed at analyzing the strategic advantages of biotechnologies and their potential for the sustainable development of oil and gas companies. In this context, the company developed and implemented its own strategy for the development of innovative projects aimed at integrating biotechnologies into current business processes, which demonstrates new horizons for the development and strengthening of the positions of oil and gas companies in the global market.

1 INTRODUCTION

One of the key factors for ensuring the sustainable development of the oil industry and its successful adaptation to changing market conditions is the need for deep modernization of the national oil sector. During the twentieth century, the oil market was the most important engine of industrial development, but the modern challenges of the transition to the information age require the transformation of market mechanisms in the direction of ensuring sustainable economic growth and revision of the factors of the reproductive process.

Since the beginning of the 21st century, the oil market has been characterized by high volatility (Fig. 1). Price changes are caused by changes in the regional structure of production and qualitative changes in the extracted oil. Thus, the weighting of the oil composition over time due to physico-chemical processes in geological formations during production affected the change in energy prices, due to more complex processes for obtaining high-quality fuels that meet the new introduced quality standards (Euro class). The oil and energy market has also been affected by the changing dynamics of international supplies and the evolution of the role of oil in the energy strategies of world economies in the light of the increasing environmental requirements of society (Borodin, Panaedova, Ilyina, Harputlu, Kiseleva, 2023).

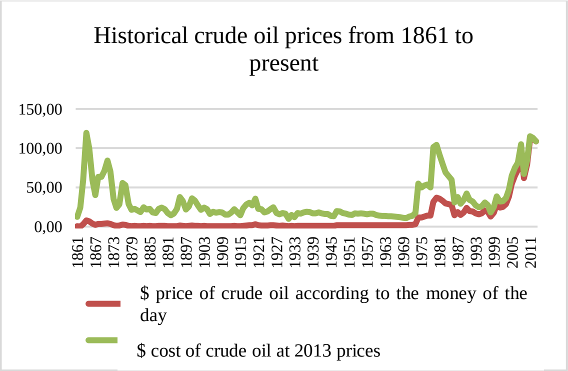

Figure 1: Historical crude oil prices in dollars per barrel from 1861 to the present (BP Statistical Review of World Energy 2014).

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Given that over the past 10 years, the share of income to the federal budget of Russia from the oil and gas sector has consistently ranged from 40 to 50% (BP Statistical Review of World Energy 2014), it is necessary to develop strategies for diversifying investment portfolios of oil companies in conditions of uncertainty. One of the ways to diversify the risks of changes in oil prices may be investing in innovative projects.

Innovative projects are projects aimed at developing new products or services that can lead to improved productivity and competitiveness of the company (Meifort, 2016), as well as changes in existing markets and the emergence of new ones. In the context of modern business, many such projects are implemented in the form of startups (young innovative companies). These startups are often pioneers in their field, seeking to bring revolutionary changes to the market.

In the face of uncertainty and financial opportunities, companies invest in emerging technologies and markets. Research shows that it is long-term foreign institutional investors who influence the efficiency of investments in emerging markets, especially in firms subject to excessive investment and agency problems. This shows the high value of long-term investments in new technologies and technology startups (Mian, Mian, 2023).

At the same time, startups that are actively engaged in patenting their developments demonstrate high innovation activity. Existing studies show that the number and quality of patents filed can serve as an indicator of startup innovation activity (Nanda, Rhodes-Kropf, 2013). This emphasizes the importance of patenting as a means of confirming and protecting innovations, and also points to the link between investment and innovation activity.

It is becoming relevant to study the possibilities of increasing the economic sustainability of oil corporations by diversifying their investments in innovative projects with an emphasis on projects in the field of biotechnology as the most attractive.

An analysis of the dynamics and structure of investments in the biotechnology sector suggests that, despite the observed fluctuations and a slowdown in the growth of the share of investments since 2020, the industry remains attractive to investors (Fig. 2). The potential of innovative projects in the field of biotechnology is high, as they are associated with global challenges and problems.

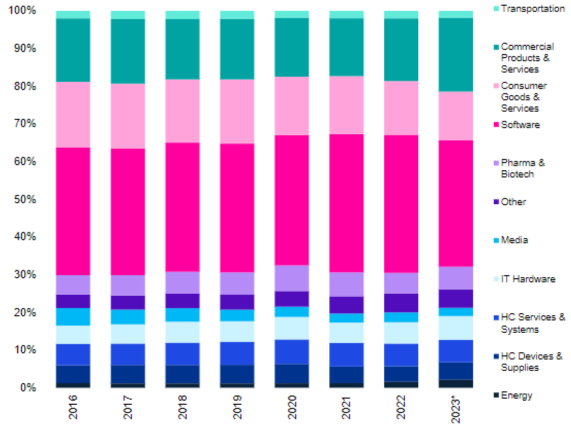

Figure 2: Venture financing by sector in the USA in 2016-2023, number of completed transactions (KPMG, 2023. Venture Pulse Q3'23).

Biotechnologies play a key role in addressing environmental sustainability issues through the development of biofuels and biodegradable materials, ensuring food security with genetically modified crops capable of withstanding extreme weather conditions, and responding to public health crises with the rapid development of vaccines (Figure 3).

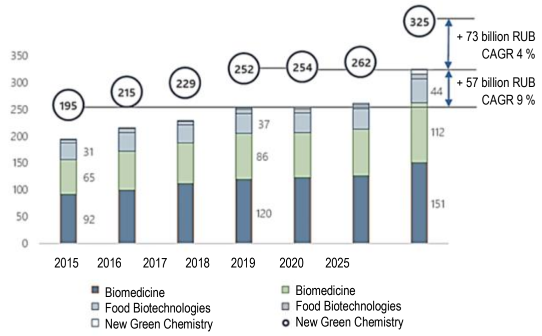

Figure 3: Dynamics of the volume of growth of the biotechnology market (Orlova, 2019).

The biotech industry has been experiencing volatility in investment flows since 2020. However, this does not have a significant impact on the long-term prospects of the sector. A wide range of subsectors, each of which is engaged in the development of advanced biotechnological solutions for specific tasks, contributes to the maintenance of intensive development and innovative progress in this area.

Biotechnologies are divided into the following subsectors according to the scope of their application:

- **Biomedical Technologies** cover the development of medicines, vaccines, diagnostic tools and therapeutic methods that are conditioned by the use of living organisms or their components. Technologies and projects in this sector play a key role in improving human health and fighting diseases.

- **Food Biotechnologies** are the application of science and technology to improve the quality, safety, nutritional value and taste of food. Such technologies include fermentation, genetic engineering of plants and animals, as well as the development of new food additives and ingredients.
- **New Green Chemistry sector** is focused on the use of biological processes and renewable bioresources to create more environmentally friendly and sustainable chemical products and materials, while replacing traditional petrochemical processes.
- **Agricultural Biotechnologies**, or Agricultural Biotech, apply methods of genetic engineering, cell biology and other approaches to increase yields, improve resistance to pests and diseases, as well as to improve the nutritional value of crops.
- **Industrial Biotechnology** is engaged in the creation of innovative solutions for the manufacturing sector, including bio-processes for wastewater treatment, biofuel production (bioenergy direction) and the production of biopolymers.

Each of these subsectors plays a separate important role in socio-economic development and improving the quality of life of the population at the global level. Therefore, the importance of investing in this area and the development of the industry is emphasized as an opportunity to increase the economic sustainability of oil and gas companies.

As a primary investment strategy, oil and gas companies should consider investments in the field of industrial biotechnology, in particular, in the development of bioenergy projects. This strategic decision is due to the need to diversify the energy portfolio of companies and reduce their dependence on fossil fuels. This direction is of particular importance against the background of the marked increase in electricity consumption in the Russian Federation, which in 2023 increased by 1.45%, reaching 1,106.3 billion kilowatt-hours, with a projected increase of 11.48% by 2028 (Kindratyshin, 2023). Investing in renewable energy projects will enable oil and gas companies to adequately respond to increasing demand and at the same time reduce their vulnerability to unpredictable fluctuations in hydrocarbon prices. In addition, such an investment policy contributes to strengthening market positions, ensuring the stability and competitiveness of companies in the process of global transition to cleaner and more sustainable energy sources. These measures fit harmoniously into long-term strategies for sustainable development and innovative transformation in the energy sector.

Bioenergy (including traditional use of biomass) is the largest renewable energy source, which will account for 12.6% of total energy consumption in 2020. In 2022, global electricity production from renewable sources increased by 8.1% compared with an increase of 5.5% in 2021 (REN21, 2023. Renewables 2023 Global Status Report collection).

According to the graph, the share of bioenergy in the total global energy consumption reached 5.7% in 2020 (Fig. 4). Sources of modern bioenergy include agricultural waste, forestry and specialized energy crops. This makes it more environmentally sustainable in comparison with traditional biomass, the extraction of which may entail environmental consequences.

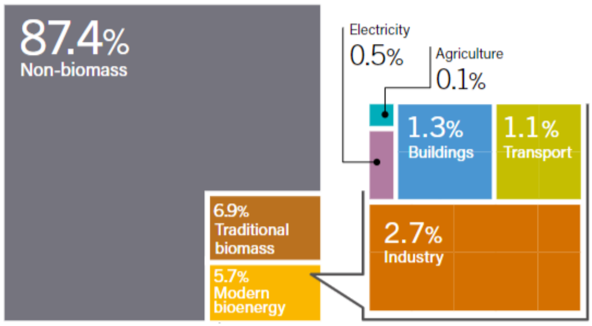

Figure 4: The share of bioenergy in the total volume of final global energy consumption, 2020 (Zhong, Bazilian, 2018).

The use of bioenergy in industry, where its share is 2.7%, is carried out for the production of heat, steam and electricity; in construction (1.3%) bioenergy is used in heating and cooling systems of buildings; in transport (1.1%) - as biofuels, for example, ethanol and biodiesel; in energy (0.5%) - in the production of electricity through the combustion or conversion of biomass; in agriculture (0.1%) - for fertilizers and pesticides and in the production of biogas from waste.

Sustainability and increased attention to the use of alternative energy sources allows us to recommend oil and gas companies to take into account investments in developing biotechnological projects (startups) and technologies in their development strategy.

The practice of global oil and gas companies shows successful examples of integrating renewable energy sources into the development strategy (Zhong, Bazilian, 2018). In particular, direct use of solar energy can be singled out to reduce operating costs, as with Total at gas stations, and the creation of new divisions for the development of renewable projects, for example Equinor. Companies are also investing in various aspects of renewable energy, for example Shell in wind energy and entering into partnerships for joint development of projects, as British Petroleum and Eni do in solar energy, seeking to diversify their businesses and strengthen their position in the clean energy market.

There are successful examples of the inclusion in the strategies of large oil and gas companies of the diversification of business assets through investments in technologies that complement their core operations and infrastructure. For example, the authors have shown how the integration of biofuels into existing production chains can contribute to reducing the carbon footprint and prolonging the exploitation of traditional fossil energy sources (Herzog-Hawelka, Gupta, 2023). Some companies have already invested in biofuels. For example, Shell is the largest distributor of liquid biofuels in the world (as of 2012) and is a large oil and gas company with a diversified portfolio. Petrobras, Brazil's state-owned oil and gas company, has also invested in liquid biofuels, creating a subsidiary after the Brazilian government introduced an extensive biofuel support program.

However, it is necessary to note the difficulties that companies face when implementing innovative, in particular, biotechnological projects: the high cost of implementation, the need to develop new technologies, the shortage of qualified specialists, restrictive regulation, as well as the need to radically change the corporate culture and business models of companies. In addition, oil and gas companies risk losing the value of their traditional assets in the context of the global transition to clean energy. This requires them to be flexible and adapt to new market conditions.

And to increase the demand for biotechnologies, it is necessary to ensure the supply on the market and stimulate demand with the help of fiscal incentives, mandatory standards for the use of biofuels and other measures (Marvik, Philp, 2020). A comprehensive approach at the country level is needed, as well as significant political efforts, coordination and state participation in the areas of innovation policy, carbon policy, industrial policy, taxation and waste disposal.

Thus, this study is aimed at analyzing the investment portfolios of Russian oil companies and identifying opportunities for the development of their investment strategies, including portfolio diversification and with a focus on minimizing risks.

2 MATERIALS AND METHODS

The research uses materials from scientific publications, analytical reports, annual reports of oil and gas companies of Gazprom Neft PJSC, Rosneft Oil Company PJSC, Tatneft PJSC, Lukoil PJSC, as well as data from open sources. Methods of analysis, synthesis, generalization, analogy, comparison were applied. The object of the study is Russian oil companies.

3 RESULTS

As a result of the analysis of the annual reports of Russian oil and gas companies, their strategic priorities were identified, as well as the directions of development of the Russian oil and gas industry, taking into account global energy trends and the policy of domestic economic development.

The volume of Gazprom Neft's capital investments showed an increase of 31.3% in 2022 and reached 2,841.8 billion rubles. The main volume of investments was directed to the development of key projects, including the construction of the Power of Siberia gas pipeline and the development of the resource base of the Yamal Gas Production Center (PAO Gazprom neft'. Godovoj otchet 2022).

In addition, strategic attention was paid to processing, where the construction of the Amur Gas Processing Plant became the most important project. In the electric power sector, the company invested in the reconstruction of power unit No. 9 at CHPP-22, improving energy efficiency and reliability. In the field of transportation, a significant achievement was the completion of the construction of the Urengoy–Pur-Pe oil and condensate pipeline, with a total length of 124.9 km.

Considerable funding was allocated to increase the depth of processing at the Omsk and Moscow refineries, which contributed to the modernization of production facilities and a significant reduction in environmental impact (PAO Gazprom neft'. Godovoj otchet 2022).

As part of the strategic direction of innovative development of Gazprom PJSC, special attention is paid to R&D, the purpose of which is to develop technologies and technical solutions for the economically profitable development of hard-to-reach regions and the creation of new highly liquid products, in particular liquefied natural gas based on domestic technologies. The company actively integrates interdisciplinary research into all areas of its activities, including through synergetic interaction with subsidiaries, providing an integrated approach to innovation. This implies the formation of an open innovation ecosystem that contributes to improving the efficiency and competitiveness of industry developments within the framework of technological priorities (PAO Gazprom neft'. Pasport programmy innovacionnogo razvitiya PAO «Gazprom» do 2025 goda).

As part of the strategic analysis, Gazprom PJSC initiated a comprehensive evaluation procedure aimed at identifying progressive innovative areas that can contribute to improving the economic efficiency of operating activities. The sensitivity of operational indicators to scientific and technical innovations was analyzed, taking into account specific territorial and geological factors affecting project capital and operating costs. Based on these calculations, key technological areas were identified and systematized, investments in the development of which will allow the corporation to maximize economic returns (see Figure 6).

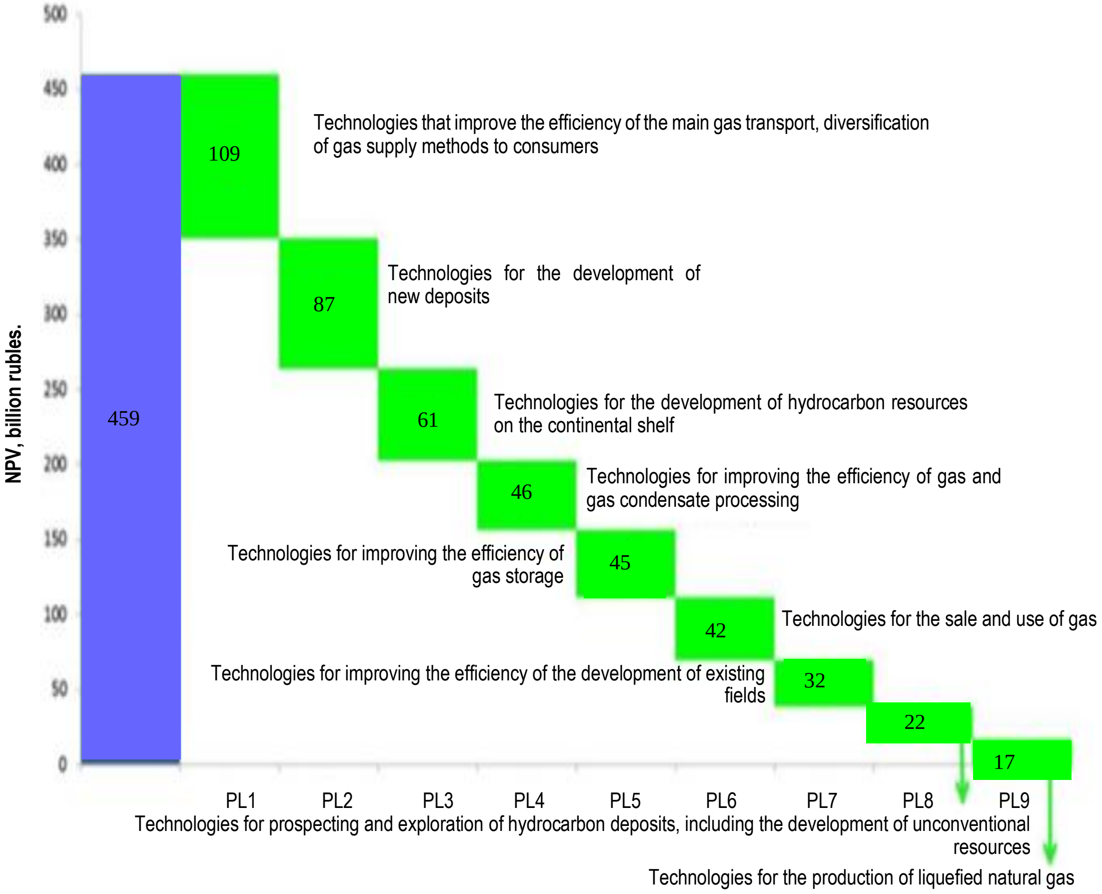

Figure 5: Graph of the dependence of investments in technological projects (net present value) on expected efficiency.

As part of the dynamic development of technological innovations, Gazprom PJSC is strategically working out the directions of its R&D potential. It is particularly worth noting sub-item 9 of the strategic R&D table for gas assets, which mentions the prospects for using microbial biotechnologies to obtain bioprotein from natural gas. This direction opens up new horizons for expanding the gas use market and increasing its sales volumes.

Thus, current investments and research in microbial biotechnologies allow Gazprom to focus on the field of biotechnologies as a separate cost item in the near future. STC Gazprom Neft has developed a new strain of bacteria that significantly increases the efficiency of production of xanthan gum, a key component for drilling fluids in the oil industry. The prospects for the creation of such production promise a 10% reduction in costs.

LUKOIL PJSC is implementing a decarbonization strategy in the period from 2022 to 2024, aimed at reducing both direct and indirect energy emissions. The main directions of this strategy include improving the energy efficiency of production processes, the development of renewable energy sources, such as wind and solar power plants for the company's own needs, as well as minimizing technological losses during the extraction and transportation of hydrocarbons.

In addition to these measures, LUKOIL is actively researching and developing low-carbon fuels, including hydrogen and biofuels. In particular, the company focuses on the development of biofuel mixtures, such as gasoline mixed with ethanol and diesel fuel with the addition of methyl esters of fatty acids. These products comply with European environmental standards and contribute to reducing the impact on the environment, especially in regions with heavy use of vehicles. However, despite the inclusion of bio-components in fuel mixtures, their share remains relatively low, which underlines the company's strategic decision to focus on more traditional and proven approaches in the field of renewable energy sources.

In the 2021 report, the company invested 2,650 million rubles in decarbonization for renewable energy projects and energy conservation programs of Russian and foreign companies, but the main focus was on improving traditional energy sources and increasing their efficiency (Table.1) (PAO Gazprom neft'. Pasport programmy innovacionnogo razvitiya PAO «Gazprom» do 2025 goda). For the period from 2018 to 2021, the energy obtained from biomass amounted to 0 million kWh annually. This indicates that during the period under review, LUKOIL PJSC did not use biomass as an energy source for its production needs.

Table 1: Production energy consumption from renewable energy sources 2018-2021.

Indicators	UoM	2018	2019	2020	2021	Reporting system
LUKOIL Group	million kWh	1.5	10.4	13.6	15	GRI 302-1
	million GJ	0.005	0.037	0.049	0.054	
Russian organizations	million kWh	0	0	0	2.3	
Foreign organizations	million kWh	1.5	10.4	13.6	12.8	
Share of energy consumption from renewable energy sources	%	0.0011	0.0075	0.0105	0.0113	
Geothermal energy	million kWh	0	0	0	0	
Wind energy	million kWh	0	0	0	0	
Solar energy	million kWh	1.5	10.4	13.6	15	
Hydropower	million kWh	0	0	0	0	
Energy derived from biomass	million kWh	0	0	0	0	

In the context of the company's overall strategy for the use of renewable energy sources, the focus is on solar energy, the use of which has increased from 1.5 million kWh in 2018 to 15.0 million kWh in 2021 (PAO Gazprom neft'. Pasport programmy innovacionnogo razvitiya PAO «Gazprom» do 2025 goda).

Rosneft has ratified an investment plan for 2022 with a capital investment of 1.1 trillion rubles, purposefully focusing on maintaining and expanding current and prospective oil and gas assets in accordance with the company's strategic objectives for production and replenishment of reserves. The program includes investing in projects in the field of oil refining and retail network development that have the potential to adapt to changing internal and external market conditions through the use of portfolio management methods.

During the reporting period, the company processed 94.4 million tons of oil, reaching the level of processing depth of 76.2% and increasing the share of light oil products to 57.1%. These indicators reflect an increase in the efficiency of production processes. At the same time, Rosneft provided the domestic market with high-quality motor fuels, recording a record volume of sales of petroleum products in the amount of 42.1 million tons, which is 6.0% higher than the previous year (PAO Rosneft'. Godovoj otchet 2022 PAO "Rosneft'").

Despite the increase in refining productivity, an analysis of the structure of the investment program for 2021 shows that the share of investments in oil refining, amounting to 64 billion rubles, remains relatively smaller compared to investments in production and exploration, reaching 956 billion rubles (Fig. 5).

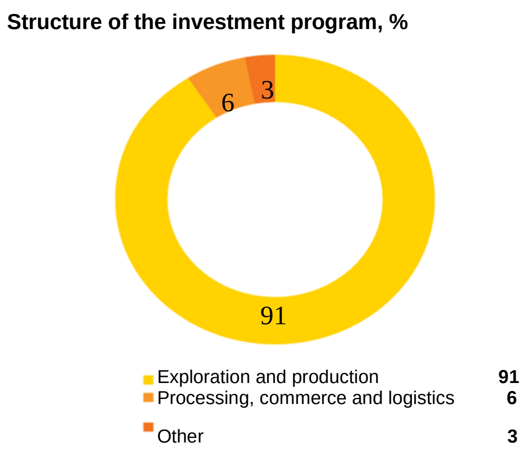

Figure 6: Investment portfolio of Rosneft Oil Company PJSC (PAO Rosneft'. Godovoj otchet 2022 PAO "Rosneft'").

Such structural asymmetry in the investment strategy may indicate the continued dependence of the company on fluctuations in world oil prices (PAO Rosneft'. Godovoj otchet 2021 PAO "Rosneft'").

The investment portfolio of Tatneft PJSC shows that despite the predominance of investment interest in the exploration and production segment, the key asset of the company is oil refining (Fig. 6).

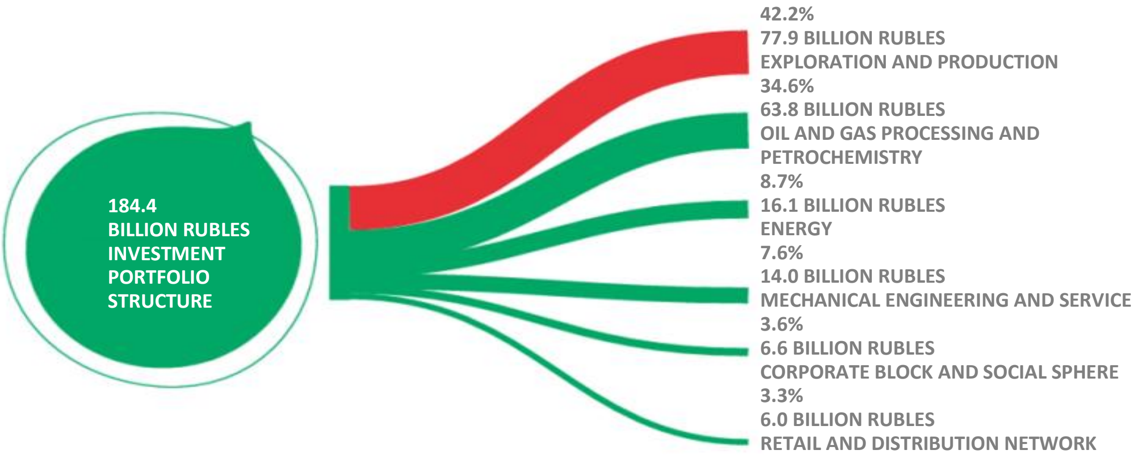

Figure 7: Investment portfolio of Tatneft PJSC (PAO Tatneft'. Godovoj otchet 2022 PAO "Tatneft'").

The analysis of the structure of the value chain shows the key role of the oil production and refining segments, which accounted for about 96% of the total volume in 2022 (Fig. 7).

Figure 8: Assets of Tatneft PJSC (PAO Tatneft'. Godovoj otchet 2022 PAO "Tatneft'").

The company's value-added profit in 2022 reached 416 billion rubles, which is 70% more than in the previous year. The profitability of value added (the share of profit in value added) in 2022 was 42% compared to 29% in 2021 (PAO Tatneft'. Godovoj otchet 2022 PAO "Tatneft'").

It is important to note that the company implements a strategic distribution of investments in key areas of activity, in particular, focusing on the development of the biotechnology segment.

Within the framework of this strategy, support is being provided for the creation of a specialized Biotechnology Center, whose task is to integrate biological products into the production processes of the enterprise. One of the priority activities of the center will be the production of biofuels based on a wide range of renewable plant biomass. This direction will allow the company to expand its capabilities in the production of alternative bioenergy resources, thereby strengthening its market position in the context of the development of renewable energy sources (PAO Tatneft'. Godovoj otchet 2022 PAO "Tatneft'").

The development of a systematic approach to the integration of biotechnological projects into the company's existing assets can be based on the experience of international firms and the practices of leading domestic oil and gas enterprises, such as Tatneft PJSC.

A key step is the creation of research centers focused on the study and development of new biotechnological processes. This will be the impetus for a technological breakthrough in the production of bio-products from various types of biomass. An important aspect will be cooperation with leading universities and scientific institutes for the exchange of knowledge and commercialization of research, which is confirmed by the news about the creation of a biotechnological cluster ITMO and Tatneft (PAO Tatneft'. Godovoj otchet 2022 PAO "Tatneft'").

After the establishment of biofuel production, the process of introducing biorefinery technologies is underway, which make it possible to obtain not only fuel from biomass, but also high-cost chemical products, such as biocomposites and biochemicals, which will allow the company to enter the markets with high margin products.

1. The introduction of the principles of circular economy will allow the company to fully use waste as raw materials for the production of biological products. This includes the development and implementation of technologies for processing by-products and waste into valuable energy products, which was reflected in the launch of a biogas plant by Tatneft in Tatarstan. The project makes it possible to convert manure into electricity and fertilizers, disposing of 500 tons of raw materials daily and producing 6.1 million kWh per year, which supports the environmentally sustainable development of the region and demonstrates the effective internal use of resources (https://www.kommersant.ru/doc/5316995).

Thus, based on the analyzed experience of oil and gas companies, it is possible to identify the main stages of the investment strategy when investing in biotechnological projects. These stages cover the full cycle from research to implementation of innovations. The initiation of the process begins with the research and development of new technologies, followed by their adaptation to the specific conditions and specific needs of the oil and gas company. The next stage includes the practical application of these technologies and their integration into existing production processes (Table 2).

Table 2: The main stages of the investment strategy of oil companies when investing in biotechnological projects.

Investment strategy stage	**Description**	**Expected results**	**Necessary measures**
Research and development	Identification of potential biotechnologies suitable for the oil and gas company's asset portfolio	Market analysis and selection of technologies for further development	Creation of advanced scientific and technical centers
Pilot testing	Testing of biotechnological solutions in the context of the company's current assets	Prototype testing preparation for implementation	Creation of technology implementation initiative groups
Realization	Implementation of biotechnological solutions in the company's current assets	Optimization of economic benefits and profitability of projects	Creating groups to evaluate current solutions
Improvement	Integration of third-party technological solutions to improve processes	Improving process efficiency with less investment	Creation of corporate venture funds

Innovative projects integrated at the Improvement stage do not exist autonomously and require passing through all stages of the investment strategy, as a result of which projects either evolve into independent initiatives or remain in the role of targeted, niche solutions.

These stages of the investment strategy ensure the adaptation of biotechnological solutions to the strategic goals of the company and contribute to the comprehensive improvement of processes leading to improved operational efficiency, improved product quality and improved environmental sustainability of the business.

4 CONCLUSIONS

In conclusion of this study, it can be noted that the current situation of oil price volatility poses a significant challenge to the stability and predictability of revenues in the oil and gas industry. This instability in the global oil market underscores the critical need for oil and gas companies to form an investment portfolio that would include assets from more stable and innovative areas, in particular, biotechnology. The integration of biotechnological projects into the portfolio of companies helps to reduce investment risks and opens up new prospects for sustainable growth.

Nevertheless, there is a fluctuation in the approaches of large oil companies regarding the diversification of their portfolios towards biotechnology. Despite the understanding of the need for this step, many companies are still focusing on traditional areas, such as exploration and production of oil and gas fields. Maintaining such a conservative strategy leads to prolonged dependence on the dynamics of oil prices and increases economic risks. This fact emphasizes the importance of strategic planning and emphasizes the need to take decisive action towards the integration of biotechnological innovations.

In this context, the development and implementation of clearly structured strategies for the integration of biotechnological projects are becoming a priority for oil and gas companies. Successful implementation of such strategies requires significant investments in research, development, pilot testing and scaling of innovative technologies. The application of this approach will allow companies not only to comply with international environmental standards, but also ensure their sustainable development in the context of global energy transformation, guaranteeing long-term success in a dynamically changing energy landscape.

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