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APPLICATION OF INNOVATIONS IN THE OIL AND GAS SECTOR OF KAZAKHSTAN

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Abstract

The Republic of Kazakhstan is a major oil exporter, ranking second in the CIS after Russia in hydrocarbon reserves and crude oil production. As the national oil and gas company, KazMunayGas is modernizing infrastructure, implementing innovations, and promoting the development of brownfields. The purpose of the article is to analyze the investment policy in the oil industry, their dynamics, investments in scientific research and innovation, as well as support for research and development (R&D) that contribute to the economic efficiency of enterprises. The objectives are to identify the main aspects of innovation activity; conduct an analysis and evaluation of innovation activity; and propose ways to improve innovation activity. The scientific novelty lies in the justification of the transition from extensive production to digitalization of the industry, the implementation of modular technologies (Industry 4.0) and a comprehensive analysis of the oil and gas sector. The article utilizes general scientific methods to reveal the main content of the work. The study highlights the need for diversification, the introduction of new technologies to enhance competitiveness, and an increase in the share of innovative products. In conclusion, it was concluded that in the foreseeable future, the oil industry of Kazakhstan will remain an important sector of the national economy.

Keywords: KazMunayGas, oil industry, innovation, investment, economic efficiency.

ҚАЗАҚСТАННЫҢ МҰНАЙ-ГАЗ СЕКТОРЫНДА ИННОВАЦИЯЛАРДЫ ҚОЛДАНУ

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Андатпа

Қазақстан Республикасы негізгі мұнай экспорттаушы болып табылады, көмірсутегі қоры мен шикі мұнай өндіру бойынша ТМД-да Ресейден кейін екінші орында. Ұлттық мұнай-газ компаниясы ретінде «ҚазМұнайГаз» инфрақұрылымды жаңғыртуда, инновацияларды енгізуде және қоңыр кен орындарын игеруге ықпал етуде.Мақаланың мақсаты – мұнай саласындағы инвестициялық саясатты, оның серпінін, ғылыми зерттеулер мен инновацияларға инвестицияларды, сондай-ақ кәсіпорындардың экономикалық тиімділігін арттыруға ықпал ететін ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстарға (ҒЗТКЖ) қолдау көрсетуді талдау.Міндеттері – инновациялық қызметтің негізгі аспектілерін анықтау; инновациялық қызметті талдау мен бағалауды жүргізу; және инновациялық белсенділікті жақсарту жолдарын ұсынады.Ғылыми жаңалық экстенсивті өндірістен саланы цифрландыруға көшуді негіздеуде, модульдік технологияларды енгізуде (Индустрия 4.0) және мұнай-газ секторын кешенді

талдауда.Мақалада жұмыстың негізгі мазмұнын ашу үшін жалпы ғылыми әдістер қолданылады. Зерттеу әртараптандыру, бәсекеге қабілеттілікті арттыру үшін жаңа технологияларды енгізу және инновациялық өнім үлесін арттыру қажеттілігін көрсетеді.Қорытындылай келе, жақын болашақта Қазақстанның мұнай өнеркәсібі ұлттық экономиканың маңызды саласы болып қала береді деген қорытынды жасалды.

Кілт сөздер: ҚазМұнайГаз, мұнай өнеркәсібі, инновация, инвестиция, экономикалық тиімділік.

ПРИМЕНЕНИЕ ИННОВАЦИЙ В НЕФТЕГАЗОВОЙ СФЕРЕ КАЗАХСТАНА

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Аннотация

Республика Казахстан входит в числе стран-экспортеров нефти, занимая второе место в странах СНГ после России по запасам углеводородных ресурсов и добыче сырой нефти. «КазМунайГаз» как национальная нефтегазовая компания модернизирует инфраструктуру, внедряет инновации и способствует развитию старых месторождений. Целью статьи является анализ инвестиционной политики в нефтяной отрасли, их динамика, вложения в научные исследования и инновации, а также поддержка научно-исследовательских и опытно-конструкторских работ (НИОКР), которые способствуют экономической эффективности предприятий. Задачами являются - выявить основные аспекты инновационной деятельности; провести анализ и оценку инновационной активности; предложить пути для совершенствования инновационной деятельности. Научная новизна заключается в обосновании перехода от экстенсивной добычи к цифровизации отрасли, внедрении модульных технологий (Industry 4.0) и комплексном анализе нефтегазовой сферы. В статье применены общенаучные методы, позволяющие раскрыть основное содержание работы. Результатом исследования является необходимость диверсификации, внедрение новых технологий для повышения конкурентоспособности и рост доли инновационной продукции. В заключение сделан вывод о том, что в обозримой перспективе, нефтяная отрасль Казахстана останется важной отраслью национальной экономики.

Ключевые слова: КазМунайГаз, нефтяная промышленность, инновации, инвестиции, экономическая эффективность.

Introduction

Over the past decade of international economic development, significant changes have taken place in its structure, linked to the need to apply innovation, new technologies, and improve R&D. In the new geopolitical and geo-economic conditions, it is becoming increasingly difficult for states to organize effective economic activity without an industrial innovation policy. One of the most important priorities of economic policy and state strategy is to strengthen innovation activity in various sectors of national industry. In this regard, the “State Program for Industrial and Innovation Development of the Republic of Kazakhstan (RK) for 2020-2025” was approved, the key objectives of which are to increase the industrial capacity of basic industries, technological development, innovation, and digitalization [1].

The theoretical basis for this article is the Concept for the Development of the Oil Refining Industry of the Republic of Kazakhstan for 2025-2040, adopted on July 21, 2025. Among the most important problems that need to be addressed are the transition from oil exports to deep processing, increasing the capacity of oil refineries, and developing R&D. The document is aimed at strengthening energy security, reducing the economy's dependence on fluctuations in crude oil prices, and creating high-tech jobs [2].

An equally important confirmation is the theory of the innovation economy, where knowledge and technology play a crucial role. The theory of sustainable development (ESG) aims to implement clean technologies and competitiveness in foreign markets. The concept of digitalization (Industry 4.0) envisions the use of smart wells, big data, and automation to optimize production processes. In modern conditions, the role of the state is to coordinate innovation activities, finance R&D, and create infrastructure to overcome the technological gap.

Thus, these theories are applicable to our study with an emphasis on the outcome of Kazakhstan's investment policy aimed at the technological development of the oil industry.

Investments in research and innovation can help oil companies improve production and refining efficiency and minimise negative environmental impacts. In this context, it is important to establish cooperation between scientific institutions and industrial enterprises to help oil companies improve the efficiency of their production and economic activities.

Over the past 30 years, international practice has developed a certain amount of experience in applying various measures to increase the effectiveness of innovation. For example, the Republic of Korea and Singapore have introduced tax holidays for knowledge-intensive businesses. Developed and developing countries have made the development of fundamental research a priority in their socio-economic sphere. In many countries, science is funded from the budget, resulting in a multiplier effect of research results that determine long-term progress in all spheres of life.

R&D spending in Kazakhstan has reached a record high over the past few years.

Table 1. R&D indicators for 2018-2023

Indicator	Value	Dynamics	Analysis
Total R&D expenditures	172.6 bln KZT	+42% comparedto 2022	Record growth reflecting increased state support for science and innovation
5-year growth	Doubled	2018–2023	Indicates strategic strengthening of science in economic policy
Astana	36.7 bln KZT	–	Concentration of government-funded research institutions
Almaty	77.2 bln KZT	–	Largest scientific and educational hub
MangystauRegion	13.6 blnKZT	–	Linked to oil and gas sector specialization
East Kazakhstan Region	8.2 bln KZT	–	Industrial andtechnologicalfocus
KaragandaRegion	7.8 bln KZT	–	Strong industrial and research base
Source: National Statistics Bureau of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. Spending on science in Kazakhstan increased by 42% (official statistics for 2023). Reference: https://energyprom.kz/articles-ru/industries-ru/zatraty-na-nauku-v-kazahstane-vyrosli-na-42			

The 42% growth indicates a transition to a more innovative economic model. However, significant territorial concentration (two-thirds of funds go to Astana and Almaty) points to regional imbalances in scientific development.

Based on data from the National Statistical System of Kazakhstan, spending on science in Kazakhstan is divided almost equally into three major categories: natural sciences, humanities (including medicine, social sciences, and agriculture), and engineering. It is worth noting that the most significant growth occurred in the two categories of R&D that are most important for the Kazakh economy. Funding for engineering and technology amounted to 80 billion tenge (an increase of 10.6 billion tenge), while funding for natural sciences amounted to 53.1 billion tenge (an increase of 22.9 billion tenge). Expenditures on other scientific fields also increased, but in absolute terms they were not as noticeable [3].

Investments in scientific research and innovation can help oil companies improve the efficiency of production and processing, as well as minimize negative environmental impacts. In this context, it is important to establish cooperation between scientific institutions and industrial enterprises.

Quite a few studies by foreign and domestic authors are devoted to issues of the development of the oil sector and oil refining, their impact on the country's macroeconomy, and the assessment of individual aspects, among which we note: U. Shahzad, D. Ferraz, B. Dogan, do Nascimento Rebelatto [4], M. Smith, M. Whalen, A. Hussan [5], and E. Kalinenko [6].

A.E. Tolepov, A.B. Maidyrova, in their work "Analysis and Assessment of Innovative Activity in the West Kazakhstan Region Based on the Innovation Development Index," propose a method for calculating the regional innovation development index, which determines the level of development of innovative activity not only in this region, but also in the Republic of Kazakhstan. This method is calculated based on indicators of innovation potential and innovation receptivity. The scientific significance of the study lies in the fact that the introduction of innovations contributes to the growth of economic indicators in various sectors of industry [7].

S.S. Makhanov, U.Zh. Shalbolova, and S.M. Yegemberdieva, in their article "The Impact of Investment Activity in the Oil Refining Sector on the Economy of Kazakhstan," examine the effects of investment activity aimed at creating production facilities for oil refining products. Investment activity in oil refining is currently developing dynamically both in Kazakhstan and in global industry markets [8].

The collective work of Kazakh scientists, Kazakhstan's Participation in the Global Energy Market: Problems and Prospects for Development, examines the energy strategy of the Republic of Kazakhstan, taking into account the real geopolitical situation in the world and the problems of the country's realization of its national energy potential. The authors recommend developing such areas of foreign trade in energy resources as maritime transport and the tanker fleet, attracting the necessary investments. Kazakhstan needs to increase its own transport capabilities by forming an energy policy focused on active cooperation with the world's largest energy consumers. In this regard, attracting foreign investment will contribute to the efficiency of the fields being developed, which have been in operation for more than 100 years [9].

In their article "Features of managing oil projects in the USA, China, Iraq, Kazakhstan, and their impact on the economies of these countries," Nai chao Han and Adambekova A.A. examined innovative factors contributing to the development of the national economies of these countries. The study uses content analysis, historical-chronological, statistical, and comparative methods, as well as annual reports of oil companies. The article is interesting to us because it

defines macroeconomic indicators in the construction of a project-based approach to oil project management [10].

Thus, scientific works highlight various aspects of enterprises investing in the innovative sphere to improve economic indicators.

Materials and methods

The theoretical and methodological basis of the article consists of theoretical and applied developments by domestic and foreign scientists that address issues related to the formation and development of an innovative economy. The research methods used were interdisciplinary and institutional approaches, analysis and comparison, and other general scientific methods. During the research, an analysis was conducted of state policy in the field of innovation, which is aimed at strengthening international cooperation and expanding the sphere of business contacts. This article used a research strategy that is determined by the selected scientific methods. Thus, content analysis was used to analyze the strengths and weaknesses of innovations in the oil sector, as well as opportunities and threats. At the same time, a systematic method was used to study the development of innovations in the oil and gas sector. A comparative analysis of statistical data on the innovative development of science presented in various sources was also used.

Research results

«Embamunaigaz» is engaged in the acquisition, exploration, development, production, and export of hydrocarbonrawmaterials. The Company's main oil and gas operations are carried out on oil and gas assets located in the Atyrau region of the Republic of Kazakhstan. The history of oil field development in Emba dates back more than 100 years, and the official history of Embanumaygaz JSC began in 1922 with the creation of the Embanef oil trust to develop the Dossor and Makat fields.

«Embamunaigaz» JSC comprises six production divisions located in Atyrau and four districts of the Atyrau region: Zhayikmunaygaz, Dossormunaygaz, Kainarmunaygaz, Zhylyoimunaygaz, Embunayenergo Management, and Production and Technical Maintenance and Equipment Procurement Management (UPTO and KO). In recent years, Embunaygaz JSC has been actively implementing horizontal drilling at its fields due to the depletion of reserves. This technology allows for the development of hard-to-recover oil reserves in the Embinsk fields, which peaked many years ago. Horizontal drilling has many advantages and allows a large number of vertical wells to be replaced with a single well. This technology significantly reduces harmful emissions into the environment. It also extends the “life” of the fields by involving hard-to-recover oil reserves in development. In recent years, a total of 14 horizontal wells have been drilled at the Emba oil fields, the last of which at the Gran field (NGDU Zhayikmunaygaz) has a horizontal section length of 1 km, which is the longest well in the KazMunayGas group of companies. The effectiveness of horizontal drilling at the Emba fields has been proven, with productivity 8-10 times higher than vertical wells, so from 2021, wells will only be drilled using horizontal methods. In addition, EMG implements programs to modernize oilfield equipment and improve oil preparation quality in order to improve production and economic performance. A strategic focus is the implementation of a fleet renewal program, which aims to replace worn-out and obsolete special equipment and improve technological equipment. As of early 2021, Embamunaygaz JSC had 46 fields with remaining oil reserves in categories A+B+C1 (geological/recoverable) 481.1/87.7 million tons, and the average depletion of field reserves is 70%, which once again confirms many years of oil production.

The development concept of « Embamunaigaz » JSC until 2027 defines a set of rules and principles that guide the Company in its decision-making and determine the successful development of its business. This document serves as the basis for the development of subsequent policy documents, forecast financial and economic models (business plans), risk management systems, the Company's annual budget, as well as for the formation of the Company's project portfolio, including investment projects. The implementation of the Development Concept will make a significant contribution to the economic development of the region and confidence in the future. Priority areas of activity:

- conducting geological exploration work under existing and new contracts,
- conducting additional exploration at existing fields,
- improving production efficiency at existing fields.

At its existing fields, the Company extracts oil and intensifies production by introducing new technologies to increase the oil recovery factor (ORF).

The main macroeconomic factors affecting the Company's financial position include: oil price dynamics, inflation rates, currency exchange rate fluctuations, in particular, the exchange rate of the tenge against the US dollar.

According to the Ministry of Energy of the Republic of Kazakhstan, oil production in Kazakhstan in 2020 amounted to 85.7 million tons, which is 4.8% lower than the record level of 90.5 million tons in 2019. At the same time, actual production figures are in line with the targets (101%) revised at the start of the pandemic. Over the year, 68.5 million tons of oil were exported, which amounted to 101.8% of the target.

Production and financial indicators for 2024: 2.79 million tons of oil were produced, 31 fields were developed, and 158 million m3 of commercial gas was processed.

Fields are considered mature when they are in the third or fourth stage of development, when oil production declines, so new technologies are needed. High water content, falling flow rates, and difficulties in extracting raw materials are all problems inherent in such subsoil areas.

When operating old fields, Embamunaigaz uses innovations such as process digitalization (using the Internet of Things, big data, and AI), automation (SCADA systems), and modern methods of oil production intensification. It also uses 3D modeling, cloud computing, and other advanced technologies aimed at improving efficiency and extracting residual reserves [11].

«Embamunaigas» JSC (a subsidiary of KMG) is using the innovative STRYDE wireless data logging system at the Gran field in the Atyrau region as part of its research and development work. The system consists of the world's most compact and ultra-lightweight autonomous receivers weighing 150 grams, which can withstand extreme temperatures and operate without recharging for 28 days with continuous data logging. Downloading highly detailed, high-quality information takes only 4 hours. This significantly increases the speed of seismic data collection and input into processing.

One specialist can carry and install up to 90 receivers. Overall, the system makes it easy to deploy a high-density observation network. At the same time, the number of personnel involved is reduced by 50%, productivity is increased by 4 times, the weight of field equipment is reduced by 20 times, the amount of field equipment is reduced by 80%, and field work time is reduced by an average of 30%. In addition, the system minimizes environmental impact, improves production safety, and reduces the cost of geological exploration. Modern seismic data will allow for a new assessment of mature oil and gas fields and open up opportunities to extend their life cycle. Emba Munai Gaz considers the Gran project to be a practical example of the synergy between science and technology, which provides a foundation for further innovation.

The project is being implemented in cooperation with the Samau Science and Technology Initiatives Center Fund of Samruk-Kazyna JSC, Atyrau University of Oil and Gas named after S. Utebaev, and «Samga Petroleum» LLP, the official representative of British STRYDE technology in Kazakhstan and Central Asia.

It is noteworthy that young specialists from the S. Utebayev Atyrau University of Oil and Gas are involved in the implementation of the project, thereby contributing to the professional development of Kazakhstani personnel and the scientific and practical base as a whole.

In recent years, «Embamunaigas»JSChas been introducing new approaches used by international companies to minimize negative environmental impact, improve environmental safety, and promote the rational use of natural resources. In terms of the technology used, the advantage of biological treatment is that it has no negative impact on the environment, unlike common and cheap methods of processing oil-containing waste, such as thermal methods (incineration), which cause secondary pollution of the environment due to the formation of incomplete combustion products of hydrocarbons. In order to protect coastal and aquatic ecosystems, the protective dam at the Prorva field of the Zhylyoimunaygaz NGDU is being reinforced, as well as monitoring flooded and submerged wells at the Tazhigali field, which is currently in conservation. Gas piston power plants have been launched on a pilot basis to provide electricity to the Y.Z.K. and Zaburunye fields of the Zhayikmunaygaz Oil and Gas Production Department.

In 2023, the 10 main fields of Embamunaygaz JSC were transferred to "digital field" mode. Management is carried out from the Production Process Visualization Center, located in the EMG office in Atyrau. All information on the wells is sent to the center. The introduction of IT technologies is becoming a prerequisite for effective production, which is why the company has been actively implementing new technologies in recent years. The "Digital Field" project was launched at the Uaz field in 2016. It was then implemented at the Prorvinskaya group of fields (Aktobe, Western Prorva, Dosmukhambetovskoye, S. Nurzhanov), and the Zhanatalape, Eastern Makat, Eastern Moldabek, Kamyshitovoye SW, and Kamyshitovoye SE fields.

In 2021, emergency response centers were opened in four oil and gas production departments at once: Zhylyoimunaygaz, Dossormunaygaz, Kainarmunaygaz, and Zhayikmunaygaz. Now, each oil and gas production department has the ability to monitor production processes and respond quickly to malfunctions in wells and field equipment, thereby reducing well downtime. The technology provides continuous processing of field data and helps not only to respond quickly, but also to constantly monitor the process, which now involves specialists from all branches of the company's management. By optimizing the technological regime, it is possible to reduce well downtime and, accordingly, oil production losses [12].

Between 2020 and 2024, KZT 250.8 billion will be invested, of which KZT 98.2 billion will be allocated to high-tech projects, helping to strengthen the Company's competitive position in the international commodity market. In 2024, oil reserves increased thanks to a comprehensive approach that included 3D seismic exploration, laboratory core analysis, and reinterpretation of GIS materials, confirming the importance of integrating various research methods. In 2024, cooperation with international companies actively developed. At the Berezovsky site, applications from Sinopec, LUKOIL, and Chevron are being considered with the aim of introducing advanced solutions for subsoil development, which will allow the best international experience to be adopted at the Mugodzhar site. The involvement of Shell and Chevron will allow deep drilling technologies to be tested, which have significant potential for expanding operations. In the Zhylyoi project, the main terms have been signed with CNOOC

for the joint implementation of digital twins of fields, which will improve the planning and monitoring of production processes [13].

In Kazakhstan's oilindustry, innovation and R&D are focused on improving the efficiency of production and processing, as well as modernizing production. A key factor has been the introduction of a mandatory R&D levy (1% of production costs) and the active development of large fields, which stimulates innovative approaches to production.

At the same time, the domestic oil industry faces certain problems and challenges:

Dependence on crudeoil exports: Kazakhstan's oil industry is still heavily focused on crude oil exports, which reduces the added value of its products.

Global market competition: Global competition and oil price volatility require constant improvements in production efficiency and innovation.

Limited internal expertise: Need to attract foreign investors and technologies to solve complex problems in the field

Against the backdrop of growing demand for hydrocarbons, one of the significant trends in the global oil and gas industry in recent decades has been the growth of investment in exploration and production.

Table 2. Foreign investment in the oil and gas sector of the Republic of Kazakhstan for 2000-2024.

Year / Period	Global Upstream Investment (USD bln)	Dynamics	Analysis
2000	200	—	Beginning of global investment expansion
2014	780	Nearly 4× growth	Peak of the commodity supercycle
2015–2016	~400	Almost –50%	Oil price collapse and CAPEX cuts
2018	480	Recovery phase	Market stabilizationafterdownturn
2019	>500	Moderategrowth	Positiveinvestmenttrendresumed
2020	~350	Decline	COVID-19 impact and demand shock
2021	~420	Recovery	Gradualpost-pandemicrebound
2022	~499	Stronggrowth	Energy security concerns and higher oil prices
2023	~528	Continuedgrowth	Increasedupstreamspendingglobally
2024	~570	Acceleratedgrowth	Supply constraints and geopolitical risks
Source: International Energy Agency; National Bank of the Republic of Kazakhstan; ENERGY Insights & Analytics			

Kazakhstan occupies a strategic position: the share of investment (3%) exceeds the share of production (2%), which indicates high growth potential. The oil and gas sector remains the main driver of foreign direct investment inflows.

As part of the State Program for Accelerated Industrial and Innovative Development, work has been carried out to modernize three Kazakh oil refineries in Atyrau, Pavlodar, and Shymkent. Taking into account the modernization of oil refineries, investment projects are being implemented in Kazakhstan to create world-class oil and gas chemical production facilities. These include the "Creation of a complex for the production of aromatic hydrocarbons

(benzene and paraxylene) at the Atyrau oil refinery" and the "Construction of an integrated gas chemical complex" in the Atyrau region to ensure the production of polypropylene and polyethylene [14].

According to data from the Ministry of Energy of Kazakhstan, in 2025, it is planned to produce 96.2 million tons of oil and gas condensate, which is 9.7% more than in the previous year. The increase is due to the expansion of production at the Tengiz field and the ongoing development of the Karachaganak fields. Over the past 25 years, Kazakhstan has managed to turn its oil industry into a source of geopolitical influence, become the second largest oil exporter in the CIS in terms of production volume, and build a complex system of interaction with major international companies. On the international stage, Kazakhstan has established itself as a reliable partner in the energy sector. For example, after Russia cut oil supplies in 2022, Germany began importing Kazakh oil through the Druzhba pipeline, which ensured the operation of the oil refinery in Schwedt and strengthened Kazakhstan's position as an alternative energy supplier to Europe, significantly enhancing the country's international standing.

Amidrapid technological development and the need to increase the efficiency of hydrocarbon production, the Kazakh oil industry is actively implementing digital solutions. One striking example is the Smart Field Airankol project, implemented by Caspian Oil in cooperation with the Kazakh company Intelligent Digital Solutions LLP [IDS]. The project was launched in 2018 at the Airankol field, which is in the late stages of development. The goal was to maintain and systematically increase production levels. As part of the project, all processes were comprehensively digitized, from the well to the back office. The implementation of the system made it possible to increase oil production by 10%, extend the field's operating life by 6 years, and reduce operating costs by 30%.

According to forecasts by British BP, global demand for oil will remain roughly the same as it is now until 2030, without any sharp fluctuations.

The role of the industry will only grow in the future, and petrochemicals will become the main consumer of oil. The future belongs to green technologies, with a Competence Center and a hydrogen energy laboratory having been established.

The prospects for Kazakhstan's oil and gas industry are enormous, and its potential has not yet been fully realized. The development of the industry will continue to bring new technologies and competencies to Kazakhstan, attract investment, create new production facilities, give Kazakhstan additional political weight, and help improve its negotiating position [15].

For more than 30 years, Kazakhstan has been simultaneously building an independent state, implementing socio-economic reforms, and ensuring economic stability. Under these conditions, it has been unable to allocate sufficient funds to science and technology. In recent years, the country has faced serious challenges in the scientific sphere, but it has enormous potential to make up for lost ground.

Today, several key and interrelated trends are shaping the direction and priorities of R&D in the global oil and gas industry:

• **Digitalization and automation.** The industry is implementing digital technologies to improve operational efficiency, enhance production safety, and reduce costs.

• **Decarbonization and sustainable development.** Amid (periodically) intensifying global pressure to respond to the multifaceted challenges of climate change, a significant and growing share of R&D investment is being strategically directed toward the development of decarbonization technologies.

• **Advanced materials.** Ongoing research into new and innovative materials is helping to create stronger, more corrosion-resistant, and longer-lasting equipment. This is critical to extending the life of key assets and ensuring safe and reliable operation in increasingly harsh and extreme environments.

In Kazakhstan's oil and gas innovation ecosystem, Dereknet is a noteworthy digital and innovative project that provides a platform for comprehensive verification of production data. Selected to participate in a state scaling program under the auspices of the Ministry of Energy, Dereknet is a solution developed in Kazakhstan to address one of the key challenges facing the industry: ensuring the accuracy and reliability of operational data in complex production processes. The platform is already undergoing pilot implementation by major international operators working in Kazakhstan, including Tengizchevroil [TCO], Karachaganak Petroleum Operating [KPO], and North Caspian Operating Company [NCOC] position [16].

Table 3. SWOT analysis of innovations in the oil and gas sector of the Republic of Kazakhstan

	Direction		**Direction**
№	**Strengths**	№	**Weaknesses**
1	Large reserves of oil and gas.	1	The economy is highly dependent on raw material sectors, which creates risks when energy prices fluctuate, as well as dependence on foreign technology.
2	The established transport infrastructure connecting Asia and Europe.	2	The need to import high-tech equipment and services.
3	Membership in the Eurasian Economic Union (EAEU).	3	High operating costs, especially at new fields
	Opportunities		**Threats**
1	Implementation of advanced digital technologies (artificial intelligence, 4D seismic).	1	The global transition to green energy, which could reduce demand for oil and gas in the long term, as well as increased competition from other exporting countries.
2	Implementation of innovative technologies to increase production efficiency and reduce costs.	2	Volatility of oil and gas prices on global markets.
3	The development of related industries, such as engineering for the oil and gas sector, which could create new jobs and reduce imports.	3	Geopolitical instability and sanctions pressure.
4	Using digital technologies to increase the transparency of companies' production activities.	4	Declining attractiveness of Kazakhstan as an investment destination due to rising cost of capital and other risks.

The qualitative characteristics of this table show that Kazakhstan's oil and gas industry has real prospects for further development in the complex international relations associated with market price instability, the geopolitical situation, and environmental challenges.

Thus, general recommendations for the innovative development of the oil and gas industry in Kazakhstan can be formulated:

- It is necessary to improve innovation policy, taking into account changes in the international market, attracting large investments, and adhering to the long-term priorities of the national energy market.
- For the successful development of the innovation sector of the oil and gas complex, it is necessary to develop proprietary technologies so that businesses will pay attention to them and prefer them over foreign ones.
- Kazakhstan is integrated into the global energy market, so it is necessary to define strategic priorities that reflect the characteristics and specifics of the domestic economy, as well as the interests of the state, subsoil users, and society as a whole.
- The strategic goal of innovation in the oil and gas complex is sustainable economic development, and to achieve this, losses at all stages of the technological process must be reduced, which should be facilitated by a high-quality innovation policy of the state.

Conclusion

Improving innovation policy is aimed at the qualitative development of the oil industry. Foreign direct investment plays a key role in economic development when domestic resources are scarce. Foreign capital provides financing, facilitates technology transfer, and increases labor productivity, which ultimately contributes to the competitiveness of the economy. Innovative development impacts economic indicators, providing the domestic market with high-quality products. At the same time, it strengthens economic resilience and creates new jobs, allowing Kazakhstan to consolidate its position in the global market and achieve technological advancement.

Kazakhstan is well positioned to make significant strides in innovation. The government and private sector are increasingly recognizing the importance of innovation, as evidenced by a number of new initiatives and reforms. Kazakhstan has enormous potential to develop a strong R&D ecosystem, but realizing this potential will require a gradual shift toward a more strategic and long-term approach to investment in science and research. There is a certain confidence that the country will be able to lay the foundation for sustainable technological progress and strengthen its position in the global innovation landscape.

Today, KazMunayGas, as the national oil and gas company, preserves the rich heritage of dozens of enterprises that played a key role in the development of oil production in Kazakhstan and implements strategic projects, modernizing infrastructure, introducing innovations, and contributing to the development of old fields.

The development of Kazakhstan's oil and gas chemistry industry is a new step in the diversification of the economy, the introduction of advanced processing technologies, and the creation of modern engineering, technical, and blue-collar jobs. Projects such as the Integrated Gas Chemical Complex have the potential to become a new center of attraction for stimulating the country's technological growth.

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