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IMPROVEMENT OF THE MANAGEMENT SYSTEM OF INNOVATIVE DEVELOPMENT OF THE GAS INDUSTRY OF AZERBAIJAN

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ABSTRACT

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GENERAL DESCRIPTION OF THE WORK

Relevance of the topic and the degree of development. Energy carriers have become the main tool of geopolitics, and the factor of natural gas has demonstrated its importance in ensuring the energy security of the continent. The demand for gas in European countries has sharply increased, and Azerbaijan Republic (AR), as a country with hydrocarbon resources, is actively expanding its gas exports to Europe. To ensure gas production volumes, the need to expand the use of innovative approaches in the development of the gas business has grown. The developing gas sector of the country, taking into account the growth of foreign currency revenues, can quickly access the best innovative technologies to expand its resource base by developing new hydrocarbon fields in the Caspian shelf to meet the domestic natural gas needs of the country. The implementation of new gas projects requires attracting large investments and modern innovative technologies within the framework of investment and innovation activities (IIA), which should aim to increase gas production volumes to meet the domestic and export needs of the country. The economy of the AR significantly depends on natural resources, and its priority goal is diversification and attracting investments for innovative development. This situation requires the development of innovative activities in the country, primarily in the oil and gas complex (OGC), which has the necessary resources and a developed foreign economic activity (FEA).

The implementation of innovations in the economy depends on the innovativeness of the country, where conditions are created for the transition to a new level using new technologies and management methods. Innovative development contributes to economic growth, increased competitiveness, and improved quality of life. The assessment of innovative development (ID) of countries is carried out through the Global Innovation Index (GII), in which the AR occupies low positions, confirming the need to improve the management system of investment and innovation activities (IIA) with state participation, especially in the oil and gas complex (OGC).

Innovative technologies must be implemented in all sectors of OGC, and innovative activities should form the foundation for the development of gas extraction and gas transportation companies (GETC), where foreign investments play an important role. The optimal development of new and existing gas and gas condensate fields (GGCF) requires gas extraction companies (GEC) to implement innovations throughout the entire "life" cycle of hydrocarbon fields: from geological exploration (GE) to the complete extraction of gas and condensate from productive reservoirs. Therefore, the improvement of the planning and management system for innovative development in the gas sector should rely on modern innovative technologies and economic-mathematical models (EMM).

The growing number of publications and scientific discussions on the research potential of the gas industry in the AR confirms the relevance of the issue addressed in the dissertation. Theoretical approaches to interpreting the content and assessing the main economic categories of strategic planning and innovative development in the oil and gas industry (OGI) are reflected in the works of many foreign scholars, such as: Vasukhina O.V., Vishnevsky K., Imaykina O.I., Nikolaev A.V., Nikulina O.V., Morgunov P.P., Tebeckin A.V., Karasev O., King W., Kogut A., Maisner D., Sinelnikov A.A., Troshina E.P., Falco S.G., Freeman K., and others. Issues related to the monitoring and assessment of the implementation of innovative strategies were discussed in the works of Aliyev A., Adams R., Bessant D., Veliev V.M., Guseynova A., Guseynova K., Kaplyuk E., Kerimli I., Kerssens-van Drongelen I., Nikolaev A., Safarov G., Suleymanov G., Tagiev M., Shepurek S., Hauser D., Zettelmeyer F., Holt R., Yuzbashyeva G., and others.

The problems of developing the national innovation system of the AR, as well as the tasks of clustering economic zones by the level of innovative development, conducting assessments of factor indices by the level of education, ensuring infrastructure elements, and providing information support, are covered in numerous works of domestic scientists, such as Aliyev A., Aliyev S., Aliyev T., Bayramov A., Gasanov R., Huseynov A., Kasumov F., Nadzhafov Z., Muradov A., Tagiev A., and others. In analyzing the state and prospects of the

oil and gas industry (OGI) of the AR, as a foundation for the sustainable development of the fuel and energy complex (FEC), the applicant relied on the works of well-known scholars such as Abbasov Ch., Aleskerov A., Aliyev Sh., Alirzaev A., Atakishiev M., Valiev V., Dzhabiev R., Ahmedov M., Gadjiev Sh., Gasanov R., Gafarov Sh., Dzhamilov M., Kuliev T., Manafoyev G., Meybullayev M., Musaev A., Mustafayev N., Nadirov A., Samedzade Z., Farzaliev M., Shekeraliyev A., and others.

The analysis of the works of domestic and foreign scholars on the issues of planning and managing innovative development in the gas industry revealed new tasks arising from the global energy crisis and the need for the diversification of gas supply routes. Research is needed with a systemic analysis of innovations in the expansion of gas resources, field development, improvement of gas transportation infrastructure (GTI), and diversification of exports. Solutions are required for assessing the effectiveness and methods of implementing innovations to increase gas production and transportation. The gas business demands comprehensive solutions and new approaches in innovation management. To develop the theory of IIA, methods of evaluating effectiveness should be improved, forecasting models for production should be created, and a strategy for innovative development of the gas industry should be developed, considering natural factors, competitiveness, and forecasts for hydrocarbon reserves.

To systematize the problem and formulate the dissertation's task, an analysis was conducted of optimal planning and management methods for innovative development in the gas industry, as well as methods and EMM aimed at improving the technical and economic efficiency (TEE) of developing GGCF and gas transportation systems for the export of Azerbaijani gas using innovative approaches.

The issues being studied align with the "State Program for the Development of Industry in the Republic of Azerbaijan" and the "National Priorities for Socio-Economic Development: Azerbaijan 2030." The research is based on the theory of economic development, where the use of IIA and the improvement of the planning and management system for innovative development in the gas industry

contribute to increasing the efficiency of GGCF development and ensuring gas production for domestic needs and transportation to continental markets. Information and knowledge are production resources, and innovations are the driving force of innovative development in the gas industry. The results of the dissertation are aimed at creating a methodological foundation and methods, as well as improving the innovation management system for economic growth.

The relevance of the issue of improving the management system for innovative development in the gas industry is due to its significance for science and the economy of the AR. The development of innovation management methodology in gas extraction and transportation under high competition and complex geoeconomic situations is crucial for the country's economy. To increase gas production, it is necessary to use economic-mathematical models for assessing the resource base and the effectiveness of innovations, as well as for forecasting the condition of well stock. The key task is the development of the gas industry through innovative projects and improving state regulation of investment and innovation activities in oil and gas companies. The study of economic and production relations is aimed at enhancing the competitiveness of the industry and analyzing the experience of domestic and foreign science.

The object and subject of the research. The object of the research is the system of innovative development of the gas industry in the AR, which is evaluated as an economic structure with comprehensive development.

The subject of the research is the economic and production relations (connections) arising in the process of forming, developing, and improving the elements of the innovative system of the gas industry in the AR with the aim of increasing its competitiveness.

The objectives and tasks of the research. The goal of the work is to improve the conceptual model and mechanisms of the innovation management system in the gas industry, aimed at substantiating a balanced strategy for gas extraction and transportation in the context of the global energy crisis, which allows

meeting the growing needs (for domestic consumption and export obligations) of the country.

The main objectives of the research are as follows:

- Investigation of theoretical and methodological aspects and foundations for forming the innovation development strategy of the gas industry in the AR;
- Study of the current state and trends in the innovation development of the gas industry in the AR, determining its role and place in the country's economy, allowing for the identification of technical and economic aspects and the level of its development;
- Study of the main directions for forming strategic reserves of the gas industry and examination of the economic aspects of state innovation policy in this area;
- Analysis of the innovation level of the AR, including the OGI, affecting internal and external factors, and the study of the experience of leading countries with developed gas industries in the implementation of innovative technologies and investment management;
- Development of the main principles of state innovation policy and methodological foundations for improving the innovation strategy of the gas industry;
- Study of the relationship between investments and innovations as factors of economic growth and the development of the gas industry in the AR, as well as the impact of foreign investments and leading foreign companies on its development;
- Assessment of the prospects for cooperation between the AR and Caspian region countries for joint development of hydrocarbon fields, diversification of export directions, and potential re-export of gas, as well as the implementation of regional gas projects;
- Formation of the position of the innovation strategy for the gas industry, based on the analysis of internal, external, and eco-economic factors;
- Conducting a systematic analysis of the eco-economic aspects, main problems, and risks arising in the process of implementing innovations, developing models and methods of management in the development of gas resources;

- Study of economic and methodological approaches to assessing the effectiveness of the gas well fund and development of a model for calculating critical parameter values that characterize the profitability of gas well operations;

- Development of a methodology for determining the profitable operating period and forecasting critical parameters of operational wells at the final stage of developing GGCF, transitioning them to the capital repair stage;

- Improvement of EMM and development of methods for determining the parameters of profitable operation of extraction facilities, calculating the predicted well flow rates, and assessing gas losses during their repair;

- Development of a methodology for integrated modeling, management, and evaluation of TEE of innovations in the development of gas resources, including GTA in the gas well fund;

- Improvement of the forecasting system for the pace of gas resource development as the foundation of an innovation strategy, using EMM and management mechanisms for the development of GGCF and their impact on the gas industry;

- Improvement of the principles of the relationship between the state and the gas industry for the implementation of innovative projects, as well as the system of regulation of investment and innovation activities in the oil and gas sector;

- Improvement of the system for forecasting and managing innovations in the development of gas resources, forming prospects for expanding the export of Azerbaijani natural gas through the implementation of new projects;

- Study of the development of the gas business in the long term through the implementation of innovative gas projects, considering strategic reserves of the gas industry in the energy security system and sustainable economic development of the country;

- Evaluation of the economic development of the gas industry, considering diversification and export delivery of Caspian gas, in the context of the energy crisis in Europe;

- Assessment of the prospects for developing the energy potential of the Caspian Sea to form a new economic development

model for the region and the prospects for the AR to become a leading gas country and exporter to European markets;

- Study of the prospects for cooperation between the AR and Caspian region countries for joint development of hydrocarbon fields, diversification of export routes, and potential re-export of gas, as well as the implementation of regional gas projects;

- Evaluation of the state and prospects of developing the resource base of hydrocarbons, increasing gas production volumes, and expanding GTI to formulate strategic priorities, scenarios, and directions for the development of the gas industry (including "green" energy), through the diversification of export deliveries and implementation of new projects—alternative pipeline routes (to minimize risks related to transit countries);

- Improvement of mechanisms and assessment of the prospects for improving the quality of management and effectiveness of reforms in the oil and gas industry to strengthen the position of the gas sector;

- Improvement of strategic management mechanisms, identification of key projects, and formation of promising directions for the innovation development of the gas industry in the AR.

The research methods include: systems analysis; mathematical modeling; cluster analysis; SWOT analysis of the oil and gas complex of the AR; as well as general methodological principles of scientific research, a set of methods of economic analysis, data classification methods, and forecasting theories.

The main points to be defended are:

- A complex of organizational and economic methods through institutional transformations in the OGC, forming the basis for state and sectoral strategic planning, aimed at implementing the targeted tasks of innovation development policy based on national energy security program documents, by forming a strategic resource base of hydrocarbons that meets the internal and export needs of the country in gas, contributing to the sustainable functioning of the gas industry and its investment attractiveness in a market economy.

- Innovation development strategy for the gas industry, including development scenarios and resource base exploration, based on a combination of optimal options for expanding reserves and gas

production volumes, increasing the technical and economic efficiency of developing new promising gas fields and involving old fields in industrial operation (by increasing well productivity), which is a priority for the fuel and energy complex.

- Methods and systems for managing the gas industry through the implementation of innovation policy within the framework of expanding the resource base of hydrocarbons and gas extraction volumes from the Caspian shelf's gas fields, developing GTI, and diversifying gas pipeline routes, including alternative ones, for exporting Azerbaijani gas (and hydrogen in the future), aimed at ensuring the country’s energy security and prosperity.

- The prospective planning system for gas extraction volumes from gas fields based on an approximating mathematical model of accumulated field data ("debit-time") that allows for forecasting well debits, estimating recoverable reserves, and ensuring the reliability of forecasts for more than five years, which is a strategic goal for the sustainable development of the gas industry.

- Economic and mathematical model for forecasting gas well productivity, allowing the determination of the time to reach critical values (parameters), in contrast to calculating the profitable operation period of a well, assessing the feasibility of transferring it to the stage of capital repair, selecting and planning priority objects for geological-technical measures (GTM), and calculating gas losses during operations to ensure the required volume of gas and condensate extraction.

- Justification of main transit routes (including alternative ones and through swap agreements between Azerbaijan and Caspian region countries) for exporting Azerbaijani gas, in cooperation with Turkey as a gas “hub”, Europe as an energy consumer, and gas-producing countries in the Caspian region, through the implementation of innovative approaches aimed at strengthening the country's position as a reliable exporter and transit country, a participant in ensuring continental energy security, generating additional revenue for the state budget, and minimizing potential risks in interactions with partners involved in GTI.

- Technical and economic justification for the reliable operation of Azerbaijan's gas transportation system (GTS) to ensure reliable and uninterrupted fulfillment of contract obligations for gas supplies (both for domestic consumers and export) through forecasting the technical condition of the GTI, expanding underground gas storage capacity (to ensure additional transported gas volumes in case of emergencies in extraction facilities), developing and implementing innovative technologies, and optimizing operational modes of gas transport networks.

- A comprehensive vertically integrated business model aligned with the strategic goal of the gas industry, ensuring improved operational efficiency, reliability of export supplies, and gas supply to the country, while allowing Azerbaijan to enhance its rating as a producer and supplier of energy resources due to accumulated industrial and scientific-technical potential.

The scientific novelty of the dissertation.

1. An author’s theoretical and methodological model and approaches are proposed for the formation of the ID strategy of the gas industry of the AR, aimed at increasing its efficiency in the current economic and geopolitical conditions, taking into account its growing role in the country's economy, as well as the need for reforming the NGI, strengthening the position and potential of the gas industry within the energy sector.

2. An author’s periodization of the development of the gas industry of the AR at its current stage of formation is proposed, and for the first time in the work, the role and place of the gas industry in the country’s economy are defined, its current state, trends, and the main stages of the formation of the gas business and prospects of its IR are identified, including the technical and economic aspects of its designation and development level.

3. New phenomena, previously not considered as determining factors, were studied, such as the regulation of gas extraction and the capacity of main gas pipelines (MGP), considering consumer preferences (including contract structures and terms for export supplies), economic growth, and other internal and external factors. For the first time, the theory of gas business development is considered

in the interrelation of its key components according to the principle: "natural gas extraction – resource base of hydrocarbons – MGP capacity – consumer – attracting new gas fields to development."

4. Principles and approaches to the formation of a system for managing IR in the gas industry with the use of EMM and methodological foundations are developed, aimed at exploiting the AR's resource base through the development of gas fields and evaluating their efficiency, enabling the formation of strategic reserves of gas production and the export potential of GTI, taking into account long-term national development priorities.

5. For the first time, principles and approaches are developed using EMM for forecasting gas production volumes, considering the expansion of the resource base of hydrocarbons and increasing the capacity of MGP, ensuring their profitable operation.

6. The author's approach is proposed for substantiating the role of IR in the RA gas industry with the involvement of large energy and financial institutions from around the world in developing new gas fields on the Caspian shelf, developed under complex geological and climatic conditions.

7. For the first time, a concept for managing the well stock is developed, oriented towards applying technical and economic optimization mechanisms for costs during the development of gas fields, achieved through the implementation of innovative technologies and fundamentally new approaches.

8. Principles and approaches to planning and managing innovative technologies within the framework of implementing GTM on the operational gas well stock are developed, aimed at increasing gas and condensate production and evaluating their technical and economic efficiency.

9. A model for IR in the gas industry is proposed through the creation of new gas production centers (including joint exploration of hydrocarbon fields with Caspian region countries), diversification of gas supplies and GTI, taking into account new realities in the global energy market. This idea is formulated for the first time.

10. For the first time, the necessity for diversifying gas pipeline routes (including alternative ones through swap agreements between

RA and Caspian region countries) for export and possible re-export of gas is formulated and justified. Proposals are made to enhance the competitiveness of the country's gas industry on the global energy market and minimize risks associated with gas transport routes.

11. The idea of diversifying the GTS and priority directions for the development of gas export infrastructure along the Bakı-Naxçıvan-İğdır (BNI, Baku-Nakhchivan-Igdir) route to EU countries is proposed, with subsequent connection to the existing and planned GTS of Turkey and Europe.

12. New methodologies for creating an integrated gas business model, aligned with the strategic goals of the gas industry in AR, are presented, enabling an increase in gas and condensate production volumes, changes in supply directions, and diversification of gas pipeline export routes to the European market to ensure the economic security and sustainable development of the country's economy.

The theoretical and practical significance of the research. Three monographs on the researched issues have been published, and the results of the conducted research were used in the development of program materials for the implementation of innovations in the exploration of hydrocarbon (HC) fields. Some of the dissertation's provisions are also used in the educational process for the training and retraining of highly qualified specialists in the fields of economic management, economics of technological innovations, and oil and gas industry.

Approval and implementation of results.

The materials of the dissertation were presented and discussed at the following international and national conferences:

- Müasir dövrün trendləri: "Yaşıl iqtisadiyyat və dayanıqlı inkişaf: İqtisadiyyat və Sosial Elmlər sahəsində Tədqiqatçıların I Beynəlxalq Konfransı (ICRESS – 2024). UNEC. Konfrans materiallari I hissə. Bakı, Azərbaycan 16-17 Dekabr 2024;

- I international Conference on Smart Environment and Green Technology- ICSEGTZA24 (Azerbaijan Republic Odlar Yurdu University), Baku Azerbaijan, 11-12 April 2024;

- Postkoflikt vəziyyətlərdə yenidənqurma və bərpa. III Beynalxalq elmi konfrans. ADNSU (Baki, 2023);

- The Fourth Eurasian Conference Innovations in Minimization of Natural and Technological Risks Satellite Symposium Technological (Baku, 2021, 2022, 2024, 2024);

- III International scientific forum on computer and energy sciences: WFCES 2022 (Almata, 2022);

- Proceedings of the International Scientific Conference: development directions and priorities (Melbourne, 2021);

- Science. Education. Practice: proceedings of the International University Science Forum (Toronto, 2021);

- Международных научно-практических конференциях: "О новой парадигме развития нефтегазовой геологии" (Казань, 2020); "Наука и технологии в нефтегазовом деле" (Краснодар, 2019, 2020); "Инновационные технологии в нефтегазовой отрасли" (Ставрополь, 2019-2024); "Булатовские чтения" (Краснодар, 2019-2024).

Organization of the dissertation research. The dissertation research was conducted at the Azerbaijan Technical University.

Volume and structure of the dissertation. The dissertation consists of an introduction (25,208 characters), 6 chapters (first chapter – 73,085 characters, second chapter – 58,423 characters, third chapter – 56,452 characters, fourth chapter – 57,332 characters, fifth chapter – 50,903 characters, sixth chapter – 59,659 characters, conclusion – 11,147 characters), a list of references used, and appendices. The total volume is 392,209 characters (without figures, tables, diagrams, graphs, list of references, and appendices). The work is presented on 362 pages and includes 86 tables, 207 figures, graphs, and diagrams, and 441 entries in the list of references.

BRIEF SUMMARY OF THE WORK

The introduction justifies the relevance of the research topic, outlines the degree of development of the problem, the theoretical and methodological basis of the work, defines the aim, tasks, subject, and

object of the research, scientific novelty, theoretical and practical value of the work, formulates the research results, and the main provisions to be defended.

The first chapter, "Theoretical and Methodological Foundations and Economic Aspects of the Innovative Development of Azerbaijan's Gas Sector," analyzes the theoretical, methodological, and methodological foundations for forming the innovation strategy of the gas sector, considering ecological and economic components, strategic reserves of oil and gas companies within the framework of the main principles of state innovation policy, and the issues of management and risk assessment in the implementation of innovative technologies for gas resource development[1,2].

The conducted research showed that the producer (of extraction, storage, processing, and transportation) and exporter of HC resources in AR forms its mission as the most effective and balanced state company, responsible for gas supply to consumers and fulfilling export contracts with a high degree of accountability. However, this position carries certain risks, and considering the ongoing changes in the international energy market, there is a need to improve the system to coordinate production activities and meet consumer demands, achieving long-term competitive advantages. To address the tasks of creating an effective coordination system in the gas sector with high-quality management, and implementing efficient and innovative management elements that can integrate the tightly formalized control over the closed system of gas extraction with changes in the energy market and consumer interests, the introduction of a production strategy for the innovative development of the gas sector (PSIDGS) is necessary. This strategy should manage the development of HC fields,

[1]Гасумов Э.Р. Оценка эффективности внедрения инноваций при разработке газовых месторождений. - Ставрополь: Изд. “Дизайн-студия Б”. 2020. -552 с.

[2] Гасумов Э.Р. Принципы государственной инновационной политики в отношении газовой отрасли Азербайджана /Евразийский союз учёных. -2020. - № 11(80). -Том 5. -С.29-33.

which largely depends on the quality of the relevant managing entity (GETC, GGCF)[3,4].

The main aspect is the development of a behavior model in the specific market situation of the sector as a whole, which serves as the core of strategic management, functionally defining the chosen basic strategy for the main activities of the gas industry, including a set of measures and programs, essentially forming a resource program that ensures their practical implementation. An important element of PSIDGS is the decision on vertical integration of production, relationships with partners and suppliers, with the key element remaining the management of HC reserves (Fig. 1).

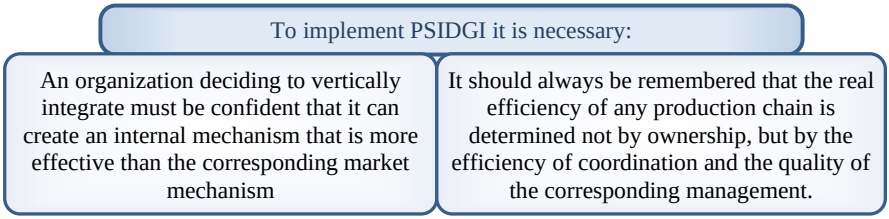

Figure 1. Basic steps in implementation PSIDGI

Investments are the main source of IIA, which contributes to the technical and economic growth of the sector and improves the efficiency of the implementation of oil and gas projects. There is a need to develop a comprehensive state policy in this area applicable to the OGC and to create conditions that guarantee the safe activities of foreign investors[5].

The signing of the international contract (Contract of the Century) for the joint development of three oil fields - "Azəri,"

[3] Гасумов Э.Р., Валиев В.М. Формирования стратегических целевых показателей развития газовой отрасли Азербайджана в области инновационной деятельности // Фундаментальные исследования. -2022. -№ 2. -С.10-15.

[4] Gasumov E.R. Formation of the innovative development strategy of the gas industry of Azerbaijan based on analysis of influencing factors //Sciences of Europe. - 2020. - No.60-4(60). - V.4. - P. 18-24.

[5] Гасумов Э.Р. Принципы государственной инновационной политики в отношении газовой отрасли Азербайджана /Евразийский Союз Учёных. - 2020. - № 11(80). -Том 5. - С.29-33.

“Çıraq,” and “Günəşli” in the Caspian Sea, not only revived the oil industry but also gave an impetus to the development of the gas sector.

In the dissertation, the candidate defines the need to apply a systematic approach to managing the PSIDGS as an effective means of achieving the set goal, which implies the systematic construction of key and functional development strategies[6].

The results of the analysis allowed for the formulation of strategic guidelines for the development of PSIDGS for gas extraction in the context of globalization, within the framework of state innovation policy aimed at increasing production efficiency and competitiveness. The importance of innovative technologies in the OGC is growing, and its effectiveness depends on many factors, including scientific and technical support, infrastructure, legal security, and state policy in various sectors.

An analysis of the experience of developed countries shows that, in the context of global competition, not only those with a scientific base and natural resources succeed, but also those with an effective national innovation system, including a developed infrastructure and clear government policy at various levels[7].

The feasibility of managing state innovation policy in the gas industry at both the national and sectoral levels has been identified[8]. The state must establish "rules of the game" that make the gas business inefficient and unprofitable in a competitive environment without innovations, encouraging companies to reduce costs through the use of innovative technologies[1,3].

The innovative success of the gas industry depends on the country's scientific and technical potential and the level of state regulation of innovation policy. Research has shown that the country

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[6]Гасумов Э.Р. Основные принципы системного анализа при проектировании и управлении разработкой газовых месторождений //Булатовские чтения. - 2022. - Т. 2. - С. 251-257.

[7]Gasumov E.R. Technical and economic aspects of the development of the gas industry in Azerbaijan //East European Scientific Journal. - 2020. -No. 10(62). - Part. 4. - P.25-28.

[8]Gasumov E.R. Technical and economic aspects of the development of the gas industry in Azerbaijan //East European Scientific Journal. - 2020. -No. 10(62). - Part. 4. - P.25-28.

has the resource base, scientific potential, and personnel reserves for implementing IIA in the diversification of the economy. The development of HC fields requires the implementation of innovative projects, which are associated with risks, especially in the development of GGCF, where geological factors and the reliability of reservoir models must be taken into account to avoid negative financial and economic consequences[9,10].

The degree of exploration of HC fields determines the completeness and quality of information, the reliability of field models, and the risk assessment of modeling, which is important for digitalization – the implementation of modern IT in the development of OGF fields.[11].

This allows for forecasting the TEE of innovations in project solutions for HC extraction. The decision on the usefulness of innovations can be made through a systematic approach, which includes creating a database, developing projects, and using modern forecasting methods that build a model reflecting reality, rather than just a set of goals. The analysis of management and risk assessment of implementing innovative technologies in the development of GGCF allows for the formation of strategies for their use, evaluating efficiency, and selecting optimal methods to increase the profitability of HC fields[12].

The author studied the issues of identifying and utilizing the strategic reserves of the gas industry to ensure energy security and sustainable economic development in the country, with an optimal level of gas extraction. The strengths of the economy of AR and the

[9] Гасумов Э.Р. Управление и оценка рисков внедрения инноваций при разработке газоконденсатных месторождений //Фундаментальные исследования. -2020. -№ 12. - С 33-39.

[10] Гасумов Э.Р., Гасумов Р.А. Внедрение инноваций при освоении месторождений углеводородов //Естественные и технические науки. - 2019. - №6(132). - С.100-105.

[11]Qasumov E.R. Qaz kondensatı yataqlarının işlənməsində yeniliklərin tətbiqinin texniki və iqtisadi səmərəliliyinin modelləşdirilməsi, idarə edilməsi və qiymətləndirilməsi məsələləri //UNEC Elmi Xəbərləri. - 2020. – G. 8. - S.98-111.

[12] Gasumov E.R., Veliyev V.M. System analysis of innovation management problems in gas condensate fields development //Eastern European Scientific Journal. -2020. -No 4. -P.15-20.

key factors for the development of the gas business were identified (Table 1).

Table 1. Strengths of the AR economy in the implementation of gas projects

Strengths
- High level of economic and energy security - Favorable geopolitical and geographical position in the transit corridor between Asia, Europe and the Middle East - Favorable climatic conditions; economic and cultural ties with neighboring states, CIS countries and the world, trusting partnership with the EU on energy issues

Energy security is defined by the availability of energy resources, economic, environmental, and technological acceptability (Figure 2).

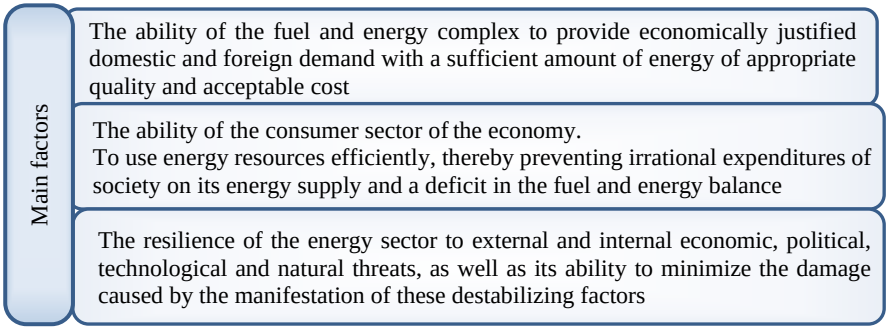

Figure 2. Key factors influencing the state of energy security

New gas projects provide the Caspian countries with opportunities to export energy resources to the global market, influencing the security and stability of the region. For the energy efficiency of the economy, government policy measures are required to create a favorable environment, form prospective standards, and support strategic initiatives. When determining the prospects for the gas industry, it is important to consider key trends for IR and the achievement of strategic goals.

The realization of MGP projects with the participation of AR and the increase in gas production have strengthened the country's role as an international supplier and transit hub for energy resources.

As part of the ID of the gas industry, it is necessary to develop sustainable development scenarios for at least 25 years, taking into

account the trend of a low-carbon economy and focusing on hydrogen production. In the coming years, the expansion of the HC resource base will be related to the development of new geological structures in the Caspian, primarily on the southern shelf (bordering Turkmenistan and Iran), which aligns with the strategy of meeting the country's domestic and export natural gas needs. The author recommends applying methodological approaches to enhance ecological insurance in the OGF, including environmental risk assessment, damage estimation in emergency situations, compiling a list of companies, productions, and substances, as well as conducting actuarial environmental calculations. The eco-economic aspect is defined as the process of maintaining dynamic balance through the targeted use of potential and environmental conditions, including when developing offshore gas resources.

In the second chapter, "The Current State and Prospects of Innovation Development in Azerbaijan's Gas Industry," the theoretical aspects of the current state, trends, and prospects for the development of the gas industry are analyzed. The experience of leading countries with developed gas industries in the fields of innovation and investment management is reviewed, and the main directions of the innovation policy for the gas industry in the AR are formed. This chapter reveals the concept and essence, as well as defines the role and place of the gas industry in the country's economy, highlighting five stages of the development of the OGC in AR.

The current state of the gas industry serves as a starting point for strategic development, and the forecast of the organization's future condition should be based on its objective potential to develop in a real environment, taking into account the expansion of the environment itself. Today, natural gas is the fastest-growing component in global energy consumption, and according to forecasts, by 2030, its consumption worldwide will increase by almost 800 billion cubic meters. Gas production globally has increased from 2005 to 2350 trillion cubic meters over the last decade, an 18% rise. However, the

polarity of gas production is fundamentally different from the polarity of its reserves[13,14].

The resource base is the foundation for long-term development, with forecasted gas reserves in Azerbaijan (AR) estimated at 1.5 to 7.0 trillion m³ (mainly in the western part of the country, on the Caspian shelf) according to national and foreign sources. Experts from SOCAR estimate these reserves at 2.55 trillion m³, and currently, Azerbaijan's hydrocarbon reserves across all categories exceed 4 billion tons of oil equivalent (toe).

Over the past 10 years, annual gas production in AR has more than doubled: over 30% comes from the Shah Deniz field, about 25% from the Azeri-Chirag-Gunashli (ACG) block, and the rest from other fields. It is estimated that by 2025, production will reach 50 billion m³ per year, with the majority (including associated gas) coming from hydrocarbon fields on the Caspian shelf, where 80% of gas reserves and 93% of condensate are concentrated. The development of the hydrocarbon industry has contributed to the growth of other sectors (such as petrochemicals, oil machinery, etc.) and the formation of the Baku agglomeration. The sharp increase in gas production has enabled AR to meet its own needs, eliminate imports (up to 5 billion m³ per year), and become an exporter of gas.[15,16].

As part of the oil and gas strategy, AR has harnessed the energy potential of the Caspian Sea and formed a new economic model for the region. Gas projects have enabled the implementation of a new concept for socio-economic development and the identification of key directions and indicators for the country, including the state budget. The goal of the new stage of development is to increase the competitiveness of the economy and integrate it into the global system,

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[13] Qasumov E.R. Avropa qaz bazarinin vəziyyətinin təplili // UNEC Elmi Xəbərləri. -2023. - Cild 11. - S. 27 – 45.

[14] Гасумов Э.Р. Горючий газ в истории развития Азербайджана // Евразийский союз ученых. - 2020. - №10(79). -Том 8. - С.7-11.

[15] Гасумов Э.Р. Азербайджан становиться газовой страной и экспортером газа в Европу //Естественные и технические науки. - 2021. - № 3. - С. 104-111.

[16]Qasumov E.R. Azərbaycan kontinental qaz bazarinda mövqeylərini möhkəmləndirir //UNEC Elmi Xəbərləri. - 2022. - G. 10. - S. 46-61.

ensuring long-term growth. The gas industry plays a key role, with foreign investments and production-sharing agreements contributing to economic growth[17].

This chapter discusses the approaches to developing a conceptual model and mechanisms for strategic management of innovative development, as well as the justification for the strategy of exploiting the GGCF. The key factors influencing the strategic development of AR are identified, taking into account the predominance of revenues from oil and gas companies in the GDP structure, which allows for the construction of a new economic model focused on innovation. Today, the economy cannot be viewed separately from political processes, so among the key factors, both economic and political ones are present (Table 2)

Table 2. Key factors for building a model, where the main factor is the indicator associated with ID in the gas industry

Economic parameters of the model under consideration, which are of a quantitative nature
Volumes of hydrocarbon reserves; volumes of gas and condensate production; volumes of domestic consumption; volumes of exports and imports; prices for energy resources; implementation of innovations; investments in the industry
Qualitative parameters, which include the political aspect
Energy security; economic benefits; geopolitical stability; technological modernization; pipeline supply

The analysis of all the mentioned factors will, on one hand, assess the current state of the gas industry, and on the other hand, forecast the development directions in the medium term, taking into account the current geopolitical and geo-economic situation in the region and the world[18].

[17] Qasumov E.R. Qaz layihələrinə qoyulan investisiyaların effektivliyinin qiymətləndirilməsi üçün metodoloji əsasların tədqiqi //İpək yolu. Azərbaycan Universiteti. - 2021. - G.1. - S.45-55.

[18]Гасумов Э.Р. Анализ современного состояния и тенденция развития газовой отрасли Азербайджана //Вестник Алтайской академии экономики и права. - 2022. - № 3-2. - С. 159-166

The issues of gas export and transit, as well as the implementation of international gas projects, have become an integral part of AR's foreign policy. In 2020, with the start of gas supplies to EU countries, AR further strengthened its position as a reliable energy exporter[19]. The commissioning of the South Caucasus Pipeline (SCPx), Trans-Anatolian Pipeline (TANAP), and Trans-Adriatic Pipeline (TAP), which are part of the Southern Gas Corridor (SGC), is of historical significance for AR and the Eurasian region, altering the energy map of the continent. It has been established that the implementation of gas projects and fulfilling international gas export obligations is directly linked to the state and effective development of OGF.

The techno-economic aspects of developing HC fields play a key role in the strategy of the oil and gas complex. Last year, domestic demand for gas increased by 10%, mainly due to the gas-chemical industry and a 9% growth in consumption by the population. Thanks to the successful development of South Caspian fields, the gas industry in AR has made the country a powerful gas producer, impacting economic development and improving the living standards of the population. The increase in gas production contributes to the diversification of markets, which is an important part of AR's energy strategy. The gas business is attracting the attention of the EU and major companies.[20]. Currently, AR is strengthening its position in the international energy space, with the gas industry becoming an important resource for FEA. The work also examines the foreign economic aspects and the need for developing a geo-economic methodology, as well as analyzing international gas projects considering the country's interests. The author proposes the improvement of the market diversification system, which should be carried out not only from financial-economic, commercial, and technical-technological perspectives but also considering

[19] Qasumov E.R. Azərbaycanin qitənin qaz nəqiliyyati infrastukturun diversifikasyasinda iştiraki. //UNEC Elmi Xəbərləri. - 2021. - G. 9. - S.60-71.

[20] Valiyev V.M., Gasumov E.R., Prospects for innovative development of Azerbaijan's gas industry //Austrian Journal of Humanities and Social Sciences. - 2020. - No. 11-12. - P. 68-75.

geopolitical factors and competitive situations (taking into account the interests of other participants in the gas market in the region) related to the implementation of new gas projects. In this regard, creating the necessary resource base of HC and improving the efficiency of OGGF development is an important part of state policy in managing the FEC[21].

Conceptual approaches to the techno-economic assessment of developing HC fields on the offshore shelf should be based on methods for evaluating the effectiveness of gas projects, taking into account criteria and risks. Factors influencing the development of the gas industry and strengthening its position in the economy of AR have been identified. The contribution of the innovation factor is measured by investment indicators, with the main criterion for effectiveness being the increase in profitable reserves and gas production, while maintaining a balance between growth and extraction. Sources of risks in the implementation of innovative projects have been identified, with the most significant ones highlighted for assessing effectiveness[22].

The necessity of transitioning to an integrated risk management method has been proposed, where tools and methods are used collectively throughout the structure of the gas industry, and management is aligned with the ID strategy.

In the third chapter, "Formation of the Model and Methods of Innovation Management in the Development of Gas Resources of AR," the principles of methodological foundations for the implementation of innovations and forecasting their pace in the development of gas resources are considered. The chapter also discusses the formation of the ID strategy for the gas industry in gas production and transportation, based on the analysis of influencing factors[3].

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[21]Гасумов Э.Р. Инновационные решения для обеспечения проектного уровня добычи газа //Нефтепромысловое дело. - 2016. - №10. -С.20-27.

[22] Gasumov E., Gasumov R., Suleymanov G., Kurbanov Kh. Risk management in the production and transportation of natural gas under the conditions of the economic crisis in the energy market //Table of Contents RT&A, Special Issue. The Fourth Eurasian Conference and Symposium RİSK-2022 ”İnnovations in Minimization of Natural and Technological Risks”. - 2022. - V. 17. - No 4(70). - P. 502-505

A systematic analysis of innovation management problems in the development of gas resources has been conducted. A methodology for forecasting the pace of their implementation has been proposed. Economic and methodological foundations for improving the innovation management system and forecasting the development of gas resources in AR have been formed as the basis for the innovation strategy [13,14]. EMM for individual stages of gas resource development have been proposed.

The choice of innovation policy strategy includes determining the directions of state regulation of IIA, methods for developing scientific potential, and setting goals that correspond to socio-economic tasks. State regulation should be combined with an effective competitive mechanism in the innovation sphere. Concentrating state resources on fundamental innovations that ensure structural changes in the economy is an important principle. Effective development of IIA in the OGC is possible through the implementation of an active state and corporate policy, including the introduction of organizational and technological innovations[2].

The main directions of state support for IIA have been identified, creating favorable conditions for innovation processes in the gas sector. An effective way to stimulate innovation is through the provision of state incentives, such as tax benefits.

The author proposes new approaches to forming an ID program for the industry, which serves as a long-term planning and management document, integrated into the strategic development system of GETC and designed for a ten-year period. This program includes a set of interconnected measures aimed at developing and implementing new innovative technologies and services that meet global standards, as well as creating favorable conditions for the development of IIA in both the gas sector and related industries.

The key elements of the long-term state policy program in OGF have been studied, along with the provisions that characterize the expected results of the IIA program. The economic support includes a multi-scenario analysis of the commercial effectiveness of innovative technologies applicable in the extraction and

transportation of gas, taking into account the specifics of the industry[3,6].

The formation of the provisions of the ID strategy for the gas sector, based on a systematic analysis of influencing factors, creates the foundation for forecasting the pace of gas resource development for long-term planning and industry management, integrated into the structure of OGF[13,14]. The most important result of the systematic analysis of OGF development is obtaining the most reliable geological and commercial information about the field and individual productive horizons for the considered period, in order to forecast the pace of their implementation. Economic and methodological foundations for improving the innovation management system and forecasting the development of gas resources in AR have been established[9]. Such an approach allows regulating the volume of gas production to increase its recovery factor from the reservoir and improve the TEC of OGF development, which can be achieved after refining the initial reserves of the deposit.

To enhance the effectiveness of OGF development, a general management system scheme has been proposed, divided into several subsystems: productive layer, production wells; subsystems for field data collection; subsystems for preparing data for transfer[23,24] (fig. 3).

Рисунок 3. Схема двухконтурного управления разработки НГМ и ГГКМ

[23]Валиев В.М., Гасумов Э.Р. Технико-экономическая эффективность геолого-технических мероприятий в скважинах //Естественные и технические науки. - 2022. - № 3(166). - С. 96-100.

[24] Гасумов Э.Р. Технико-экономическая эффективность геолого-технических мероприятий //Территория “Нефтегаз”. - 2021. - №12. – С. 66-72

The systemic approach to innovation management in OGF development allows for the selection of more effective methods, considering that there are numerous ways and technologies aimed at increasing the reservoir yield, each characterized by different cost levels for enhancing gas production.

The author proposes a methodology for managing innovations using a database of well funds, regularly updated with new data. The database includes geological, hydrodynamic, technological, and technical information, as well as a history of repair work. The result is achieved through a well-founded calculation and automated analysis of the effectiveness of implementing innovative technologies during the GTM realization.

The proposed innovation management approach is based on systemic analysis and a database for decision-making regarding the feasibility of innovations. A mechanism for selecting operational gas wells for innovation implementation has been developed, considering the efficiency of candidate wells. The integrated systemic approach allows for the optimization of system parameters, improving the effectiveness of the method, and ensures continuous monitoring and optimization of the business process at a high level [25].

The definition of effective and ineffective types of innovations for OGF (reserves and wells), depending on the conditions of their application, allows for the identification of reasons behind the unsuccessful implementation of innovations.

When implementing the systemic approach, the factors influencing the effectiveness of their implementation include the technological parameters of the wells before performing capital repairs (CR), the geological-physical characteristics of the productive reservoir, and the specific indicators of the OGF[26,27].

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[25] Гасумов Э.Р. Внедрение инноваций при освоении месторождений углеводородов // Естественные и технические науки. - 2019. - № 6(132). - С.100-125.

[26]Gasumov E.R., Valiyev V.M., Gasumov R.A. Increasing the efficiency of repair and insulation works in gas condensate wells with subhorizontal borehole termination //SOCAR Proceedings. - 2024. - No 3. - P.66-73.

[27]Гасумов Э.Р., Валиев В.М. Оценка эффективности работы эксплуатационной газовой скважины и перевод ее в стадию капитального ремонта //Международный научно-исследовательский журнал. - 2020. - №11 (101). - Часть 2. - С.56-63.

The proposed block of statistical models allows for the selection of wells for innovative technologies and forecasting the results. Based on calculations of projected gas and condensate production from OGF, gas extraction planning is carried out. The effectiveness of CR is enhanced through the scientific organization of innovation implementation, based on a systemic analysis. The economic stage of analysis includes the creation of a cost nomogram, which helps identify key performance indicators of innovations and factors ensuring effectiveness (Table 4)

Table 4. Stages of operation of production gas wells (EGW) for which gas losses were calculated

Well Operation Stages
- Well development after completion of major repairs (MR) - Well development after major repairs (MR) - Well studies before and after major repairs (MR) - When removing accumulated fluid at the bottomhole during operation - Technological gas losses during fluid removal

The proposed innovation implementation planning system will improve its justification, provide an evidence base for the rational use of all resources, and, when implemented as an automated information system, will become a valuable tool for planning GTM for the well stock. The introduction of systemic analysis procedures into the design and management practices of OGF development will significantly enhance the effectiveness of well CR.

As a result of determining the system of interrelations between the elements of innovative activities, it was found that the gas sales sector is also a determining factor and directly participates in defining the directions of innovation development, as well as the requirements for the quality of the extracted products and services provided. In the gas industry, innovations are focused on gas production and sales, so innovation management is seen as part of the marketing activity of the GETC. The concept of managing the development of the gas industry has been expanded and clarified, including the introduction and

justification of a new management function – EMM with its new additions[28].

The proposed innovations allow for the optimization of additional input factors, investment and financial activities, and the overall functioning of the GETC, creating new directions for improving efficiency through the development of specific measures and programs. This modeling, in economic-mathematical form, reflects the development of the gas industry and ensures improved analysis and management.

To develop the most optimal method for OGF development, a digital model of the field was proposed as a means of managing innovations. This model enables more efficient use of the potential of the existing system. The proposed reservoir model is necessary for obtaining maximum information and understanding of the current state of HC deposits, for forecasting gas production, and for assessing the effectiveness of innovations.

The fourth chapter, "Development of Economic-Mathematical Models for Assessing the Efficiency of Gas Well Fund Operations and Increasing Its Profitability," is dedicated to the development of economic-methodological methods and models for evaluating the efficiency of gas well fund operations, mathematical models of the exploitation properties of HC reservoirs, and their application in forecasting calculations for flow rates and critical values of gas flow parameters that characterize the dynamics of OGF wells. This is done to assess the TEE in the development of gas resources[29,30].

Economic-methodological methods and models for forecasting the dynamics of gas well flow rates and total gas production across the

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[28] Гасумов Э.Р., Торопцев Е.Л., Таточенко Т.В. Экономико-математическое моделирование потенциала инновационного развития газовой отрасли посредством кластеризации //Газовая промышленность. - 2014. - №704. - С.31-35.

[29] Гасумов Э.Р. Технико-экономическая оценка разработки программного комплекса для строительства скважин месторождениях углеводородов //Вестник Алтайской академии экономики и права. - 2024. - № 4-1. - С.32-40.

[30] Гасумов Э.Р., Гасумов Р.А. Математическая модель для расчёта процессов самозадавливания насосно-компрессорных труб жидкостью с помощью продувки скважин //Нефтепромысловое дело. - 2020. - №8(620). - С.46-51.

entire field have been developed. These models are based on evolutionary "flow rate-cumulative withdrawal" curves. The practical applicability of these models lies in the fact that, through the accumulated volume of extracted gas, they indirectly reflect the actual changes in the conditions of field development. They represent the current state of the field and will allow for the assessment of TEE and the timelines for the profitable development of GGCF[31].

The development of a methodology for forecasting the operation of gas wells allows for predicting critical parameters for CR and improving the assessment of innovation efficiency. Research on the factors influencing innovations in GTM proposed a methodology for comprehensive modeling and evaluating their TEE. The evaluation uses forecasted and actual gas flow rates, which helps identify the causes of low flow rates and determine optimal GTM. The forecasting is based on an equation linking flow rates with filtration parameters[32].

The tasks of cost management have been solved through forecasting the time of water breakthrough and the period of profitable operation of wells, as well as forecasting the critical parameters for transitioning wells from the development GGCF to the CR stage. The economic efficiency of gas well operations and gas losses during the transition of a gas well to the CR stage were evaluated.

Calculations based on the proposed methodology allow for determining the forecasted time of water breakthrough in a well. The time of the start and end of water breakthrough is calculated based on the gas extraction plans from the well. Approximate estimates of water breakthrough time are made by calculating the accumulated gas withdrawals corresponding to the beginning of water breakthrough

[31] Гасумов Э.Р., Гасумов Р.А. Особенности цифрового фильтрационного моделирования продуктивных залежей //Наука. Инновации. Технологии. - 2021. - №2. - С.7-28.

[32] Гасумов Р.А., Толпаев В.А., Ахмедов К.С., Гасумов Э.Р., Першин И.М. Аппроксимационные математические модели эксплуатационных свойств газовых скважин и их применение к расчётам прогнозных дебитов //Нефтепромысловое дело. - 2019. - №5(605). - С.53-59.

and its complete breakthrough[33,34]. The forecast evaluation of the gas production volume over the profitable lifespan of a well can be determined using the formula

$$V_g\left(t_n; t_{praf}\right) = 365 \cdot Q_b \cdot \int_{t_n}^{t_{praf}} a \cdot e^{\alpha \cdot t + \beta \cdot t^2 + \gamma \cdot t^3}\, dt \approx 365 \cdot Q_b \cdot \sum_{t=t_n}^{t_{praf}} q_{year}(t) \quad (1)$$

A methodology for selecting well flow rate data, forming tables, processing information, and calculating the profitable well operating time and expected gas production has been developed. The recommended software program for forecasting well productivity, based on data flow rate approximation, allows for determining the time to reach critical parameter values different from the calculated profitable operation period. Based on the research, a geological-technological model of the gas field is developed, defining the dynamics of water encroachment and residual hydrocarbon reserves, which serves as the basis for selecting and planning wells for workover operations (GTM). A method for calculating gas losses when wells are transferred to the workover stage is also proposed.

The methodological foundations for determining forecast indicators based on well flow rate dynamics allow for predicting the volumes of gas reserves to be extracted and the recovery factor, making informed decisions about well selection for workover operations (GTM), and assessing their economic efficiency. Approximation mathematical models for forecasting the dynamics of gas well flow rates are proposed, based on reported gas production data from previous years of the development of the gas field (GGM), for wells that operated both without and after specific types of workover operations[35].

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[33] Валиев В.М., Гасумов Э.Р., Прогноз критических параметров перехода эксплуатационных скважин в стадию капитального ремонта //Наука и техника в газовой промышленности. - 2020. - № 4(84). - С. 52-61

[34] Гасумов Э.Р. Прогнозирование времени обводнения и самозадаливания газовых скважин //Евразийский союз учёных. - 2020. - №8-5(77). - С. 19-22.

[35] Гасумов Э.Р. Оценка потерь газа при переходе скважины в стадию капитального ремонта //Наука. Техника. Технологии (политехнический вестник). - 2020. - № 3. - С.89-92.

Models for calculating the forecasted flow rates of a well over 70 months have been considered, with test examples of graphs showing the relationship between flow rates and real data obtained using a computer software program. The model allows for determining the moment when the well's flow rate falls below the profitable value, at which point it is advisable to transition the well to the CR.[36].

The calculations of forecasted well flow rates before and after CR, taking into account the costs of GTM and additional profits, will help select the most rational repair methods based on TEE. Methodologies for calculating critical parameters that determine the need to transition wells into the CR have been developed using mathematical statistics and approximation theory. Preliminary assessments of the feasibility of transitioning wells to CR allow for determining the sequence of well shutdowns for GTM and identifying those that require immediate repair.[37].

The main criteria for assessing the TEE of gas well operations and the need to transition a well into a GTM program are a combination of geological-technical, geological-field, and production parameters that characterize the condition of the productive reservoir, well, and gas collection network.

The assessment of the TEE for implementing innovations in GTM is based on the forecasted well productivity and gas production volume, using mathematical methods for flow rate estimation. The use of a digital model allows for forecasting expenses and costs associated with innovations in GTM. This method reliably estimates well productivity and gas production over a short period (up to three months), which is crucial for planning GTM and implementing innovations during the development of the GGCF[38,39].

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[36] Gasumov E.R. Assessment of the feasibility of transferring production wells to the stage of capital repairs //SOCAR Proceedings. - 2022. – No 4. - P. 35-44.

[37]Гасумов Э.Р. Расчёт процессов периодических продувок самозадавливающихся газовых скважин //Строительство нефтяных и газовых скважин на суще и на море. - 2021. - №1. - С. 49-55.

[38] Гасумов Э.Р. Оценка эффективности работы эксплуатационной газовой скважины и перевод ее в стадию капитального ремонта // Наука. Инновации. Технологии. - 2020. - № 3. - С.49-64.

[39] Гасумов Э.Р. Особенности разработки мелких месторождений углеводородов //Естественные и технические науки. - 2020. - № 3(141). - С.117-121.

The forecast of critical parameters for transitioning wells to the stage of CR allows achieving results that impact the TEE (Table 5).

Table 5. Results achieved by forecasting critical parameters for the transition of operational gas wells (EGW) to the capital repair (CR) stage

Indicators influencing the technical and economic effect
- Improving the quality of long-term planning of geological and technical measures (GTM) at fields - Improving the reliability of gas extraction management in extreme situations, when for unforeseen reasons it is necessary to vary gas extraction at the field within wide limits - Reducing the risks of wells entering technological modes that provoke the destruction of the reservoir; developing optimal management decisions on switching wells to shutdown and commissioning mode in extreme situations that require varying gas production volumes within a wide range - Managing costs and improving the efficiency of gas and gas condensate well (GGKM) development.

The main factors influencing the actual and forecasted indicators of the TEE of innovation implementation during the development of GGCF can be determined using the chain substitution method of plan-factor analysis, considering the specific features of hydrocarbon field development. A well management mechanism has been developed with a proposed algorithm for evaluating efficiency and accounting for exploitation risks, along with recommendations for deciding the closure of unprofitable wells. A methodology for calculating the forecasted and actual efficiency coefficient of innovation implementation in GTM has been developed, which includes assessing the payback period and investment volume, allowing the evaluation of deviations in actual gas production from the planned values[1,40,41].

Economically, it is reasonable to compare the actual coefficient of technological effect from the implementation of GTM with the financial strength reserve (F_{SM}), which indicates the permissible

[40] Gasumov E.R. Evaluation of the effectiveness of the introduction of innovations in the oil and gas industry. - Deutschland. Lap lambert - 2012. -205 p.
[41] Gasumov E.R. Innovative Risk Management for Geological and Technical (Technological) //SOCAR Proceedings. - 2020. - No. 2. - P. 8-16.

percentage decrease in gas production after which the CR will fall into the negative TEE zone:

$$F_{SM} = \left(\frac{Q_i - Q_{bi}}{Q_i} \right) \cdot 100\% \quad (2)$$

To assess the artificial reduction of a well's flow rate during the implementation of GTM on a well, a parameter for utilizing the well's production capacity was introduced, which is calculated using the formula [42]

$$K_{in(i)} = \frac{Q_{mi}}{Q_i} \quad (3)$$

The author proposed a methodology and principles for evaluating the TEE of implementing innovations in GTM, using chain substitutions as a tool for plan-factor analysis, due to its versatility in models of mixed types. To build a model for evaluating the effectiveness of implementing GTM with innovative technologies, a formula was proposed[1]:

$$E_{e(pr)} = \begin{pmatrix} \sum_{i=1}^{n_x} \left(\left(P_{mp} - P_{cix} \right) \cdot Q_{ix} \cdot K_{mpix} \cdot K_{mix} \cdot K_{iuix} \cdot K_{six} - D_{mix} \right) - \sum_{i=1}^{n_{bx}} Edix \\ - \sum_{i=1}^{n_o} \left(\left(P_{mp} - P_{cix} \right) \cdot Q_{io} \cdot K_{mpio} \cdot K_{mio} \cdot K_{iuio} \right) - \sum_{i=1}^{n_{bx}} E_{dio} \end{pmatrix} \quad (4)$$

The algorithm for plan-factor analysis of the effectiveness of GTM includes the sequential substitution of forecast values of factors with actual values in the calculation of the projected TEE, while leaving other indicators unchanged. The technological effectiveness of innovations is evaluated based on the outcomes of all effects, including the implementation of measures at wells within the GTM framework, aimed at increasing productivity, gas output, restoring operability, and ensuring the target level of production with minimal costs. Investment evaluation in innovations must consider both financial and economic aspects. The analysis shows that economic

[42] Гасумов Р.А., Толпаев В.А., Ахмедов К.С. Среднесрочный прогноз дебитов добывающих скважин в среде MS Excel //Автоматизация, телемеханизация и связь в нефтяной промышленности. - 2012. - № 7. - С.32-36.

effectiveness can be satisfactory even if financial indicators are not justified. To evaluate, only costs related to the implementation of innovations, affecting the cost of production at wells with GTM "with innovation," should be taken into account[1,40].

In the fifth chapter, "Research on the Innovation-Investment Development of Azerbaijan's Gas Industry in the Context of High Competition in the Global Energy Market," the study examines IIA as a factor of economic growth in the oil and gas complex, the contribution of foreign companies to the development of the gas industry while harnessing the energy potential of the Caspian, and how this shapes a new economic model for the region[43].

The strategy for the innovation development of the gas industry in AR has been improved, outlining its economic development prospects and role in shaping the new energy map of the continent. The principles of interaction between the state and the GETC in implementing the innovation-investment development strategy in the gas industry have been studied, as well as its role in establishing AR as a gas-producing country and exporter to the European market, along with the prospects for implementing gas projects.

The connection between investments and innovations as the basis for economic growth in AR's gas industry has been examined. The impact of the innovation-investment factor and foreign energy companies on the development of the industry has been analyzed, along with the relationship between the state and the GETC in implementing the IID strategy[44].

The prospects for expanding the export of Azerbaijani gas and implementing new projects have been examined. The energy potential of the Caspian Sea and its impact on the region's economic model have been studied, as well as the significance of oil and gas reserves for

[43] Gasumov E.R. Role of foreign investment in the development of the oil and gas industry in Azerbaijan //Sciences of Europe. - 2021. - V. 2. – No 65. - P.6-12.

[44] Qasumov E.R. Azərbaycanin qitənin qaz nəqiliyyati infrastukturun diversifikasyasinda iştiraki //UNEC Elmi Xəbərləri. - 2021. - G. 9. - S.60-71.

global markets. The reasons for the interest in this region have been identified[45] (fig. 4).

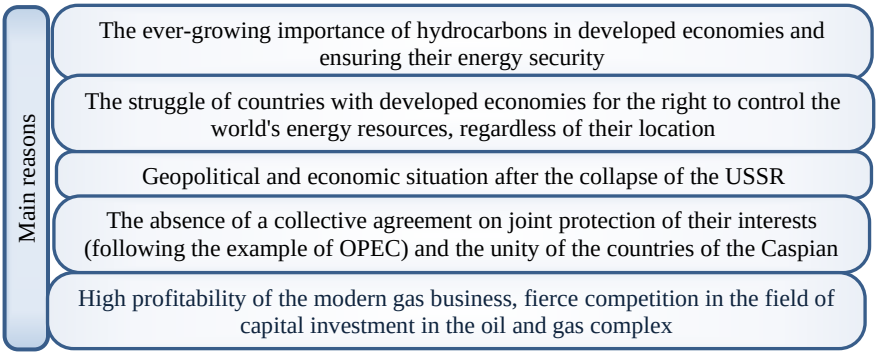

Figure 4. Main reasons for interest in the Caspian oil and gas region

The strategic significance of any oil and gas region is determined by the volume of its proven reserves of raw materials, production costs, and the potential for extraction and transportation of hydrocarbons, as well as its geographical location. The proven total resources in the Caspian Sea allow for a projection of oil production in the range of 200 million tons and gas production of 270 billion cubic meters per year during the period of 2021–2024. In this context, for a region with significant HC reserves, a key task for the effective implementation of export potential is determining optimal transportation routes for hydrocarbons to global markets. The author notes that the solution to this issue depends not only on the interests of gas exporters and importers but also on the overall geopolitical power balance in the region. In this regard, ensuring access for the Caspian states to gas export infrastructure is of immense importance for safeguarding their economic and geopolitical interests. From the author's perspective, the most significant countries in terms of gas transportation volumes across Azerbaijan's territory and political interests are the Caspian region states, particularly the export potential

[45] Gasumov E.R. Current state and development trends of the gas industry in Azerbaijan //International independent scientific journal. - 2021. - No.26. - V. 2. - P.3-7.

of Azerbaijan, Kazakhstan, Russia, Turkmenistan, and potentially Iran in the future[46,47].

With AR's participation under the framework of PSA, the South Caucasus Pipeline (SCPx) was built to transport gas from the Shah Deniz field to Turkey and Georgia, and since 2020, to Europe via the Southern Gas Corridor (SGC). The SGC pipeline is a shortened version of the "Nabucco" project and includes the pipelines SCPx, TANAP (Trans-Anatolian Pipeline), and TAP (Trans-Adriatic Pipeline), through which gas is transported to Europe, including Italy, with the potential for involving new resources, including those from the Caspian region and the Middle East.

The mutually beneficial cooperation between the countries of the region in the field of hydrocarbon transportation should become a key factor in realizing the economic and political interests of the gas-producing countries of the region. The author views innovations as a process that contributes to the growth of gross profit in the gas sector, while investments are seen as a means to ensure this process. Analyzing the stages of the investment and innovation process helps investors make decisions regarding their investments. The role of the state in innovation and investment development within the framework of the energy development strategy is discussed, as it regulates energy prices to avoid unnecessary energy costs.

The export of Azerbaijani gas under long-term contracts is carried out taking into account the payment terms and the interests of the importer to maximize profits. Innovations play a dual role: on one hand, they meet the growing needs of the country, and on the other hand, they stimulate the development of scientific and technological

[46] Gasumov E.R. Caspian region may become one of the main gas suppliers to Europe //Scientific journal. - 2021. - No.18. - V. 1. - P.5-9.

[47] Veliyev V.M., Gasumov E.R. Caspian region may become one of the main gas suppliers to Europe //Science. Education. Practice: proceedings of the International University Science Forum. Infinity Publishing. Toronto. - 2021. - Part 1. - P.16-23.

[47] Гасумов Э.Р. Перспективы сотрудничество прикаспийских стран при освоение нефтегазовых месторождений //Евразийский союз учёных. - 2021. - № 2(83). - Том 5. - С. 12-19.

potential. The key directions for the development of the gas sector have been defined[27] (table. 6).

Table 6. The most significant areas of development of the gas industry

Significant directions
- Encouraging capital investments in the development of new oil and gas fields (NGF) and the improvement of gas transportation infrastructure (GTI) - Creation and qualitative growth of large modern centers for the production of gas and gas condensate (GGC) - Development of offshore hydrocarbon fields (OHF) - Implementation of innovative projects (IPR) related to the construction of pipelines - Increasing the efficiency of using various energy resources in the industry - Encouraging the use of innovative technologies (IT) - Development of hydrogen and “green” energy

The key resources for the innovation potential of the gas sector are mineral raw materials, material-production, and technological resources that allow for the extraction of HC. Attracting and effectively using foreign investments, innovations, and managerial expertise has been a crucial condition for the stable functioning and development of the OGC in AR.

Oil policy and strategy have become the foundation for the development of the gas sector, taking into account economic and geopolitical factors. It serves as both a budget-forming industry and a platform for the development of other sectors of the economy, strengthening the country’s position on the world stage. These factors are key to the implementation of IID, which is closely linked to cooperation with other countries and corporations. This cooperation has allowed for the attraction of modern technologies, increasing gas production and exports fivefold over 11 years, with a 20% increase in 2020 alone. Revenues from gas produced at the Shah Deniz field in 2020 amounted to 293.9 million dollars. An increase in production is expected at other hydrocarbon fields.

Research has shown that foreign investments played a decisive role in the development of the oil and gas industry and became a part of the state’s policy. The joint project with Turkmenistan on the development of the "Dostluq" field will also attract investments, including the participation of Russian companies.

As part of the diversification of pipeline routes, the potential of the TANAP pipeline to transport gas from the Caspian region and Eastern Mediterranean to Europe was studied, with the possibility of Russian gas being transported to the South Caucasus countries in the future.

The gas sector, as part of the oil and gas complex, plays a key role in ensuring the livelihood of all sectors of the economy and forming the financial and economic indicators of the country. The author emphasizes the necessity of research in hydrogen production and the use of renewable energy sources in the context of the gas sector's potential. The analysis showed that, in the future, the TANAP pipeline could transport a methane-hydrogen mixture up to 20% of its capacity to Europe without requiring additional investments[48].

Economic growth in AR will lead to an increased demand for gas, which will require solving several economic issues in the context of globalization and competition for energy resources. Modeling the fuel and energy balance will help find equilibrium between gas prices and forecast the formation of a resource base that aligns with market interests, ensuring both domestic demand and exports. This will also allow for forecasting the expansion of the resource base, production volumes, storage, transportation, and processing of gas, taking into account peak levels.

Until 2050, the main areas for the growth of natural gas production and "green" energy in AR will be the Caspian Shelf. Exploration, drilling, and development of new hydrocarbon fields (HCFs) in the deep waters of the Caspian Sea are among the most promising directions for developing the resource base in AR. One of the main directions for ID in the gas industry is the use of modern information technologies (IT) for the exploration and development of unconventional resources, the development of which will significantly expand the resource base in the OGC.

[48] Гасумов Э.Р. Перспективы производства и транспортировки (экспорта) водорода в Азербайджане //Естественные и технические науки. - 2021. - № 12. - С.228-232.

The use of IT and innovative technologies aimed at improving the efficiency of GE will eliminate the need for mechanical increases in exploratory drilling volumes, which can be seen as progress in the gas industry. To achieve these priorities, it is necessary to identify and provide economic support for promising ID directions and critical technologies, taking into account their forecasted effectiveness and global trend [49, 50]. In order to determine the priority areas for technology improvement within the framework of the ID program, it is necessary to develop a forecast for scientific and technical development for a period of at least 10 years, as well as a general development scheme for the gas industry up to 2030. The forecast should cover the entire spectrum of the gas business, highlighting business segments that form a set of interconnected and interdependent business processes.

The author proposes using EMM and economic forecasting for the scientific and technical development forecast. This approach allows for the identification and assessment of TEE linked to scientific and technical progress, as well as structuring research by industry-specific activities, taking into account interdisciplinary studies.

In this context, the results of technological audits were examined to determine the technological and innovative level of the gas industry. A SWOT analysis was based on both internal and expert evaluations and the ranking of factors within the internal environment of the OGC, including research results from the past five years. This allows the mobilization of the industry's resource potential to implement long-term development strategies[1].

In the future, Central Asian gas may be transported along the Caspian Sea bed via the "TCGP" (Trans-Caspian Gas Pipeline) from Turkmenistan through the territory of AR, with Turkey becoming the transit partner — a strategic partner of AR[71]. A systematic approach

[49]Гасумов Р.А., Гасумов Э.Р., Минченко Ю.С. Повышения эффективности строительства высокопроизводительных скважин на месторождениях и ПХГ. -Краснодар: Издательский Дом – Юг. - 2020. – 416 с.

[50] Gasumov R.A., Gasumov E.R., Minchenko Yu.S. Features of creating underground reservoirs in depleted gas condensate fields //Notes of the Mining University. - 2020. - V. 244. - P. 418-427.

to innovation-investment analysis and the study of the full "life" cycle model of the gas industry, based on technical-economic and financial planning, will help solve the tasks of forecasting the resource base and gas production rates. Since the foundation of the innovation development strategy of the gas industry is the coordinated and maximal use of the resource base and innovation potential, through the formation and support of complete technological chains, it allows for shifting priorities from gas production (extraction, storage, and transportation) to its deep gas and petrochemical processing. The annual volume of gas production in AR over the last 10 years has shown growth dynamics, increasing from 17.7 billion cubic meters in 2011 to 37.2 billion cubic meters in 2020[21,23] (table 7).

The conducted research has shown that there are additional large gas reserves—the resource base in the Azerbaijani sector of the Caspian shelf—that can be developed in future stages. This is evidenced by the drilling of wells deeper than 7300 meters, which led to the discovery of a new reservoir with high reservoir pressure in a deeper structure than those currently being developed. The current agreement on the development of the Şahdəniz gas field with partners is valid until 2030, but the field has sufficient potential to remain the main source of gas production even after this date.

Table 7. Dynamics of indicators of the gas industry of Azerbaijan

Indicators	Years									
	2006	2010	2014	2015	2016	2017	2018	2019	2020	2022
Gas production, billion m^3	6,8	24,7	28,1	29,2	29,4	28,6	30.6	35.6	37,2	43,5*
Gas export	0,0	5,5	7,8	7,3	8,0	8,9	7.9	12,5	13,4	9,1*

*** forecast*

Considering the significant external economic importance of gas exports for AR, it is recommended to use a comprehensive multi-factor approach when evaluating specific international gas projects. It is not enough to consider these projects solely from a financial, commercial, or technical perspective without taking into account the potential geopolitical issues and situations related to the implementation of these projects, as well as the external economic and geostrategic interests of AR and its neighbors.

According to the author, the implementation of new gas transportation routes through AR, involving all gas-producing countries in the Caspian region, is economically beneficial. For example, an alternative route through AR via Nakhchivan to Turkey (Igdır), and then to the European market. In this scheme, AR could become an energy transit bridge, with Turkey acting as a gas "hub" between the Caspian region (and potentially the Middle East) and the EU. It is economically advantageous to consider main gas pipelines with the possibility of reverse flow and swap gas supplies, as well as the potential for changing the direction of gas transportation. This would allow gas-producing countries in the Caspian region to have alternative options for delivering their energy resources, taking into account changes in the energy markets of Europe and/or Asia[30]. For example, the swap gas supply along the Turkmenistan-Iran-Azerbaijan route, Russia-Azerbaijan.

With the implementation of the "Nakhchivan-Turkey (Igdır)" pipeline project and the connection of the existing "SCPx," it will be possible to unite the gas transportation networks of Azerbaijan and Turkey (and potentially Turkmenistan, Russia, Iran, and Eastern Europe). Increasing gas production volumes in the Caspian region will promote the diversification of export markets, given the growing demand for "blue" fuel in the EU countries, which is one of the key elements of AR's energy strategies.

The author notes the growing intensity of global efforts to integrate the region with its natural resources into geo-economic projects. The EU views the Caspian region not only as an important source of energy resources but also as a key foothold for access to Central Asia, Iran, and the Middle East. The pipeline system could become a critical element of the European expansion strategy, including the transport route "Europe-Turkey-Georgia-Azerbaijan-Caspian Sea-Turkmenistan-Central Asia," which aligns with existing and prospective pipelines for gas exports to Europe. The key links in all considered routes are AR (and, potentially, Nakhchivan) and Turkey.

To fully utilize the potential of the Caspian region and develop the necessary gas transportation infrastructure for the extraction and transportation of gas (and hydrogen) to global markets, investments of around 200 billion dollars are required. The realization of these large-

scale projects highlights the importance of the region for the energy security of EU countries.

The foreign policy concerning the implementation of gas projects addresses two main tasks for AR: strengthening its position in the European Union market and enhancing cooperation with neighboring gas-producing countries in the region (with Turkey's participation), primarily Russia, Kazakhstan, Turkmenistan, and Iran. In the medium term, AR may adjust its energy policy, aligning it with the extraction industry while also developing pipeline transport to deliver gas and hydrogen from other gas-producing countries in the region to Europe.

In the sixth chapter, "Improvement of Strategic Management Mechanisms for Innovation Development in Azerbaijan's Gas Industry," the development of the gas industry through innovative projects is explored, and methodologies for managing innovations in gas extraction and transportation are improved. The systems of state regulation of IID are refined, mechanisms for implementing the innovation strategy are defined, and the prospects for improving the management of the OGS are evaluated. Strategic directions for innovation development are outlined, risks in the exploration of gas resources are studied, and systems for long-term gas extraction are examined. The TEE of innovations in the development of GGCF is assessed through the use of digital models and IT for systematizing management and optimizing costs[51,52].

In planning, risks are taken into account, and the specific features of the gas industry, which distinguish it from other sectors of the economy and production, are predicted. Innovations may lead to failure, so when implementing them, GETC must consider the risks and measures to mitigate them. Innovative projects are part of the gas industry development strategy, requiring the development of management principles for gas fields and GGCF to ensure the volume of gas extraction.

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[51] Gasumov E.R., Gasumov R.A. Technological efficiency of applying viscoelastic systems for temporary blocking of productive reservoir when completing wells under conditions of abnormally low formation pressures // SOCAR Proceedings. - 2024. - No 1. - P.18-29.

[52]Gasumov E.R., Gasumov R.A. Estimation of the hydrodynamic perfection of the well-reservoir system at the stage of opening a productive reservoir //Geology and Geophysics of Russian South. - 2023. - No 13(4). - P.108-123.

A systemic approach is recommended for forecasting the results of innovation implementation in gas extraction[53].

It is suggested to consider the high concentration of explored HC reserves in limited OGF, which provide the main gas extraction in AR. Innovations are viewed as an investment cluster that combines innovative-investment approaches to effectively solve the set tasks. The assessment of the impact of innovations on the activities of GETC should be based on comparing cash flows for each measure with the technologies, processes, and resources being replaced in the baseline scenario.

The author's approach to innovation management is based on databases and statistical models, which help select objects for repair and predict outcomes (Fig. 6).

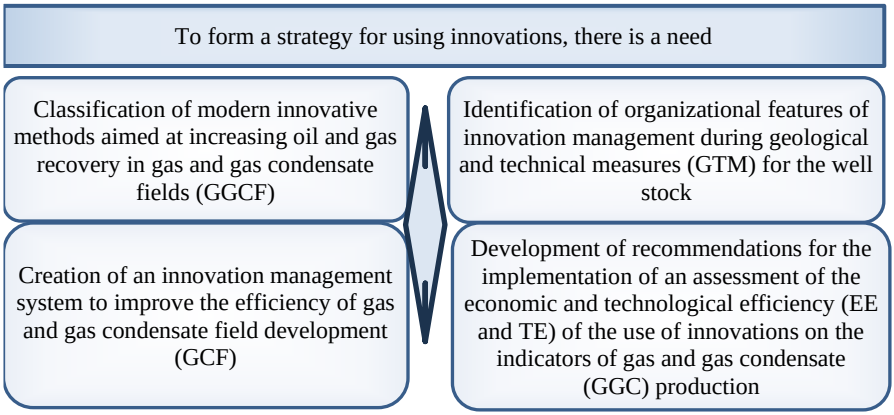

Figure 6. Formation and implementation of a strategy for using innovations in the implementation of geological and technical measures (GTM) at gas and gas condensate fields (GCF)

The innovation policy strategy for the development of gas resources is presented in the form of a diagram, and the comparison of efficiency and risk allows for the development of a methodology for managing innovation risks.

[53]Gasumov E.R., Gasumov R.A. Technical and technological solutions for limiting water inflow in gas wells with a horizontal bore end //SOCAR Proceedings. - 2023. – No 3. - P.75-82.

The author has improved the formula for assessing the effectiveness of gas export deliveries by using an energy security coefficient, which takes into account the excess of gas reserves growth over the needs, including export and technological requirements[54]. The analysis of the benefits and costs of gas exports led to the proposal of this coefficient as an important factor in the efficiency of export deliveries, as well as a risk map aimed at improving the efficiency of the gas industry. The coefficient helps determine the optimal growth of HC reserves (Table 8).

Table 8. The energy security coefficient (ES) allows to determine the optimal value of the increase in hydrocarbon reserves (HR)

Indicators	Value of the coefficient
- Covers the needs of the current period with a surplus	>1
- Falls behind current needs, possible gas shortage on the domestic market of the country, and failure to fulfill contractual obligations to importers	<1
- Covers the needs of the current period and no more	1

The calculations of the efficiency of gas export deliveries, taking into account the coefficient, showed an increase of 12-15% from 2010 to 2020 compared to exports without the coefficient. To prevent gas shortages in the domestic market, it is necessary to determine economically justified volumes of exports. It is proposed to bring the energy security coefficient to an acceptable level by increasing the pace of exploration, developing new hydrocarbon fields on the Caspian shelf, and investing in the gas industry to meet both domestic and external demand, restore the mineral resource base, and create a reserve of gas reserves, as well as develop "green" energy.

The efficiency of gas export deliveries reflects the utility of the entire gas industry chain, affecting the profitability of SOCAR and foreign exchange revenues in the state budget. It depends on the

[54] Gasumov E.R. Mathematical model for injection of viscoelastic compositions into the productive formation //Bulletin of the Tomsk Polytechnic University. -2023. - V.334. - No. 03. - P.218-228.

complex costs of gas production, which have various specific weights. Azerbaijan, while developing GTI, takes into account Europe's interests in obtaining gas and their alternative energy sources.

To identify the risks associated with gas export efficiency, the author used scenario methods, identifying that the contract price for gas has the most significant impact on efficiency. Azerbaijan, as a gas producer, considers risks to energy security and threats related to exports. Increasing gas production and the effective operation of NGK structures contribute to the expansion of the industry's resource base.

The proposed systematic approach is key to increasing the efficiency of the gas industry and the country's economy, providing new opportunities and energy security. Innovative gas projects, diversification of routes, and alternative paths were explored. Improvements in government regulation and innovation policies for industry development were proposed, including mechanisms to improve energy efficiency, ecology, exploration, extraction, MGP, UGS, and gas processing.

It is suggested to amend the regulatory framework to enhance environmental safety and the technological level of facilities. In tax regulation, principles were proposed such as stimulating gas pipeline construction projects for exports and providing property tax incentives for companies transporting gas from hydrocarbon fields to consumers.

Key tasks that need to be solved to achieve the strategic goals of gas sector development were identified (Table 9).

Table 9. Main tasks requiring solutions to achieve the strategic goals of the gas industry (GI) development

Main tasks
- Activation of geological exploration work to ensure expanded reproduction of the material and raw material base (MRB) - Compensation for the decline in gas production at old fields by commissioning new ones - Creation of appropriate gas transportation infrastructure (GTI) to ensure gas supplies to the domestic market and diversification of its export supplies; construction of main gas pipelines (MGP) and gas transportation infrastructure (GTI) - Development of production, use and transportation of hydrogen as one of the areas of development of the low-carbon economy of the Republic of Azerbaijan - Rational use of valuable fractions of hydrocarbon raw materials (HRR) and associated petroleum gas

The development of GTI should be accompanied by the development of UGS systems to create operational gas reserves in key consumption regions, minimizing fuel supply risks during peak periods. The gas sector strategy should take into account changes in both internal and external demand, as well as the transition of the global economy and energy sector to a new technological level, characterized by high energy efficiency and expanded use of non-hydrocarbon energy sources, including "green" energy and hydrogen.

Risk analysis and new opportunities for AR show that despite the growth of renewable energy, the region will still need additional gas imports as its own extraction capacity decreases. Given the market reform, it is proposed to adjust AR's export strategy by creating flexible marketing programs and ensuring safe transit. The creation of alternative pipelines for transporting gas to Europe via Baku-East Zangazur-Nakhchivan-Igdir (Turkey) is also suggested.

The necessity of developing the gas industry and gas business within the structure of Azerbaijan's FEC and implementing a vertically integrated model to increase efficiency is justified. Directions for innovation and development (IR) in the gas industry are proposed, including the expansion of the mineral resource base, the creation of new extraction centers, innovations at GGCF, joint development of OGF, expansion of PHS, alternative MGP routes, participation in gas and hydrogen transportation projects (in the future) to Europe, as well as the development of renewable energy sources and hydrogen energy.

Approaches for implementing measures requiring structural changes in the industry and government support for integration into the global market are substantiated and proposed.

CONCLUSION

1. Theoretical and methodological foundations for the formation of the gas ID strategy have been proposed, considering the economic aspects of state innovation policy regarding the OGS, which allow for identifying promising directions for its development.

2. The main problems and risks arising during the implementation of innovations in the gas industry have been identified, with methods for forecasting and minimizing them proposed, allowing for increased gas

production volumes to meet both export and domestic needs of the country.

3. Approaches for improving the introduction of innovative technologies and investment management have been proposed, using the experience of leading countries with developed gas industries.

4. Based on determining the current state, trends, and prospects of ID in the gas industry of AR, it has been conditionally divided into five stages, and strategic reserves have been identified to ensure energy security and sustainable development of the country's economy amid the energy crisis on the global market.

5. It has been determined that AR's global innovation index among world countries is not favorable and does not meet the requirements of the state economic development strategy, as it determines the ability to transition to a new, higher-quality level through the application of new technologies, progressive forms, and methods of management and organization.

6. The experience of developed countries confirms that, under global competition on the world market, not only those with a promising scientific base and natural resources successfully develop, but also those with an effective national innovation system and, primarily, developed infrastructure and clear state policy.

7. The production strategy of ID in the gas industry is a subsystem of the general strategy of the country, which represents a program of specific actions aimed at creating products for the rational use and development of the gas industry's production capacities to achieve competitive advantage, fully satisfying consumer needs for natural gas and market requirements in terms of quantity and quality, using innovations.

8. A mechanism for improving the PSIDGS in AR has been proposed, in line with the guiding principles of the state policy on industrial development and solving socio-economic issues through the application of innovative technologies aimed at increasing the production and export of natural gas, maximally satisfying consumer needs.

9. It has been established that effective and full implementation of the PSIDGS is possible, considering internal and external (economic and geopolitical) factors influencing the expansion of resource base, increased gas production and transportation, and the planning of

international export supplies, all of which are part of the state's economic strategy.

10. It has been established that earlier investments in companies with international experience and authority allow for quicker, more efficient responses with lower costs than competitors, who need to create the necessary production capacities only when the demand for them becomes apparent and urgent.

11. The creation of strategic reserves in the gas industry will ensure energy security and sustainable development for AR, where the ecological-economic components of AD are one of the main elements of innovation policy.

12. It has been established that to improve the ecological-economic components of the gas industry's ID program, government stimulation of industries striving to develop environmentally clean processes and implement ecological innovations is necessary.

13. Ecological-economic ID in the gas industry can be interpreted as a process aimed at continuously maintaining its dynamic balance by purposeful use of existing potential and environmental conditions, including when developing gas resources located on the Caspian shelf.

14. The strategy for the IID of AR's gas industry in the context of high global competition in the energy market has been formed, which will strengthen the country's position internationally and contribute significantly to the energy security of Europe.

15. Models and methods for managing innovation have been developed, using a systematic approach and economic-mathematical principles, enabling the forecasting of their implementation rates when developing gas resources.

16. Approaches have been proposed for improving systems that allow for more accurate forecasting and evaluating the efficiency of resource development projects, promoting rational utilization of gas potential, including through the use of artificial intelligence to optimize exploration, extraction, and processing processes.

17. It has been established that artificial intelligence in the gas industry increases efficiency by changing business processes based on new knowledge, improving the interpretation of seismic data and exploratory drilling, assessing expected additional gas and condensate

production, modeling economic-mathematical processes, and other goals.

18. Proposals have been made to improve the state regulation PSIDGS, through the introduction of an ID management program, which serves as a planning tool to ensure the maximum satisfaction of importers' needs for natural gas, in line with global energy market requirements.

19. Planning and management systems for ID in the gas industry have been improved, and a methodology has been developed that allows for a differentiated approach to evaluating the effectiveness of implementing innovative technologies in the sector, as well as proposing a set of methods for evaluating the operational properties of gas wells, in relation to the development of GGCF.

20. Criteria for achieving economic effect from the development of the gas business through natural gas exports, considering the diversification of supplies and the implementation of new pipeline routes, which are a promising direction for industry development, have been assessed.

21. It has been established that the influence of innovation-investment factors and foreign companies' contributions to the development of AR's gas industry was decisive, necessary, and timely, including when developing new OGF, the deep-water Caspian sector, and the implementation of MGP projects.

22. The management system for evaluating the TEE of innovations in the development of GGCF has been improved on the basis of developed EMM.

23. It has been established that an important component of gas business development is the implementation of innovative projects to create new gas extraction centers, develop fields in the complex mountain-geological and climatic conditions of the Caspian shelf, maintain production at operating fields, diversify gas supplies, and develop alternative gas pipeline routes.

24. Economic-mathematical models and methodological foundations for managing GGCF development have been developed, enabling the determination of critical parameter values that characterize the profitability of gas well operation; forecasting the period of effective

operation of gas wells and the time of their transition to the stage of capital repairs; and determining gas losses during various repair operations.

25. Approaches to improving the state regulation system for IIA and mechanisms for improving quality management and efficiency of reforms in the ~~gas sector~~OGS have been proposed.

26. The energy potential of the Caspian Sea and its impact on the region's economic development model have been studied, and directions for cooperation among Caspian countries in developing gas resources and implementing innovative projects have been proposed.

27. Criteria for achieving economic efficiency from the export of AR gas, industry development considering diversification of export supplies and new pipeline routes, which are a promising direction for FEC development, have been assessed.

28. It has been established that internal and external factors, as well as the state of the environment in which innovative projects are implemented, significantly affect the achievement of goals and obtaining TEE from the implementation of measures.

29. The possible and probable risks when implementing innovative projects in the gas industry have been studied, classifications have been developed, and algorithms for assessing the level of these risks with determining the range of acceptability, forecasting approaches, and prevention of negative effects have been created.

30. It has been established that structural reforms and further measures for economic diversification, as well as the activation of the state's role in implementing innovation processes in the OGS, are necessary to accelerate the growth rates of the OGC.

31. Directions for innovation in AR's gas industry have been proposed: expansion of the material and raw base through new gas field discoveries on the Caspian shelf, creation of new gas extraction centers, expansion of underground gas storage, reconstruction of gas supply facilities for domestic and cross-border supplies, development of renewable energy and hydrogen energy.

List of published scientific works related to the dissertation topic.

1. Гасумов Э.Р. Оценка эффективности внедрения инноваций при разработке газовых месторождений. - Ставрополь: Изд. “Дизайн-студия Б”. 2020. -552 с.

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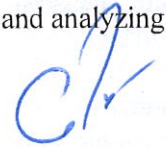
The personal contribution of the applicant

The works [1, 2, 4, 6, 10, 12, 14-19, 21, 26-28, 33, 34, 37, 38, 40, 42-45, 47-50, 53-55, 60-62, 64-69] were carried out independently. In works [3, 5, 20, 22], participation included task formulation, conducting research, and summarizing results. In works [7-9, 11, 23-25, 29-31, 35, 36, 39, 41, 46, 51, 52, 56-59, 63, 70, 71], participation included task formulation, summarizing, and analyzing the obtained results.



The dissertation defense will take place on **27 June 2025 at 14^{00}** during the meeting of the Dissertation Council ED 2.38, operating at the Azerbaijan Technical University.

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