АКТУАЛЬНІ ПИТАННЯ ЕКОНОМІЧНИХ НАУК

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ARTIFICIAL INTELLIGENCE AS A DRIVER OF INNOVATIVE TRANSFORMATIONS IN THE OIL AND GAS INDUSTRY

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Abstract: The purpose of this article is to provide a comprehensive justification of the role of artificial intelligence as a key driver of innovative transformations in the oil and gas industry at the global and national levels, with a focus on the impact of AI on the operational efficiency, environmental performance, and industrial safety systems of energy companies. The paper systematically explores the nature of the digital transformation of the oil and gas sector amid tightening environmental regulations, escalating geopolitical risks, the destruction of energy infrastructure due to the war in Ukraine, and a shortage of skilled personnel. It is shown that under such conditions, artificial intelligence ceases to be an optional tool for targeted optimization and becomes a fundamental element of new business models focused on data-driven management of all stages of the value chain-from geological exploration and reservoir modeling to production, transportation, processing, trading, and maintenance.

The methodological framework of the study comprises methods of analysis and synthesis, systemic and structural-functional approaches, as well as comparative analysis, which enabled a comparison of practices among leading international companies. The use of the case study method allowed for an in-depth exploration of the specifics of creating and scaling AI solutions for predictive equipment maintenance, intelligent support for engineers, monitoring of greenhouse gas emissions, automation of drilling operations, optimization of energy consumption, and industrial safety risk management. A synthesis of empirical data from corporate reporting and industry analytical studies showed that the implementation of AI systems provides a significant reduction in downtime, lower maintenance costs, increased asset productivity, reduced methane and carbon dioxide emissions, and creates new sustainable competitive advantages for leading companies.

Particular attention is paid to the role of data management systems as a critical infrastructure prerequisite for the effectiveness of AI in the oil and gas industry. It is argued that the quality, integrity, security, and controlled access to production and operational data are essential for the proper functioning of machine learning algorithms, the development of reliable predictive models, and the implementation of

computer vision solutions to monitor compliance with occupational safety regulations. It is shown that for Ukrainian energy companies, the priority is the phased implementation of AI solutions with a focus on areas that provide the greatest impact on operational efficiency and safety-predictive maintenance, emissions monitoring systems, video analytics of production processes, and the digitization of operational documentation. The approach proposed in this article can serve as a conceptual foundation for developing roadmaps for the digital transformation of oil and gas enterprises and for further interdisciplinary research in the field of the digital energy economy.

Keywords: artificial intelligence, oil and gas industry, oil and gas sector, innovative transformations, digital transformation, energy security, energy companies, predictive maintenance.

ШТУЧНИЙ ІНТЕЛЕКТ ЯК ДРАЙВЕР ІННОВАЦІЙНИХ ТРАНСФОРМАЦІЙ У НАФТОГАЗОВІЙ ПРОМИСЛОВОСТІ

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АКТУАЛЬНІ ПИТАННЯ ЕКОНОМІЧНИХ НАУК

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Анотація: Мета статті полягає в комплексному обґрунтуванні ролі штучного інтелекту як ключового драйвера інноваційних трансформацій у нафтогазовій промисловості на глобальному та національному рівнях, із зосередженням уваги на впливі ШІ на операційну ефективність, екологічну результативність та систему промислової безпеки енергетичних компаній. У роботі послідовно розкрито зміст цифрової трансформації нафтогазового сектору в умовах посилення екологічних обмежень, загострення геополітичних ризиків, руйнування енергетичної інфраструктури внаслідок війни в Україні, а також дефіциту кваліфікованих кадрів. Показано, що в таких умовах штучний інтелект перестає бути факультативним інструментом точкової оптимізації та перетворюється на базовий елемент нових бізнес-моделей, орієнтованих на data-driven управління всіма етапами ланцюга створення вартості – від геологорозвідки та моделювання родовищ до видобутку, транспортування, переробки, трейдингу й сервісного обслуговування.

Методичну базу дослідження становлять методи аналізу й синтезу, системний і структурно-функціональний підходи, а також порівняльний аналіз, що дозволив зіставити практики провідних міжнародних компаній. Використання кейс-методу дало змогу поглиблено розкрити специфіку створення та масштабування ШІ-рішень для прогнозного обслуговування обладнання, інтелектуальної підтримки інженерів, моніторингу викидів парникових газів, автоматизації бурових операцій, оптимізації енергоспоживання та управління ризиками промислової безпеки. Узагальнення емпіричних даних

корпоративної звітності та галузевих аналітичних досліджень показало, що впровадження ШІ-систем забезпечує суттєве скорочення простоїв, зниження витрат на технічне обслуговування, підвищення продуктивності активів, зменшення викидів метану та діоксиду вуглецю, а також формує нові стійкі конкурентні переваги компаній-лідерів.

Особливу увагу приділено ролі систем управління даними як критичної інфраструктурної передумови ефективності ШІ у нафтогазовій галузі. Обґрунтовано, що якість, цілісність, безпека і контрольований доступ до виробничих та експлуатаційних даних є необхідною умовою коректної роботи алгоритмів машинного навчання, побудови надійних прогнозних моделей та впровадження рішень з комп'ютерного зору для контролю дотримання правил охорони праці. Показано, що для українських енергетичних компаній пріоритетним є поетапне впровадження ШІ-рішень із фокусом на напрямках, які забезпечують максимальний ефект для операційної ефективності та безпеки – прогнозне обслуговування, системи моніторингу викидів, відеоаналітика виробничих процесів, цифровізація виконавчої документації. Запропонований у статті підхід може бути використаний як концептуальна основа для розроблення дорожніх карт цифрової трансформації нафтогазових підприємств та подальших міждисциплінарних досліджень у сфері економіки цифрової енергетики.

Ключові слова: штучний інтелект, нафтогазова промисловість, нафтогазова галузь, інноваційні трансформації, цифрова трансформація, енергетична безпека, енергетичні компанії, прогнозне обслуговування.

Problem statement. The oil and gas industry remains critical to the global economy, yet it is simultaneously facing pressure from technological, environmental, and geopolitical transformations. Digitalization, the war in Ukraine, stricter climate policies, and a shortage of skilled workers are forcing companies to shift from traditional resource-intensive models to innovative data-driven strategies. In this environment, artificial intelligence (AI) is evolving from a tool for targeted

optimization into a key driver of innovative changes in operational models, data management, and industrial safety systems within the oil and gas sector. However, for most companies, especially Ukrainian ones, the question remains of how exactly to integrate AI into production and management processes while taking into account safety requirements, regulatory constraints, and limited investment resources.

Analysis of recent research and publications. In recent studies, artificial intelligence is viewed as one of the key tools for improving the economic efficiency of oil and gas and energy companies, as its application makes it possible to reduce downtime, improve forecasting accuracy, optimize asset operating modes, and lower operating costs.

Intelligent drilling optimization systems that combine machine learning, reinforcement learning, digital twins, and edge computing demonstrate the ability to reduce non-productive time by 20-35%, which has a direct impact on well construction costs and overall expenses in the upstream segment [1]. A review [2] confirms that in drilling and production, AI is most often used to prevent sticking, control hydrate formation, monitor risks, and support real-time decision-making, thereby reducing emergency interventions and production losses.

Some researchers demonstrate that machine learning can be used to predict well integrity failures, reduce unplanned downtime, extend asset lifecycles, and cut emergency repair costs [3,4].

In turn, a number of researchers have systematized the use of ML, LSTM, neural networks, and proxy models in field development, intelligent history matching, reservoir simulation, and production planning, highlighting their role in reducing computational costs and accelerating the analysis of field development scenarios [5,6,7].

Research on renewable energy highlights that AI can enhance the economic viability of renewable energy projects through generation forecasting, predictive maintenance, resource assessment, and grid integration [8,9].

An important shift in recent literature is the attempt to move from technical efficiency to the financial performance of AI adoption [10,11].

In Ukrainian studies, the issue of AI application in the energy sector is primarily considered in the context of digitalization, energy security, and post-war recovery [12].

Researchers view AI as the foundation for shaping the energy grid of the future, particularly through the use of neural networks, deep learning, decision trees, and genetic algorithms to forecast energy consumption, balance production and consumption, and reduce wasteful costs. They are also researching AI systems for optimizing energy processes at enterprises and analyzing digital tools for green energy, where AI, smart grids, digital twins, and big data are viewed as means of reducing technical losses, integrating renewable energy sources, and enhancing the economic capacity of regions [13,14,15]

Identification of unresolved parts of the problem. Today's oil and gas and energy sectors require increased efficiency, cost reduction, optimization of production processes, and enhanced energy security. For Ukraine, this issue is particularly pressing due to military risks, damage to energy infrastructure, and the need to modernize it.

Artificial intelligence is a promising tool for forecasting energy consumption, monitoring equipment, optimizing drilling, managing power grids, and reducing accident rates. At the same time, existing research primarily focuses on the technical capabilities of AI, while questions regarding its economic efficiency remain insufficiently systematized.

Thus, the problem lies in the lack of a comprehensive approach to assessing the economic feasibility of implementing AI in the oil and gas and energy sectors. Solving this problem is of scientific importance for the development of methodological approaches to evaluating digital technologies, and of practical importance for justifying investments, reducing costs, improving infrastructure reliability, and strengthening energy security.

The aim and objectives of the article. The purpose of this article is to justify the role of artificial intelligence as a driver of innovative transformations in the oil and

gas industry and to establish a conceptual framework for the implementation of AI solutions, with a focus on data management and industrial safety, that is relevant to international and Ukrainian energy companies.

Main material. Companies that, just a decade ago, relied exclusively on traditional methods of geological exploration and production are now forced to rethink every aspect of their operations: from discovering deposits to managing production, from logistics to customer engagement. Overall, for Europe and Ukraine in particular, the war has caused massive damage to energy infrastructure, making the use of modern technologies-including artificial intelligence-not just a competitive advantage, but a necessary condition for the industry's recovery and development.

Artificial intelligence in oil and gas production is no longer a startup or a separate initiative of particularly innovative companies. It has become the new norm for doing business. According to a survey by Ernst & Young [16], today 92% of global oil and gas companies are already using or plan to use artificial intelligence in their production processes within the next two years. This is a striking statistic, indicating that AI has become a critically important tool for competitiveness.

The application of AI spans virtually every segment of the production chain. Companies use the technology to analyze seismic data, where machine learning algorithms can identify geological structures that humans might overlook. AI-driven reservoir modeling enables significantly more accurate predictions of reserve volumes and optimal production methods. Optimizing drilling processes through intelligent systems reduces well drilling time and lowers costs. Monitoring equipment condition using AI makes it possible to predict breakdowns before they occur, which is critically important for expensive and complex oil and gas equipment.

Economic indicators for the artificial intelligence market in the oil and gas sector show impressive growth dynamics. As early as 2022, the AI market segment in the oil and gas industry was valued at $5,13 billion. However, forecasts for the coming decade point to rapid growth: by 2034, the market size is expected to reach approximately $25,24 billion. This represents an average annual growth rate of nearly 14%,

significantly exceeding the growth rates of most other technology segments in the industry [17].

This trend is driven not only by the current buzz around artificial intelligence, but also by the tangible economic benefits companies derive from its implementation. AI enables a 20-30% reduction in exploration costs, a 10-15% increase in production efficiency, and a 30-40% reduction in equipment downtime through predictive maintenance. For an industry where every percentage point of efficiency can mean millions of dollars in savings, such figures are extremely attractive.

The intensity of innovation in the application of AI in the oil and gas industry can be measured by patent activity, and the numbers are truly impressive. The top countries by number of patent applications in this field are: The United States with 36%, confirming the technological leadership of the American oil and gas industry; China with 28%, which is actively catching up to the U.S. and has already become the second most important innovation hub; and the United Kingdom with 3%, which maintains its position as one of Europe's technological hubs in the industry. Together, these three countries control two-thirds of all patents for AI solutions for the oil and gas industry, giving their companies a significant technological advantage [18].

Despite optimistic forecasts regarding the continued importance of carbon-based energy sources in the global economy, the oil and gas industry faces an unprecedented set of challenges that require comprehensive solutions (fig.1).

The first and perhaps most significant challenge is the need for large-scale technological modernization. Although 82% of companies are already using or plan to use AI, this does not mean that implementation is easy. Oil and gas companies often have outdated IT infrastructure-systems that were built over decades and are not designed to integrate with modern AI solutions. Upgrading this infrastructure requires massive investments and time.

The second critical challenge is the shortage of specialists who understand both oil and gas processes and artificial intelligence technologies. To effectively implement AI, you need people who can translate real production problems into the language of

algorithms and, conversely, interpret the results of AI operations for operational decisions. Such specialists are scarce in the market, and competition for them from technology companies is very high. Oil and gas corporations are forced to invest in retraining their own employees, create internal training programs, and collaborate with universities.

The use of AI in the oil and gas industry includes	Surface data analysis/geological assessment
	Reducing downtime for wells/equipment
	Production Optimization and Planning
	Asset Tracking and Maintenance Using Digital Twins
	Identification of deviations
	AI-driven security
	Workplace Safety
	Decision-making based on analysis
	Emissions tracking
	Optimization of the logistics network and supply chains
	Shi-oriented inventory management / optimized procurement
	Optimization of Back-Office Processes

Fig. 1. Applications of AI in the oil and gas industry

Source: adapted from [19, 20].

The third challenge relates to data. AI is a technology that "runs" on data, and the more high-quality data there is, the better the algorithms perform. However, in the oil and gas industry, data is often scattered, comes in various formats, and may be incomplete or inaccurate. In this regard, companies should pay special attention to implementing data governance systems that ensure data quality, accessibility, and consistency-this is becoming a critical prerequisite for the successful application of AI. This aspect will be discussed in more detail as an opportunity for integrating AI into the operations of Ukrainian energy companies.

At the same time, all these challenges also create enormous opportunities. Companies that can successfully integrate artificial intelligence into their operations will gain a significant advantage. They will be able to extract more oil and gas from existing fields, discover new promising areas more quickly, operate more safely and sustainably, and respond more rapidly to market changes.

The modern world is at the epicenter of profound transformations. The war in Ukraine has triggered fundamental changes in the global energy sector, forcing both major powers and smaller nations across all continents to rethink their energy security strategies. At the same time, the technological revolution, which until recently seemed like a distant prospect, has become a reality of the present. The oil and gas industry is undergoing a qualitatively new phase of digital transformation. Leading international corporations are intensively implementing innovative solutions based on AI technologies, striving to achieve three strategic goals: maximizing operational efficiency and optimizing costs, minimizing the environmental impact of production, and ensuring the highest safety standards for employees.

In this context, it is important to examine specific examples of how artificial intelligence technologies are being integrated into the operations of international companies in the oil and gas sector. Practical experience with AI implementation allows us not only to assess the technology's real potential but also to identify the most effective approaches to its use in various business contexts.

The first company worth considering is Siemens, a German technology corporation that is currently one of the world leaders in the implementation of artificial intelligence in industry. The company operates in a wide range of sectors, from the manufacture of industrial equipment and transportation systems to energy infrastructure. With an annual turnover of over 77 billion euros and a presence in more than 190 countries, Siemens faces the typical challenges of modern industry, namely: stricter occupational safety requirements, the need for environmental transformation, and an acute shortage of skilled professionals. The company views artificial intelligence as the key tool for solving these systemic problems [21,23].

Siemens' flagship product in the field of industrial AI is Senseye Predictive Maintenance-a predictive maintenance platform that demonstrates the practical value of the technology for manufacturing enterprises. The system integrates with various manufacturer data sources: sensors on equipment, production management systems, and maintenance logs. Using machine learning algorithms, the platform analyzes vast amounts of information in real time, identifying anomalies and patterns that may indicate future malfunctions.

Senseye works by continuously monitoring the technical condition of equipment and comparing current readings with historical data and reference parameters. When the system detects deviations from normal operating parameters-such as unusual vibration, increased temperature, or changes in power consumption-it not only alerts users to the problem but also predicts when a failure might occur and what the likely causes are. The company claims that thanks to this technology, customers can increase equipment productivity by 20-30%, reduce unplanned downtime by 50%, and cut maintenance costs by 10-15% [21].

The economic rationale behind predictive maintenance lies in the shift from a reactive repair model (where equipment has already broken down) or a preventive model (scheduled maintenance regardless of actual condition) to a proactive model, where intervention occurs precisely when it is truly necessary. This is particularly critical for capital-intensive industries, where a single hour of production line downtime can cost tens of thousands of dollars.

A recent innovation from Siemens is the development of Industrial Copilot - a generative AI-based assistant specifically tailored for engineers in industrial settings [22]. Industrial Copilot performs several important functions. First, the system can automatically generate program code for industrial controllers and automation systems based on natural-language task descriptions. An engineer can describe the required equipment logic in words, and the system will convert this into functional code in the programming languages of industrial controllers (Ladder Logic, Structured Text, and others). This significantly speeds up development and reduces the likelihood of errors.

Second, Industrial Copilot serves as an intelligent diagnostic tool. When an equipment issue arises, an engineer can describe the symptoms verbally in any language-English, German, Chinese-and the system will analyze the situation by cross-referencing it with a vast knowledge base of typical malfunctions, technical documentation, and a history of similar cases. It will suggest the most likely causes of the problem and steps to resolve it, referencing specific sections of the technical documentation.

Third, the system automates administrative processes. Koerte gives a telling example: when Industrial Copilot detects an equipment issue, an employee can use a voice command to create a work order that is automatically sent to the appropriate maintenance team-even if that team is located in another country and speaks a different language. The system will translate the instructions itself, add the necessary technical information, and integrate the task into the remote team's workflows. This functionality addresses the acute problem of a shortage of skilled personnel in industry; there is a global shortage of experienced engineers who understand complex industrial systems [22].

Organizationally, the development and implementation of AI solutions at Siemens is coordinated through the Siemens AI Lab - a specialized center of excellence strategically integrated into the corporation's ecosystem. The lab performs several key functions. It serves as an incubator for new AI projects, where ideas can be quickly tested and validated before scaling up. An important function of the lab is training. Siemens has developed specialized educational programs for its employees and customers to help them understand the capabilities and limitations of artificial intelligence and learn how to work with AI tools. The company understands that technology alone is not enough – a cultural and educational transformation of organizations is needed.

Siemens also links its activities in the field of artificial intelligence to the UN Sustainable Development Goals [23]. The company positions industrial AI as a tool not only for increasing business profitability but also for addressing global challenges:

reducing greenhouse gas emissions through optimized energy consumption, improving workplace safety, and using resources more efficiently. For example, predictive maintenance not only saves money but also extends the service life of equipment, reducing the need to manufacture new parts and, consequently, the industry's environmental footprint.

Siemens' experience demonstrates how large industrial corporations can successfully integrate AI into their operations, creating value for customers and solving systemic industry challenges. Key success factors include a focus on specific practical problems (rather than AI for AI's sake), the creation of specialized centers of excellence, investment in training and cultural change, and a commitment to the ethical and responsible use of technology.

Saudi Aramco is Saudi Arabia's national oil and gas company, with a market capitalization of over $2 trillion and daily production of more than 12 million barrels of oil (about 12% of global supply). With the world's largest proven oil reserves, the company has set an ambitious goal: to transform itself from a traditional oil corporation into a leading digital energy company. The digital strategy is based on the integration of three technologies: artificial intelligence, big data analytics, and the Industrial Internet of Things [24].

Aramco's strategic decision to invest in artificial intelligence is driven by several factors. First, the enormous volume of data generated daily during the extraction, processing, and transportation of hydrocarbons makes the company a natural environment for the application of Big Data technologies. Second, the complexity of oil and gas operations – from geological modeling to managing a vast network of pipelines – requires intelligent systems capable of analyzing millions of data points in real time. Third, growing pressure regarding environmental responsibility is forcing the company to seek innovative ways to reduce its environmental impact, and it is artificial intelligence that allows for the optimization of processes to achieve environmental goals without sacrificing efficiency.

A key innovation is the intelligent monitoring of flare combustion. Gas flaring involves the release and combustion of hydrocarbon gases due to increased pressure in the system, resulting in economic losses and significant CO_2 emissions. Aramco has deployed a system comprising 18,000 data sources to monitor its entire gas processing network. Proprietary artificial intelligence algorithms compare real-time data with predictive models, allowing the system to anticipate when a facility is approaching regulatory limits and take corrective action in advance. As a result, the company maintains flaring at less than 1% of total raw gas production, which is significantly better than the global average of 3-5%.

For intelligent modeling of oil reservoirs, Aramco has created the TeraPOWERS simulator, which covers the entire hydrocarbon system of the Arabian Peninsula. The system integrates geological data from decades of exploration and is constantly updated with new information from current operations. Complex algorithms identify patterns that are invisible to the human eye, enabling the optimization of new well locations, the selection of effective methods for enhancing oil recovery, and the forecasting of long-term field productivity.

Another significant achievement is the automation of drilling using computer vision. The company has developed a well-steering system based on high-resolution cameras and AI algorithms. Real-time computer vision analyzes the placement of the drill string, identifies correct and incorrect equipment placement, and detects potential problems before accidents occur. Automation improves safety and speeds up drilling, reducing unproductive downtime.

The company also demonstrated the effective application of digital transformation at one of the largest fields, Khurais (over 20 billion barrels of reserves). Aramco deployed 40,000 sensors to monitor over 500 wells. The integration of machine learning, smart sensors, and robotics has yielded concrete results: a proprietary AI-based solution reduced fuel gas consumption in boilers; robots and drones perform routine inspections in hazardous areas. The result is a 15% increase in production and a 100% improvement in response time to malfunctions.

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Saudi Aramco is demonstrating a systematic digital transformation of the world's largest energy corporation. Key success factors: massive investments in digital infrastructure, the creation of specialized centers of excellence, the integration of AI with the Industrial Internet of Things and Big Data, and a focus on measurable results – from increased productivity to reduced environmental impact.

TotalEnergies is a French multinational energy corporation and one of the world's leading companies in the oil and gas industry. The company is actively transforming itself from a traditional fossil fuel producer into a diversified energy company by investing in renewable energy sources and innovative technologies. The company's strategy is based on flexible research and development that aligns with its growth principles, business expansion ambitions, and sustainability commitments.

To prepare for the future, the company has invested over $1 billion in research and development, industrial innovation, and digital initiatives by 2024. These large-scale investments are aimed at developing innovative technologies that reinforce the company's leading role in the energy transition. Digital technologies and artificial intelligence play a key role in accelerating the transition of both the company itself and its customers toward more sustainable energy solutions.

TotalEnergies' strategy [25] calls for flexible research and development aligned with its growth principles, ambitions, and sustainability commitments. The company's information and communication technology expenditures are estimated at $820.7 million for 2024, a significant portion of which is earmarked for digital transformation and the implementation of AI solutions.

In 2020, TotalEnergies launched its Digital Factory, bringing together 300 experts in AI and digital technologies, including developers, data scientists, and other digital specialists. By 2024, the team had developed over 100 solutions, 60 of which utilize technologies ranging from machine learning to generative AI.

The AUSEA (Airborne Ultralight Spectrometer for Environmental Application) technology, developed by the R&D department in partnership with the CNRS (French National Center for Scientific Research) and the University of Reims, is a prime

example of the development of innovative and competitive technologies. This miniature sensor, mounted on a drone, is capable of detecting and quantifying methane and carbon dioxide emissions, as well as identifying the sources of these emissions with high accuracy. This innovative technology has been deployed at the company's Upstream oil and gas sites, as well as outside its own assets under cooperation agreements. In 2022, TotalEnergies conducted its first large-scale campaign to detect and measure emissions, covering 95% of the facilities it operates in the Upstream sector.

TotalEnergies conducts annual leak detection and repair campaigns at all production sites, supplemented by monitoring using AUSEA drones and real-time continuous detection systems, which the company plans to install by the end of 2025. As part of this program, approximately 13,000 sensors will be installed at a cost of $50 million, including up to 500 sensors on a single FPSO (floating production, storage, and offloading unit) to provide full coverage of the facility. This sensor network will ensure continuous monitoring of emissions and rapid response to any anomalies (fig.2).

Thanks to the implementation of AI-based monitoring systems and other measures, TotalEnergies has achieved impressive results in reducing methane emissions [25]:

– 2010–2020: methane emissions reduced by nearly half;

– 2020–2024: emissions decreased from 64 kt CH_4 to 29 kt CH_4, representing a 55% reduction;

– ahead of schedule: the company is one year ahead of its target to reduce methane emissions by 50% between 2020 and 2025.

The implementation of AI solutions led to a 12% increase in operational efficiency through the optimization of production processes and a machine learning-based predictive maintenance system. Return on average capital employed (ROACE) reached 14.8% in 2024, exceeding industry averages. AI systems simultaneously reduced greenhouse gas emissions by 36% and improved operational efficiency.

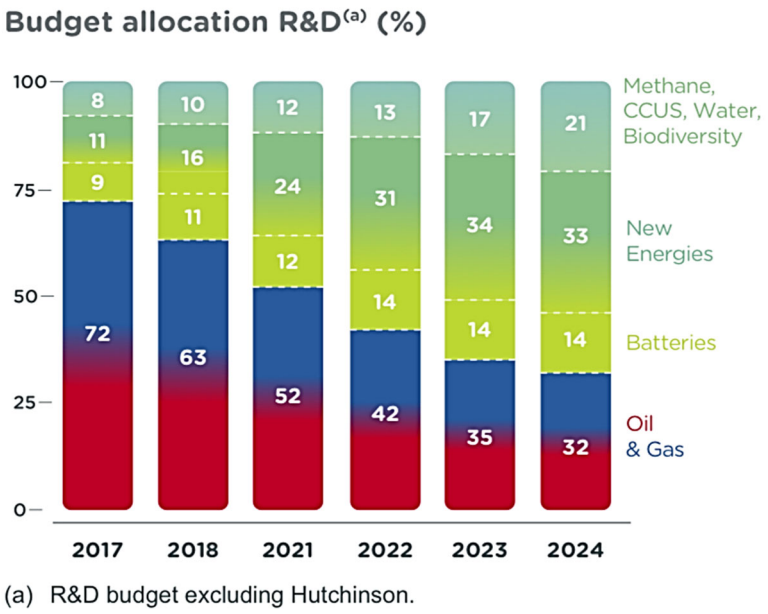

Fig. 2. Reducing emissions through digital technologies. Budget allocations [25]

AUSEA technology represents a significant breakthrough in the field of automated greenhouse gas emissions monitoring. The results of its practical application demonstrate the ability to achieve ambitious emission reduction targets while simultaneously improving operational efficiency. The successful implementation of the TotalEnergies project sets a precedent for the adoption of similar technologies in other energy companies and industrial sectors. Further development of AI-based emissions monitoring systems could be a key factor in achieving global climate goals and transitioning to a low-carbon economy.

Artificial intelligence is radically transforming traditional approaches to doing business in the oil and gas sector. Companies are actively rethinking their operational models, shifting from traditional resource-intensive approaches to digitally driven strategies based on data analytics and decision-making algorithms.

Companies that integrate AI into their operations early on are building significant competitive barriers. According to an IBM study, 75% of oil and gas executives believe that investments in artificial intelligence will provide a measurable competitive advantage over the next three years [26]. The key advantage lies in the

speed of decision-making and the flexibility to respond to market changes. In an industry where prices fluctuate by the minute and geopolitical events instantly impact markets, this advantage is critical.

Leading companies in the industry have accumulated unique data over decades of operations - from seismic surveys to telemetry from thousands of wells. This vast amount of information, processed by AI algorithms, creates a network effect where each new operation improves the accuracy of forecasts and the effectiveness of decisions. It is virtually impossible for competitors to quickly replicate such an asset, making technological leadership a sustainable competitive advantage.

Conclusions. The future of the oil and gas industry is inextricably linked to the development and implementation of cutting-edge AI technologies for corporate data management and production safety. Development prospects in this area center on the creation of comprehensive systems that integrate data management with AI-based safety technologies.

Modern energy companies are increasingly relying on data-driven approaches in their business processes, which is radically changing the way corporate data is managed. At the heart of these changes lies the concept of Data Governance as an end-to-end business process that ensures transparent, reliable, and effective management of corporate data by integrating people, processes, and technologies. An effective data management system must ensure the quality, security, availability, and value of data to support operational efficiency, regulatory compliance, and strategic management decision-making. This is particularly critical for oil and gas companies, where even minor errors in data processing can lead to millions in losses or serious accidents.

The potential of AI solutions for cost optimization and safety improvement remains enormous. Companies that strike the right balance between technological capabilities, regulatory requirements, and economic feasibility will be able to gain significant advantages in the form of reduced operational risks, improved workplace safety, and optimized business processes.

For Ukrainian energy companies, adapting such practices is possible through the phased implementation of AI solutions focused primarily on predictive maintenance, emissions management, and industrial safety, with strict adherence to national and European regulatory requirements. Further research should focus on developing specific roadmaps for digital transformation for Ukrainian oil and gas companies and building models to assess the economic viability of individual AI projects.

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