

Digitalization of the fuel and energy industry: a study of new technologies and their potential

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Abstract. The article describes technologies that are implemented into the production processes, evaluates digital solutions taking into account the latest trends that will allow fuel and energy companies and the industry as a whole to increase the competitiveness of their products, identifies the problems of digitalization of the fuel and energy industry and suggests possible solutions.

1 Introduction

In recent years, the fuel and energy industry has accumulated a large amount of structured data which can provide the industry with new opportunities for the development and efficient use of the existing infrastructure. However, in order to process and use this data in the production process, companies need to implement modern information and digital technologies. The development of new digital technologies and the use of existing ones will allow the fuel and energy companies to improve the competitiveness of products and the industry as a whole.

According to the report of the ranking agencies Deloitte and iR&D Club, in terms of the digital maturity, the ranking of fuel and energy companies (hereinafter referred to as the FE companies) is 2.5 out of five points.

The industry lags behind the banking and trade sectors and the automotive industry (the ranking is based on a survey of the largest companies in the key industries with a turnover of 50 billion rubles a year). [1]

Digital maturity data indicates that new technologies can change the market balance, which can change the strategy of fuel and energy companies, allow for the implementation of new initiatives and create advantages for other economic sectors.

Many industries have been already involved in the technological race for digitalization in all the industries, including the fuel and energy one. For example, in fields with hard-to-recover oil and gas reserves, 3D seismic models and digital twin technology are used in oil refining. New technologies can reduce exploration, production and processing costs, improve production safety and production capacity.

According to some experts, digitalization can speed up the process of seismic data processing. This data is used in making decisions where and how to drill. Due to the data analysis, the field start-up time can be reduced by 30-40%.

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2 Materials and methods

The digitalization of the fuel and energy industry affects all the sectors: the electric power sector, the oil and gas sector, including mining, transportation and processing, and the coal sector.

The digitalization is intended to implement the following technologies into the industry:

- Big data.
- Neurotechnologies.
- Artificial intelligence for the analysis of big data and operation of the support system and decision making.
- Components of robotics and sensors to increase labor productivity, develop and operate hard-to-reach deposits in order to ensure the safety of life and health of workers.
- Wireless communication for monitoring facilities and employees, ensuring safety and reducing the number of emergency situations and injuries.
- Digital twins.

Digitalization also covers all the stages of the technological cycle. In particular, using the digital technologies in the oil and gas sector, the process of geological exploration is being improved to monitor field works and reduce the production cost by 40% compared to the aerospace technologies [2].

As part of the digitalization in the fuel and energy industry, the process of robotization helps improve labor safety and reduce staff labor costs. Robotization will allow the fuel and energy company to increase the efficiency of field development by 5-7%, reduce production costs and increase the volume of recoverable resource by 30%. [1]

To assess the reliability of equipment, effectiveness of the development of new fields in the oil and gas industry, Machine Learning and Big Data technology is used.

This technology allows companies to reduce well construction time and total costs by 15%, to optimize the schedule of diagnostic checks of oil and gas equipment and reduce the cost of oil production.

The machine learning algorithms can automate the collection of information on oil production, optimize the process of equipment diagnostics, improve the efficiency of equipment use, reduce downtime and increase the volume of production.

According to expert estimates, the potential economic effect from these technologies can be up to one million additional tons of oil and gas [3]

To develop companies' activities and improve their efficiency and competitiveness, digital technologies and various programs are a crucial element of the strategic development.

Taking into account the existing trends, the article will consider what technological solutions companies use in the production process. The article also aims to evaluate the economic effect, identify problems and suggest possible solutions.

3 Results

For many years, fuel and gas companies have been using digital technologies to analyze hundreds of thousands of models and options for installing and operating equipment. The artificial intelligence system helped improve the efficiency of decision making by 25%, while reducing the time for assessing promising drilling sites to several minutes. Currently, the integrated analytical data management platform 'Smart Data Lake' has been successfully implemented as part of the analytical projects of the regional sales department with the aim to improve the operational efficiency of sales activities [4]

One of the most interesting projects of the company is the digital field. In real time, using a 3D platform, employees monitor all performance indicators, each physical object is

represented by a digital twin that provides detailed information about its state and operation. Drones are also used to monitor the integrity of pipelines and prevent tie-ins into the system.

The digital technologies help the companies to improve the energy efficiency of processes by 5%, reduce logistics costs by 5%, which will make it possible to obtain an economic effect of around one billion rubles a year. [5]

Geological, geophysical and other data in the oil and gas industry have a narrow specialization and processing features tied to the features of a particular software developer, which creates technological barriers for implementing new technologies, in particular for machine learning, and can reduce their investment attractiveness and potential effect.

As part of the open OSDU community, the universal and unified data processing architecture format can make it easier for subsoil users and developers of specialized software to develop and test new technologies, to reduce the cost of launching new digital solutions, to accelerate business processes in geological exploration, to reduce costs and deposit development cycles, and to increase the production efficiency. [17]

In the oil and gas industry, the advanced technologies assist in processing data and obtaining detailed information about an object. For example, they can be used to analyze cuttings (small pieces of cuttings). Geophysics data help understand what rocks the cuttings consist of. The latest equipment and software make it possible to perform this procedure in the well during drilling.

The use of powerful computers and specialized software makes it possible to transfer a real reservoir into a digital “twin” (3D model), which helps understand how to drill, what and in what volumes to pump, how and where to perform the process of hydraulic fracturing. [18]

Table 1. Benefits of using smart technologies in the oil and gas industry.

Parameters	Field management technologies		
	Active management	Reactive management	Proactive (smart) management
Increase in oil production, %	1	4	10
Increase in oil reserves, billion tons	5	10	15
OEC increase, %	1	5	10
Unit costs for automation, % of revenue	1	2	4
Reduction in the unit cost of oil, %	2	5	15
Increase in labour productivity, %	1	5	10

The use of digital technologies by fuel and energy companies solves both technical and financial problems. In particular, the use of digital twins makes it possible to reduce risks in the production and processing of oil and gas.

The use of predictive analytics at refineries makes it possible to foresee failures of compressors, which can save several million dollars. [1] The use of the digital twin technology can help avoid power outages and solve the problem of energy consumption in a more rational way.

In addition, this technology can help improve the performance of companies by reducing the need for personnel in hazardous and remote areas.

The energy industry is not lagging behind. As part of the digital technology project, new tasks have been set: development of renewable energy sources, distribution generation, and electric transport. [10]

The income in generation and distribution can increase through the analysis of available data, automation of business processes and local implementation of digital solutions. [8]

Most energy companies automatically collect data on physical indicators at specific facility's points, create their own data lakes that allow for storing and processing data with different levels of structuring and retention periods, and expand the use of Master Data Management (MDM) to eliminate inconsistencies in operational data.

To protect the company from financial risks caused by the equipment downtime and breakdown, VR and AR technologies are implemented. VR simulators work out a variety of scenarios for equipment failures and cope with emergency situations faster after working through possible force majeure in virtual reality.

ARs are augmented reality simulators used in the oil and gas sector to simulate the operation of specific components and processes. Workers get a real-time overview of live zones, which speeds up the processes of installation and commissioning, ensures the safety of personnel, simplifies the troubleshooting procedure, allows the company to attract experts from different countries, and reduces financial and time costs.

However, energy companies are facing a number of difficulties. First, big data takes up a lot of space. The volume of data is growing; traditional storage systems cannot process it and huge storage systems cannot solve the problem. This creates the second problem - data processing. To work with information and benefit from it, experts are needed which increases the production costs. With the use of new tools for working with data, companies have to spend a lot of money on their development. [7] In addition, a large amount of information is fragmented, unstructured, incorrect and obsolescent.

The issues of streamlining information flows and ensuring the timely exchange of data between structural units, which is necessary for prompt decision-making, need to be addressed.

The use of several information systems in one business process causes the inconsistency of data. In addition, in the digital transformation, barriers that impede the implementation of new technologies and solutions can arise due to the low interest of the companies, the lack of legal acts for effective regulation, the low level of competitiveness of domestic digital solutions and high dependence of the Russian market on foreign products [16].

4 Discussion

In the digital transformation, many companies face a number of problems, including difficulties caused by the lack of a scalable industrial infrastructure for implementing and maintaining solutions in the ICT market, which can create a threat to the business continuity.

The process of implementing digital technologies by some enterprises is slower due to a number of factors such as:

- The need to train staff.
- Cyber threats due to the connection of new devices to the network.
- Lack of qualified IT specialists with knowledge of the fuel and energy industry.
- Features of the technology of production processes determine the creation of complex information products and make it difficult to use unified digital platforms.

Some problems arise due to the fact that IT systems are not connected, scattered across departments, which causes a misunderstanding of what data the company has, who and how uses it [12].

To eliminate these problems, companies need to create a unified centralized system, implement effective mechanisms for collecting, storing and managing data, generating reliable and timely corporate reporting to optimize processes, make clearer management decisions, and model possible development scenarios.

Possible solutions:

- Automation through complex infrastructure solutions that provide for the collection and real-time processing of information [15].
- Creation of own ecosystem/data platforms for solving problems of predictive and regulatory analytics.
- Development of solution architectures using various tools, including smart statistical reporting services, analytical services (dashboards, RPI, Self-service), industrial Internet of things. [7]

5 Conclusion

In modern conditions, the advantage of digitalization is a multiple reduction in labor costs for the analysis and interpretation of big data. For this purpose, machine learning and artificial intelligence technologies are used, the drilling process is monitored in real time, the trajectory is corrected, high-quality 3D models are developed to achieve the desired level of production and reduce the environmental burden on the environment. The digital technology also reduces the number of errors in the design of objects through the use of predictive analytics, which helps prevent breakdowns and equipment failures. Most importantly, the companies can get a significant economic effect which, as experts predict, can amount to 382 billion rubles per year [1]

Energy companies have been implementing new security standards to ensure the security of wireless networks, encryption systems to work with cloud storage systems, and access control systems.

Along with the new technology, it is necessary to amend legal acts, support highly qualified personnel, involve public companies in innovation activities, establish minimum requirements for digital solutions, ensure regulatory policy flexibility and cybersecurity of implemented solutions. [14]

Many companies follow global trends, in particular in combining energy companies with companies from other industries with the aim to develop innovative digital solutions; in the electric power industry, this interaction is part of the development of platform solutions in the field of facility security, system reliability, provision and payment for energy services.

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