

THE ROLE OF GREEN TECHNOLOGIES IN THE OIL AND GAS INDUSTRY

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Abstract. This article discusses the need and importance of using green technologies in the oil and gas industry. It also provides relevant conclusions and suggestions on the positive or negative economic, social and environmental consequences of the transition to green technologies.

Keywords. Green technologies, green economy, green energy, oil and gas production and transportation technologies, environmental damage, economic profit.

Introduction

The oil and gas industry has been a pillar of the global economy for centuries. It is central to powering transportation systems, heating homes, and driving industry. However, the environmental impact of the industry, particularly greenhouse gas emissions and the severe damage they cause to ecosystems, is attracting increasing scientific and public attention. Now, more than ever, the oil and gas sector needs innovative solutions to ensure a sustainable future.

In this context, green technologies are emerging as a significant wave of innovation. They not only promise solutions to environmental problems, but also ensure the sustainability of the enterprise by improving its financial performance and adding value to operational efficiency. Why green technologies? These green technologies aim to mitigate climate change by stopping the causes of pollution, conserving natural resources and preserving biodiversity. For example, Carbon Capture and Storage (CCS) technologies aim to capture carbon dioxide (CO₂) from the atmosphere and store it underground, while Shell is investing heavily in electric vehicle charging infrastructure and renewable energy projects with the aim of achieving net zero emissions by 2050. This will help to significantly reduce carbon emissions.

Worldwide the transition to these technologies on a large scale is becoming increasingly urgent, measures to achieve a "green economy" have already begun in Uzbekistan. In particular, the "Development Strategy of New Uzbekistan for 2022-2026" development strategy. A number of works are being implemented to implement the set tasks, increase the effectiveness of measures taken to ensure "green" and inclusive economic growth within the framework of the strategy of the Republic of Uzbekistan's transition to a "green" economy, further expand the use of renewable energy sources, and save resources in all sectors of the economy.¹

The problematic issues related to climate change have a negative impact on the effectiveness of the reforms being implemented in the country, in particular, on economic growth and poverty reduction, and on ensuring environmental and food security. Accordingly, in this direction, great attention is paid to reducing the impact of climate change in the country

¹Decree of the President of the Republic of Uzbekistan No. PQ-436 dated December 2, 2022 to the decision ANNEX

and adapting to it, accelerating measures to transition to a "green" economy, and promoting a "green" and inclusive economic growth model.

In this regard, in order to stimulate "green" economic growth in the country, rational use of natural resources, attract "green" investments, and mitigate the negative impact of the environmental crisis, the President of the Republic of Uzbekistan adopted the Strategy for the Transition of the Republic of Uzbekistan to a "green" economy for the period 2019-2030.²Therefore, the introduction of green technologies in this area is not only an environmental necessity, but also an important factor for ensuring economic and social sustainability. Green technologies ensure the economic sustainability of companies by reducing environmental pollution, using resources efficiently, and increasing their operational efficiency.

Research methodology

This study provides a comprehensive analysis of the necessity, importance, economic, social and environmental consequences of the use of green technologies in the oil and gas industry. Through a systematic approach, the environmental, economic and social aspects of the oil and gas industry are considered as an interconnected system. Comparative analysis provides a comparative analysis of international experience and Uzbekistan's policy, legislative framework and practices in this area. Statistical analysis analyzes available statistical data, including data on oil and gas production, processing, transportation volumes, energy consumption, greenhouse gas emissions and investments. The forecasting method helps to predict the future economic, social and environmental consequences of the introduction of green technologies in the oil and gas industry.

Literature review

Research on green technologies in the oil and gas industry and their economic, social, and environmental effectiveness is becoming increasingly relevant both globally and in Uzbekistan. Many foreign and domestic economists have conducted scientific work on this topic.

Foreign economists ME Porter and C. van der Linde in their work "Toward a New Conception of the Environment-Competitiveness Relationship" theoretically substantiate the impact of environmental protection on economic competitiveness, in particular, the "Porter Hypothesis" that green technologies stimulate innovation and increase the efficiency of companies. JDSachs' book *The Age of Sustainable Development* discusses global problems and solutions for sustainable development, and the role of green technologies in the energy sector, including the oil and gas industry, is widely covered. BKSovacool and A.D'Agostino in their study *Energy Systems in the Era of Climate Change: The Green Transition* analyzed the transformation of energy systems in combating climate change, in particular the transition of the oil and gas industry to renewable energy and strategies for introducing green technologies.

Uzbek economist S.O. Gafurov, in his work "The Importance of Innovative Technologies in the Transition to a Green Economy," examined the role and importance of the use of innovative technologies in the development of a green economy in Uzbekistan. BTSalimov, in his work "Ways to Increase Energy Efficiency in the Oil and Gas Industry," covered issues of increasing economic efficiency in the oil and gas industry through the introduction of energy-saving technologies. AMAbdullayev, in his article "Prospects for the Use of Renewable Energy Sources in Uzbekistan," analyzed the development of renewable energy sources in Uzbekistan and their impact on the oil and gas sector. J.A. Usmanov, in his

²Resolution of the President of the Republic of Uzbekistan No. PQ-4477 dated 04.10.2019.

study “Green Technologies and Their Impact on the Economy of Uzbekistan,” examined the macroeconomic effects of the large-scale introduction of green technologies in Uzbekistan.

This literature serves as an important source for understanding the theoretical foundations, practical experiences, and economic, social, and environmental consequences of implementing green technologies in the oil and gas industry.

Analysis and results

At a time when the impacts of global warming demand urgent action, oil and gas companies are playing a key role in reshaping their operations in a more environmentally sustainable manner. Traditionally known for its high greenhouse gas emissions, the industry is now shifting towards more environmentally friendly approaches that aim to reduce the environmental impact of oil and gas operations. This shift is not only a response to regulatory pressures, but also a reflection of the important role of the oil and gas sector in the global economy and a growing awareness of energy consumption and environmental responsibility.

The widespread use of green technologies in the oil and gas industry is becoming increasingly important. The economic and environmental benefits that this brings are also making this trend increasingly important. For example:

- Although high, it can lead to significant savings in energy, waste and regulatory compliance in the long term. Energy efficiency techniques, such as optimizing energy consumption in production processes through advanced control systems and heat recovery technologies, can significantly reduce costs. According to 2023 reports, a 1% increase in energy efficiency can reduce a company's operating costs by an average of 0.5%

- Consumers are supporting environmentally friendly practices. Companies like TotalEnergies are developing strategies to reduce methane emissions while investing in natural gas production and infrastructure, demonstrating their commitment to sustainability. Research shows that more than 70% of consumers globally prefer environmentally friendly products and services, confirming this trend.

Table 1. Green technologies used in the global oil and gas industry

No .	Green technology	Usage	Brief description	Examples
1	Carbon capture, storage and recycling (CCUS)	Mining, Recycling	Capture and store CO ₂ gas underground or process it in technological processes.	Shell (Canada), ExxonMobil (USA), Equinor (Norway)
2	Detecting and reducing methane leaks	Mining, Transportation	Detecting and reducing methane emissions through artificial intelligence, drones, and satellites.	BP, TotalEnergies, Chevron, GHGSat
3	Solar and wind energy integration	Mining, Transportation	Providing electricity to oil and gas facilities using solar and wind energy.	Equinor (Norway), Shell (Oman)
4	Water recycling and reuse	Mining	Reducing waste by treating and reusing water used in production.	Chevron, Halliburton
5	Digital optimization and energy efficiency	Mining, Recycling	Reducing energy consumption using digital twins and artificial	BP, Shell, Schlumberger

			intelligence.	
6	Electrification of equipment	Mining, Transportation	Replacing diesel or gas-powered equipment with electric ones.	Equinor, ConocoPhillips
7	Green hydrogen production	Recycling	Converting water into hydrogen through electrolysis from renewable sources (sun, wind).	Repsol (Spain), ADNOC (UAE), BP & Ørsted
8	Biofuel integration	Recycling	Production of low-carbon fuels from bio-based feedstocks.	Neste, Shell, ENI
9	Direct Air CO ₂ Capture (DAC)	Recycling (also independent)	Capture CO ₂ directly from the atmosphere and store or process it.	Occidental + Carbon Engineering (USA), Climeworks
10	Zero-emission drilling rigs	Mining	Reducing waste through electric or battery-powered drilling rigs.	Nabors, Helmerich & Payne
11	Artificial intelligence-based carbon management platforms	All stages	Digital applications for identifying, analyzing and reducing carbon footprint.	Microsoft + Schlumberger, C3.ai
12	Green logistics and low-carbon transportation	Transportation	Ships and vehicles running on low-carbon fuels such as LNG, methanol, ammonia.	Maersk, Shell, Total Energies

Most of the above green technologies used globally are in developed countries. G7 countries such as the USA, Spain and France have already taken major steps towards a “green” economy in the oil and gas industry. Although not all of these technologies are used in Uzbekistan, some of them are being used in oil and gas fields and enterprises:

Table 2. Green technologies in the oil and gas industry of Uzbekistan

No.	Company name	Technology	Function	Area
1	Uzkimyosanoat & ACWA Power	Green hydrogen production	Chemical industry	Chirchik, Tashkent region
2	ACWA Power	Solar energy integration	Power supply	Yukorichirchik, Tashkent region
3	ACWA Power	Wind energy integration	Power supply	Bukhara region
4	Surhan Gas Chemical Operating Company	Energy efficiency and waste reduction	Gas processing	Baysun, Surkhandarya region

As a result of the application of these technologies, each of the listed oil and gas enterprises in our republic is able to make a greater contribution to both economic and social

production. The economic and social developments observed in them over the past 3 years are as follows:

Table 3. Economic and social changes in the enterprise, 2022-2024.

No.	Technology	Enterprise/Region	Financial savings	New market opportunities	Job creation
1	Green hydrogen production	Uzkimyosanoat & ACWA Power (Chirchik)	3,000 tons of hydrogen will save ~20.4 million m ³ of gas. Full project: ~830 million m ³ of gas	120,000 tons of hydrogen export potential per year, reducing 20 million tons of CO ₂	3.5-4 thousand jobs in construction and operation
2	Wind energy	ACWA Power (Bukhara region)	Long-term affordable electricity supply through \$658 million investment	500 MW project Prevents 247 million tons of CO ₂ emissions per year	550-650 jobs in construction and maintenance
3	Energy efficiency and waste reduction	Surhan Gas Chemical (Surkhandarya)	Operating costs decrease (heat, water, energy savings)	"Green" export markets will open for low-carbon products	Jobs will be created in technical service, automation and monitoring

Green technologies, especially solar and wind energy, improve air quality by producing hydrogen and obtaining energy from clean sources. The amount of harmful substances (NO_x, SO₂, CO₂, PM_{2.5}) generated by traditional thermal power plants or gas combustion is reduced, which reduces the risk of respiratory diseases, cardiovascular problems and oncological diseases. For example, the 500 MW wind project in Bukhara will prevent 247 million tons of CO₂ emissions annually, which will have a direct positive impact not only on the global climate, but also on local air quality and public health. In addition, the green hydrogen project in Chirchik will reduce industrial waste and gases, making the environment cleaner.

In regions where green technologies are being introduced — for example, Chirchik, Bukhara, Yukorichirchik — the environmental literacy and awareness of the population and the younger generation is increasing. Since large projects are being implemented with the participation of international investors, they are widely covered in the local media. This leads to increased attention to environmental issues, interest in renewable energy, and the formation of environmental protection habits. The opening of "green economy" directions in higher education institutions, environmental trainings and social campaigns at enterprises are strengthening this process.

Large international companies – ACWA Power, Uzkimyosanoat, Surhan Gas Chemical – are taking on not only economic benefits, but also social and environmental responsibility when operating in Uzbekistan. They are establishing environmental monitoring systems,

implementing the principles of “clean production” by choosing green technologies. This also serves as a positive example for local enterprises. In particular, processes such as reducing the carbon footprint, saving resources, and obtaining green certificates are forcing enterprises to adapt to international environmental standards.

The introduction of green technologies is becoming an important factor in Uzbekistan not only for economic or environmental, but also for social stability. Air and water quality is improving, diseases are decreasing; the population's ecological culture is growing; and enterprises are becoming more aware of social and environmental responsibility in their activities and are beginning to apply it in practice. This creates a solid foundation for building a healthy and sustainable society in the future.

Conclusion and suggestions

The introduction of green technologies in Uzbekistan's oil and gas industry is currently considered not only an environmental necessity, but also a strategic economic direction. Large projects implemented in the country (in particular, hydrogen, solar and wind energy projects in cooperation with ACWA Power and Uzkimyosanoat) show that this sector is now focused not only on hydrocarbon extraction, but also on the integration of carbon-free energy sources.

Uzbekistan is moving towards shaping its oil and gas industry not as an environmentally burdensome sector, but as a driver for a “green transition.” In other words, the sector is not only a means of reducing emissions, but also:

- development of new green economic clusters (e.g. hydrogen cluster, low-carbon logistics);
- realistic connection of science and education with industry (research-based energy projects);
- is becoming a key platform for broader reforms such as “greening” the local supply chain (e.g., using environmentally certified materials).

It is from this perspective that Uzbekistan's green energy transition strategy can be viewed as a model of national transformation that combines economic growth, environmental security, and social stability. Approaches based on the integration of public policy, the private sector, and international cooperation are of strategic importance on this path.

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