

UDC 338.22

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## THE USE OF GREEN TECHNOLOGIES BY RUSSIAN OIL AND GAS COMPANIES IN OIL AND GAS PRODUCTION AND THEIR EFFECT ON REDUCTION OF CARBON FOOTPRINT

### Introduction

The fuel and energy sector plays a key part in Russia's economy as Russian oil and gas companies are the world's largest exporters of oil, gas and derivatives. The operation of the companies is not only essential for the national economy but also critical for the ecology at locations of mining and processing facilities [1]. It is ecology that is at the heart of green energy and reduction of a carbon footprint on our planet, which governs re-focusing of all producers at these trends. In this connection, the largest oil and gas corporations in Russia implement a *carbon management* aimed at minimization of the carbon footprint on the Earth and at maximization of purities of production.

The companies use many advanced technologies that improve oil and gas cleanliness while reducing the carbon footprint and neutralizing air emission [2]. New equipment is being introduced in the oil and gas industry, which enables cleaner production. The *carbon management* becomes the basis for the neutral model of energy balance in Russia since the use of alternative energy fails to supply the country with heat and power at a full scale [3, 4]. Despite the mass use of green technologies in power engineering in European countries, it becomes increasingly more evident that the technologies produce no required effect and are incapable to supply the whole range of economic players with the needful amount of energy at a reasonable price.

It seems to be more promising to use clean technologies in oil and gas production as they can facilitate reduction of energy cost, improvement of ecological properties of air and minimization of emissions. For this reason, it is of interest to examine technologies in application by oil and gas companies in oil and gas production as green technologies. The aim of these technologies is to reduce a carbon footprint and to improve ecology on the planet of Earth.

### Methodology

The low-carbon energy trends are actualized in many countries. In Russia fairly all largest corporations integrate this policy in their managerial business environment. The largest corporations are Rosneft, Lukoil and Gazprom. They use the up-to-the-minute technologies which promote ecological properties of oil and gas production and are implemented in conformity with the full-blown concepts. For instance, Rosneft, in this context, approved the 2035 Carbon Management Plan [5]. It makes a framework for the environmental agenda of the Corporation and contains a package of measures to influence climate risks and amplify the demand for conventional sources of energy.

The Carbon Management Plan has capacities to facilitate transition of the Corporation to 100% clean carbon neutrality by 2050. Moreover, within carbon management, Rosneft evaluates its capabilities in forest restoration and in formation of a compensation potential to ensure ecologically friendly storage of hydrocarbons in mines and in salt caverns. The most essential elements of Rosneft's carbon policy are presented in **Fig. 1**.

*The article examines the use of green technologies by Russian oil and gas companies in oil and gas production and their effect on reduction of carbon footprint on our planet. The article is interdisciplinary in nature and is based on the integration of methodologies of production, technical and economic, and statistical analysis. The main research methods used in the study: content analysis, dynamic and structural analysis, statistical mathematical analysis, scientific synthesis. The analytical studies show that the key industry in the Russian fuel and energy sector—oil and gas—demonstrates an extensive trend of using green technologies in oil production and refining, which has a positive effect on reducing the carbon footprint on the Earth. There is progression of the concept of “carbon economy” in virtually all developed countries of the world. The concept is aimed at energy, resource extraction, oil and gas refining and the use of petroleum products in industrial and domestic conditions. In all of these industries, new “green technologies” are being introduced, which are aimed at reducing emissions into the atmosphere, helping to clean the air from harmful substances. In view of the growing environmental problems, oil and gas companies in many countries are striving to switch to a green economy and reduce their carbon footprint. In the coming years, we can expect increased investment in green technologies and the creation of new environmentally friendly products and services in the oil and gas industry.*

**Keywords:** gas, oil, energy, green transition, oil and gas companies, economy, energy technologies, Russian fuel and energy sector, diversification, greening

**DOI:** 10.17580/em.2025.01.12

The main factor in methane emission reduction as a result of implementation of this policy became commissioning of oil and gas gathering facilities—from wells to group units and booster pump stations in the Troitsky and Khankov sites at the Anastasievskaya–Troitsky deposit of RN-Krasnodarneftegaz. In the framework of this policy, innovative software RN-GRID developed by Rosneft is used [6]. The software was introduced under a software license agreement and promoted an enhanced efficiency of oil and gas field development. This software is a simulator of hydraulic fracturing with ensured independency of computer modeling in control over oil flow along pipelines. This is the headmost model in engineering practices and assumes 3D modeling of elasticity and flow dynamics of formations. Furthermore, it enables scaled-up conjugation of problem solving in the area of elasticity and flow dynamics of propane, and adequately represents the processes of growth of fractures in terms of reservoirs and areas of these fractures.

Lukoil also comprehends the critical nature of climate change and develops measures to control and reduce greenhouse gas emissions by means of low-carbon technology and the whole in-house business model [7]. To this effect, Lukoil uses renewable energy, participates in the Zero Routine Flaring initiative and considers enhanced energy efficiency as a main tool of adapting the Corporation to the global energy transformation. All projects implemented by Lukoil contain an efficiency criterion — a carbon footprint. This is one of KPIs for top managers, and the reduced carbon footprint of new projects becomes one of the major tasks. At least once in five years, the Corporation accomplishes the energy analysis and evaluates efficiency of expenditures connected with heat, power and water, as well as with cost of energy sources [8].

Within the framework of its policy, the Corporation has introduced and uses the technology of enhanced energy efficiency, as well as CO<sub>2</sub> (CCS)

capture and storage [9]. The technology includes modeling with advanced information technologies of artificial intelligence. These are the innovative simulators which allow re-developing geological models of reservoirs without site survey; this makes it possible to reduce air emissions during real investigation and accelerate the modeling process.

Under the mentioned strategy, Gazprom also zestfully introduces projects connected with transition of production to digital technologies. For instance, geological exploration and mining practices were infused with the Digital Deposit technologies, which enabled formation of remote control centers for drilling and extraction, as well as with the Industrial Internet of Things and Big Data. These are the break-through technologies as they allow substantial reduction in logistical costs, on-request site surveying charges and in losses per shift [10]. The gas capture and storage technology used by Gazprom allows reducing its carbon footprint. For example, at Gazpromneft, the carbon intensity of operations is reduced by 20% and is predicted to lower by 30% by 2030 [11].

For another thing, hydrogen recovery and production technologies are the new promising areas for the oil and gas industry. Gazprom's carbon management rests upon the sustainable development strategy targeted at the low carbon evolution of the Corporation. Using its climatic strategy, the Corporation plans to decrease considerably methane leakages and to implement a package of measures on the further decarbonization of the atmosphere. New types of larger-diameter pipes and gas turbine drives being in use feature improved environmental performance. The other methods of reducing emissions in hydrogen production and in development of hydrogen technologies are also actualized.

So, the largest oil and gas companies in the Russian Federation establish their development strategies on the carbon footprint reduction. To this effect, a great number of projects and activities on air decarbonization and on neutralization of the adverse impact of climate change are enforced.

These projects are based on energy efficiency enhancement, on modernization of oil refineries, evolvment of alternative sources of energy and on recovery and comprehensive utilization of CO<sub>2</sub> [12]. As a consequence, the approaches to field development and to bunkering change. The beneficial use of CO<sub>2</sub> is being improved in different ways — from concrete production to low-carbon fuel processing for aircraft [13]. Furthermore, cooperation with metallurgy is being developed, and as a consequence, the industry uses activated hydrogen, recovers CO<sub>2</sub> and pumps it into storages.

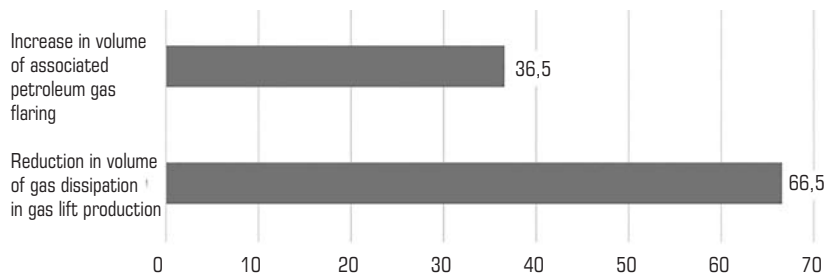
On the whole, Russian oil and gas industry is ready to use low-carbon technologies and aims at decarbonization of the national economy. Nonetheless, new engineering solutions are required to be found and handled to be prepared for the market requirements, and to realize and improve fidelity to the oil and gas industry in the country.

**Results and discussion**

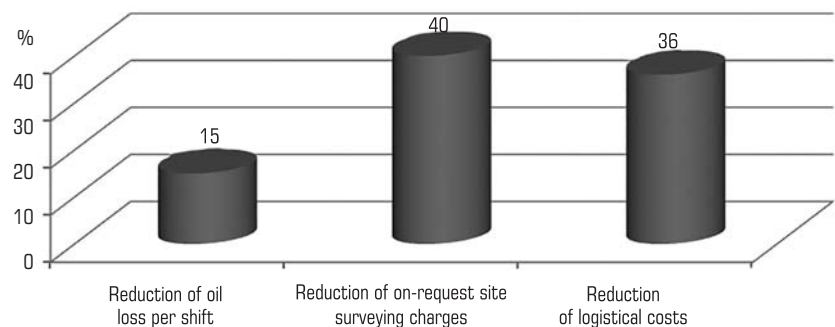
The implemented research shows that oil and gas corporations of the Russian Federation aim at reduction of their carbon footprint on the

Concept	Reduced consumption of resources, heat and electric energy saving, improved quality of operating and environmental conditions
Methods and technologies of methane emission reduction	Gas reinjection, use of gas in power and heat generation Use of gas for auxiliaries in oil and gas treatment
Beneficial use of methane	Commissioning of oil and gas gathering facilities, from wells to group units and booster pump stations
Decreased flaring of associated oil gases	Reduced greenhouse gas emission in the Extreme North
Reduced leakage of methane in transportation system	Daily surveillance of reservoirs by UAVs (drones)
Persistent increase of accuracy of data on greenhouse gas emission	Availability of data accurate to less than 1 t CO <sub>2</sub> -eq
Use of alternative sources of energy	Use of solar batteries generating electric energy
Methane emission monitoring	Advanced technologies of methane leak detection

**Fig. 1. Major elements of carbon management policy of Rosneft**



**Fig. 2. Data on methane emission as a result of carbon management introduction at Rosneft in 2023, Kt**



**Fig. 3. Quantitative data on efficiency of geological exploration and oil production digitalization at Gazpromneft**

Earth, and use new technologies facilitating achievement of the set goals. **Figure 2** illustrates methane emission indications as a result of the carbon management at Rosneft in 2023, and **Fig. 3** presents quantitative data on the efficiency of geological exploration digitization at Gazpromneft.

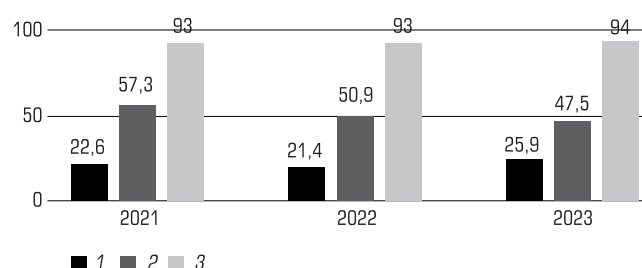
Gazpromneft succeeded in attainment of the figures in Fig. 3 owing to introduction of a new technology of low-permeable reservoir development using horizontal production and injection wells with multiple hydraulic fracturing, and program module Decision-Making Support in Low-Permeable Reservoir Drilling in RN-KIN corporate software package. The economic benefit totaled over 40 billion rubles [13].

**Table 1. Stimulators of development and application of low-carbon technologies in oil and gas industry in Russia–China cooperation**

Benefits	Economic efficiency	Effect on science and technology potential	Environmental improvement
Improvement of ecological situation in terms of greenhouse gas emission	Reduction of morbidity with the subsequent curing and rehabilitation cost cutting	Advent of innovation technologies in the field of clean energy, gas capture, cleaning of minerals etc.	Reduction of atmospheric emission, with great air purification and reduction of carbon footprint
Financial saving	Reduction of energy expenditures, with cut down costs in production and in other economic sectors	Development of new projects in energy generation and in clean material production	Reduction of air emission, improvement of general ecological situation
Renewability of energy	Decreased loss of natural resources (water, oil, gas)	Development of new projects in energy generation and clean material production	Reduction of air emission, improvement of general ecological situation
Manufacture of new-type ecologically clean construction and other materials	Reduction of costs connected with construction materials and energy	Development of new-type construction and other engineering materials	Reduction of air emission, improvement of general ecological situation
Reduction of morbidity	Reduction of expenses spent by employers on personnel, reduction of expenses spent by the government on citizens	Development of new technologies and researches in medicine	Improvement of general ecological situation
Use of new and clean types of fuel	Reduction of expenses connected with transport and cleaning of fuel	Engineering of new types of motors and transportation vehicles	Reduction of air emission, improvement of general ecological situation
International consolidation and cooperation их использовании	Investment of new economically effective projects	Development of research institutions, with international scientific teams, which promotes elaboration of new and highly efficient technologies	Joint development of new technologies toward restriction of the Earth's pollution and improvement of ecological situations inside countries

**Table 2. Share of clean energy in overall China's investment in Russia, USD million [17]**

Year	Total investment in power engineering	Investment in green energy
2011	780	300
2012	830	530
2013	2940	2290
2014	2510	590
2015	5310	2220
2016	4130	3840
2017	4010	2550
2018	2230	2230
2019	600	600
2020	630	330
2021	4480	4040



**Fig. 4. Dynamics of fuel and energy saving in oil production at Lukoil [14]**  
 1 – actual saving of fuel and energy resources, GJ; 2 – sewage disposal, Mm<sup>3</sup>; 3 – recycled water, %

Lukoil's sustainable development policy results in reduced emission and air decarbonization. As seen in Fig. 4, percentage of water recycling grows, effluents reduce and energy saving is observed in the last three years. All these have a positive effect on reduction of carbon footprint on the Earth.

On the whole, Russian oil and gas industry has a huge potential of reducing a carbon footprint on the Earth as compared with other countries. For example, gas delivered via Nord Stream has a carbon footprint less by

four times than fuel supplied by the USA. This is proved by competent rating and consulting agencies in their analytical reports [14].

All these facts confirm the promising nature of using green technologies by Russian oil and gas companies and the resultant reduction of the carbon footprint. Moreover, competitive ability of Russian oil and gas sector grows, ecology gets improved in the country and in the world, and the level of innovation development of the national economy gets elevated as the sector uses mainly technological innovations.

Innovative upgrade of the oil and gas sector results in creation of new jobs, development of high-tech production and in higher export potential of the country. Thus, the use of green technologies by Russian oil and gas industry not only mitigates environmental impact but also promotes sustainable commercial, industrial and social development.

An important objective of low-carbon technological advance in the oil and gas sphere is integration of Russia with the other countries in BRICS and EAEU. The stimulation factors of development and application of low-carbon technologies in Russia–China cooperation are described in Table 1.

In this manner, low-carbon technologies greatly improve ecological situation. They provide an appreciable economic, social and scientific and technological effect, expand scientific relationships between different countries and allow advancement in development of ecological fuels.

Recently, countries of the world essentially intensify cooperation in the sphere of the formation of common scientific potential and sharing of new technologies, including low-carbon approaches, in all energy sectors. This fact is confirmed by implemented studies, as well as by estimates of demand for climate technologies in the world and by growth of needs for clean carbon energy. As a result, almost all large corporations transit to low-carbon management, and countries develop strategies concerned with complete transition to low-carbon resources [16].

Despite such evolution of green energy, the sector is not highly profitable and yet lacks sponsorship. For another thing, it leaves unguaranteed no-break power supply and real attainment of the objectives claimed in R&D projects [17]. In point of fact, it yet remains unclear what effect the discussed technologies can produce. Nonetheless, the oil and gas sector has both potential and capacity to use such technologies, so there is a requirement for their development.

Any technology capable to reduce carbon emission promotes and cultures strategic cooperation in the low-carbon energy sphere. This is confirmed by Chinese investments in application of green technologies in Russian energy sector (Table 2). It is seen that in power engineering,

the gross share belongs to clean and low-carbon technologies. Accordingly, China lively finances energy project propelled by Russia [18].

Cooperation in low-carbon economy became really a new trend of transition of mineral mining to eco-friendly energy sources.

Another promising technology is the HI-GAS process [19]. Such technologies are to the utmost eco-friendly and challenging.

Dry coal beneficiation seems to be the most far-reaching technology. It assumes separation of valuable components from impurities and fractionation by density in air as a separation medium. Here, with the help of pneumatic equipment or on dry trays, under the action of air and regular joggle, coal particles are given different directions and trajectories of displacement (in conformity with their mass and size), which leads to division into fraction. Dry coal beneficiation allows 100% activation of coal toward its energy neutrality, with toning down of harmful properties and with removal of fossils which are the vilest for the atmosphere.

Implementation of this technology can rest upon Russia–China cooperation via construction of a new innovation infrastructure, with attraction of the Saint-Petersburg Mining University and major coal producers to carry out basic theoretical and experimental research to perfect the technology for the transfer to China. This technology can enable the engaged countries to attain faster the set goal of the energy neutrality, while Russia can attract investors in R&D and in manufacture of new products to advance the oil and gas industry.

### Conclusions

The review of green technologies used by Russian oil and gas companies in production of oil and gas, and the analysis of the influence on reduction of a carbon footprint on the Earth shows that all largest oil and gas companies of the Russian Federation base their development strategies on the carbon footprint reduction. To this effect, many projects and activities are fulfilled to neutralize adversities of climate change and to accelerate decarbonization. At the heart of these projects and activities, there is the energy effectivization, upgrading of oil and gas refineries, development of alternative energy sources, as well as the capture and complete utilization of CO<sub>2</sub>. The approaches to field development and to bunkering change. The beneficial use of CO<sub>2</sub> is improved in different ways — from concrete production to low-carbon fuel processing for aircraft.

The oil and gas industry has a huge potential to reduce its carbon footprint on our planet. As compared with other countries, the use of green technologies by Russian oil and gas companies has a promising nature and considerably reduces carbon footprint on the Earth.

For the carbon footprint reduction, it is required that the oil and gas industry of Russia develops cooperation with other countries. The analysis of China–Russia interaction shows than China potently finances Russian energy projects. For the sustainable cooperation and carbon footprint reduction, Russia should attract new investors in R&D activities, in carbon production and in advancement of oil and gas industry.

### References

- Lobus N. V., Knyazeva M. A., Popova A. F., Kulikovskiy M. S. Carbon footprint reduction and climate change mitigation: A review of the approaches, technologies, and implementation challenges. *Journal of Carbon Research*. 2023. Vol. 9, Iss. 4. ID 120.
- Rogel J., Schaeffer M., Meinshausen M. et al. Disentangling the effects of CO<sub>2</sub> and short-lived climate forcer mitigation. *Proceedings of the National Academy of Sciences of the United States of America*. 2014. Vol. 111(46). pp. 16325–16330.
- Cai A., Zheng S., Cai L., Yang H., Comite U. How does green technology innovation affect carbon emissions? A spatial econometric analysis of China's provincial panel data. *Frontiers in Environmental Science*. 2021. Vol. 9. ID 813811.
- Zeng S., Li G., Wu S., Dong Z. The impact of green technology innovation on carbon emissions in the context of carbon neutrality in china: Evidence from spatial spillover and nonlinear effect analysis. *International Journal of Environmental Research and Public Health*. 2022. Vol. 19, Iss. 2. ID 730.
- Carbon Management at Rosneft: An Integrated Approach to Methane Emission Reduction. Rosneft. Available at: [https://www.rosneft.ru/Investors/ESG/Vklad\\_v\\_dostizhenie\\_Celej\\_OON\\_v\\_obi](https://www.rosneft.ru/Investors/ESG/Vklad_v_dostizhenie_Celej_OON_v_obi) (accessed: 01.04.2024).
- New-Generation Hydraulic Fracturing Simulator RN-GRID. Available at: <https://rn.digital/mgrid/> (accessed: 01.04.2024).
- Lukoil Company. Available at: <https://lukoil.ru/Sustainability/Climatechange?ysclid=lul0zw9563302427745> (accessed: 01.04.2024).
- LUKOIL stimulates reduction of CO<sub>2</sub> emission : Top-management KPI is to include an environmental criterion. *Neftegazovaya vertikal*. Available at: [https://ngv.ru/news/lukoil\\_stimuliruet\\_top\\_menedzhment\\_snizhat\\_vybrosy\\_so2/?ysclid=lul10om2476387233](https://ngv.ru/news/lukoil_stimuliruet_top_menedzhment_snizhat_vybrosy_so2/?ysclid=lul10om2476387233) (accessed: 01.04.2024).
- Rosneft and CNPC become partners in low-carbon development. *Izvestiya*. Available at: <https://iz.ru/1286726/2022-02-04/rosneft-i-cnpc-stali-partnerami-v-sfere-nizkouglerodnogo-razvitiia> (accessed: 01.04.2024).
- Digitization gathers pace at Gazprom. *CDU TEK*. Available at: [https://www.cdu.ru/tek\\_russia/issue/2023/9/1183/?ysclid=lul12kuxar198178527](https://www.cdu.ru/tek_russia/issue/2023/9/1183/?ysclid=lul12kuxar198178527) (accessed: 01.04.2024).
- Gazpromneft: Low-carbon and high-benefit agenda. *Elitetrader*. Available at: <https://elitetrader.ru/index.php?newsid=586047> (accessed: 01.04.2024).
- Fetisov V., Gonopolsky A. M., Zemenkova M. Y. et al. On the integration of CO<sub>2</sub> capture technologies for an oil refinery. *Energies*. 2023. Vol. 16, Iss. 2. ID. 865.
- Fedorov A. E., Povalyaev A. A., Dilmukhametov I. R., Khamitov A. E. State registration of computer program, Certificate No. 2021611821 RF: Program Module of Decision-Making Support in Low-Permeable Reservoir Drilling in RN-KIN Corporate Software Package. No. 2021610761. Applied: 27.01.2021. Published: 08.02.2021.
- Lukoil—Sustainable Development. Available at: <https://lukoil.ru/Sustainability/?ysclid=lul15s8mn7961546998> (accessed: 01.04.2024).
- Novak A. Russian Gas is Four Times Cleaner than American Gas. Oil and Gas Information Agency. Available at: <https://clk.ru/3FtCNx> (accessed: 01.04.2024).
- Zhao Beiwen. The Complex Dilemma of Global Climate Governance and China's Programme Facing the New Situation. *World Economy Studies*. 2022. No. 08:3-9+135. Available at: [https://www.igcu.pku.edu.cn/\\_local/4/62/B0/DE6D393FA65DF43BF843ED1981\\_E59DCDE5\\_1A4B8DC.pdf](https://www.igcu.pku.edu.cn/_local/4/62/B0/DE6D393FA65DF43BF843ED1981_E59DCDE5_1A4B8DC.pdf)
- Lossan A. Foreign investors to build solar stations and windmills in Russia. *Rossiyskaya Gazeta*. Available at: <https://rg.ru/2017/02/26/zarubezhnye-investory-postroi-at-v-rossii-solnechnye-stancii-i-vetriaki.html> (accessed: 01.04.2024).
- Avramenko A. A., Baiguskarova A. R. PRC and Russia cooperation in the sphere of use of renewable energy sources. *Evraziyskiy soyuz uchenykh*. 2018. No. 4-6 (49). pp. 4–6.
- Is there the future for the coal industry? In pursuit of technological breakthrough. *Science and Technology*. Available at: <http://uk42.ru/index.php?id=11931> (accessed: 06.04.2024). 