

ICEST 2020

International Conference on Economic and Social Trends for Sustainability of Modern Society

INNOVATIONS AND ENVIRONMENTAL ENGINEERING IN THE ENERGY SECTOR: MODERN MANAGEMENT EXPERIENCE

M. A. Vlasova (a), E. E. Kononova (b)*, L. A. Terekhova (c), E. I. Alekhin (d)

*Corresponding author

(a) Orel State University named after I.S. Turgenev, ul.Komsomolskaya, 95, Orel, Russia, docent-ostu@yandex.ru

(b) Orel State University named after I.S. Turgenev, ul.Komsomolskaya, 95, Orel, Russia, len.kononova@yandex.ru

(c) Orel State University named after I.S. Turgenev, ul.Komsomolskaya, 95, Orel, Russia, lterekhova@mail.ru

(d) Orel State University named after I.S. Turgenev, ul.Komsomolskaya, 95, Orel, Russia, e.alekhin@mail.ru

Abstract

In the context of modern economy, there are many global problems that humanity faces daily, one of which is the transition to clean and affordable energy. This problem arose a long time ago, but a particular relevance was acquired at the beginning of the XXI century. The Russian energy sector has only recently started practicing the use of clean alternative energy. Russians generally have little effective experience in implementation of ecological innovations and engineering. The following article presents the results of the research that generalizes the experience of ecological engineering and the implementation of innovations in enterprises of energy sector. The authors presented the features of environmental engineering as a modern trend in the energy sector. A comparative analysis of environmental innovations spread in the field of energy in Russia and abroad is undertaken. The results of the analysis indicate a slow growth rate of clean energy in Russia and the need for environmental engineering and innovation introducing in the energy industry. Authors bring to your attention the best Russian ecological management experience of local companies ROSATOM and RusHydro, the experience of foreign company ENGIE was studied as well. It was discovered that it is possible to use geothermal energy as there is approximately 15 times as much of it in the country opposed to coal. The study will promote the dissemination of the experience in management of implementation of ecological innovations and engineering in enterprises of Russian energy sector.

2357-1330 © 2020 Published by European Publisher.

Keywords: Innovations, environmental engineering, energy sector, management.



This is an Open Access article distributed under the terms of the Creative Commons Attribution-Noncommercial 4.0 Unported License, permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

1. Introduction

With the beginning of the new century, the building period of world economic systems based on fossil fuels and a raw material model of the economy ends. In recent years, in foreign countries there has been a transition to environmental innovation and the desire to form green economy associated with the use of clean and climate-friendly fuels.

Environmental engineering is used as an effective mechanism for maintaining the ecological balance and environmental problems control.

It is widely believed that environmental engineering is advisable only in the field of environmental management and resource conservation, but the scope of its application is much wider.

Environmental engineering is actively used in industry with the aim of developing and introducing new systems and production technologies that reduce the negative impact on the environment by reducing harmful emissions into the atmosphere, improving the environmental friendliness, safety of products and services and ecological urban planning.

The formation of green economy leads to the need to develop mechanisms for introducing environmental innovations into the practice of Russian management, where foreign experience in using renewable energy sources in energy sector is especially important.

Renewable energy sources are energy flows extracted from inexhaustible sources. They can exist continuously or alternately, depending on the cyclical nature of the processes.

2. Problem Statement

Management of implementation of ecological innovations and engineering into the energy sector rises a number of issues of theoretical and practical content.

The analysis of publications allows us to note that the studies are not yet systemic and comprehensive. The issue of the practical large-scale use of environmental innovations in the energy sector has not been sufficiently studied, so the topic is interesting and promising for future research. In particular:

- The role of ecological engineering and innovations in the development of energy sector;
- Uneven distribution of alternative power engineering around the globe.

We shall consider each problem below.

2.1. The role of ecological engineering and innovations in the development of energy sector

Russian scientists are conducting research in this area. Arefyeva (2018) notes the role of environmental innovations in ensuring sustainable development of regional entities in the Russian Federation. Lyapina et al. (2019) consider the use of eco-innovation as one of the main elements in the formation of green economy. Aldieri et al. (2019) note the role of environmental innovation in productivity growth in Russian regions. Despite the relevance of introducing environmental innovations and eco engineering, this problem in the energy sector remains unsolved at a broad level.

2.2. Uneven distribution of alternative energy sector around the globe

Over the past decade, wind and solar energy have increased by more than 20 and 400 times, respectively. The state policy of many countries supports the development of ecology in the energy sector. Such countries as the USA, China, Great Britain, Denmark, Germany, Iceland, Uruguay and Costa Rica are leaders in the production and use of clean energy.

Ye et al. (2018) did the research related to the wind energy sector of China. Won (2018) analyze the possibility of optimization of Energy Supply System in Japan. Researchers Xuewei et al. (2018) study problems of Wind Power and Energy Storage Combined Generation System.

Research results of Chikunov et al. (2018) indicate that there is an improvement in the economic indicators of the Russian energy system based on the development of alternative energy sources. Implementation of the best experience is one of the highest priorities of development of alternative energy sector.

3. Research Questions

In course of the study the following questions were raised:

- What is the role of economical engineering in energy sector management?
- To what extent alternative energy sector has been developed in the world?
- What is Russia's experience with ecological management in energy sector?
- What is an example of successful experience in use of clean energy?

4. Purpose of the Study

Supposedly, the answers to the issues raised above will help achieve the goal and contribute to the development of recommendations on the management of implementation of ecological innovations and engineering in enterprises in energy sector.

5. Research Methods

Authors used the universal scientific research methods as well as methods for comparative and statistical analysis.

5.1. Environmental engineering as a modern trend in energy management

Environmental engineering is a set of measures related to the introduction of environmentally efficient technologies in the business processes of energy companies to reduce negative environmental impacts.

Environmental engineering is a special eco engineering activity aimed at rethinking and fundamental rearrangement of production processes using environmental innovations to reduce the negative impact on the environment and maintain the ecological balance.

Environmental engineering helps to assess the impact of production on the environment and provide a techno-economical feasibility study for a set of measures for environmental management modernization and environmental redesign of production and production technologies in the energy sector.

It is safe to say that environmental engineering is a modern and effective mechanism for preserving and restoring the ecology in Russia, helping to reduce the negative impact of production activities on the environment.

Danilovich (2018) suggests that environmental engineering in the energy sector is aimed at improving the safety and environmental friendliness of the provided services, the use of non-waste and low-waste technologies, the introduction of alternative sources of energy supply, the prudent use of resources, and the reduction of negative environmental impacts.

The stage of identifying business processes in the energy sector consists in determining the strategic goals of environmental engineering, business processes that require improvement, and at this stage, the resources necessary for the engineering are identified.

The results of environmental engineering in the energy sector are:

- A high degree of environmental diversification of various activities.
- Growth in investment in fixed assets related to environmentally friendly production
- Implementation of environmental innovation projects aimed at modernizing key business processes;
- Expanding corporate social responsibility of business in the field of improving business processes.

Research results of Bereznev et al. (2018) state the importance of determining of regional ecological index in Russia. According to the environmental ranking of countries, which is compiled by Yale Center for Environmental Law & Policy, in 2018 Russia ranks 52nd in terms of ecology and natural resources management. The position taken in the ranking indicates that the country needs to take measures to improve the state of the environment and the viability of its ecological systems. Salnikova et al. (2019) conclude that innovative projects in the field of renewable energy demand for wider implementation.

At Russian enterprises, environmental engineering is an integral part of environmental remodelling. This issue is especially relevant for regions that carry out the extensive and exhaustive character of production.

Researchers Denissova et al. (2019) note that international experience in the development of green economy defines the realization of ecological engineering in Russian enterprises.

Since the introduction of environmental engineering is gaining great popularity, special companies start to appear that provide such services to enterprises in various fields of activity.

5.2. Alternative Energy Development Analysis

The aim of the study was to conduct the environmental innovations spread comparative analysis in the energy field in Russia and abroad.

The reason for environmental innovations necessity in the energy sector is the strong negative impact of nuclear power plants and thermal power plants on the environment, the functioning of which are based on non-renewable energy sources. Renewable energy sources include the energy of sunlight, the energy of wind flows, the energy of water flows, geothermal energy, and biological energy.

The experience of Europe confirms that the United States has significant latent energy-saving potential. Europeans spend on average 30% less energy per unit of gross national product than the United States.

Many European countries introduce tax incentives and schemes to stimulate investment in equipment that reduces energy consumption. Tax exemptions apply to combined heat and power plants, boiler, electric and lighting equipment. An example of the implementation of such tax schemes is the Netherlands.

Let us turn to world statistics and present data on the use of various energy sources in the world for 2019 (figure 01).

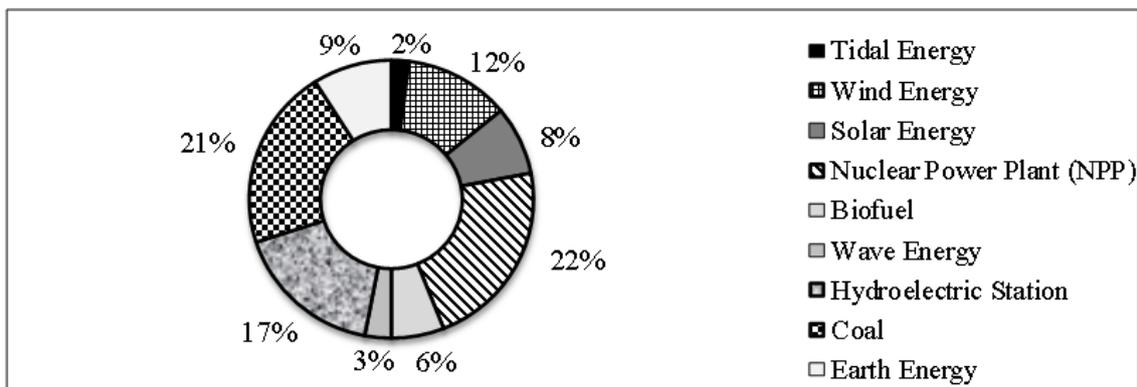


Figure 01. Distribution of various energy sources use in the global space according to 2019 data (%)
 Source: (Federal State Statistic Service, 2019)

The largest part, about 45% of the total, is nuclear power plants and thermal power plants. One can notice a positive trend in the spread of the use of wind energy (about 12%), which suggests that many countries are striving to make the transition to alternative environmentally friendly sources of energy.

In Russia for the period from 2015 to 2018, there is an increase in electricity consumption from an average of 1 050 000 to 1 100 000 billion kW / h, therefore, an increase in the need for its production (Federal State Statistic Service, 2019). In view of this, in our country, the problem of clean energy is especially relevant. Nevertheless, is there any development in this sphere and how dynamic is it?

According to Russian Federal State Statistic Service (2019) data, only less than 10% of the used energy sources are renewable. The main share (about 75%) falls on such energy sources as oil and gas, and the remainder part is coal. Researchers associate such indicators with the country's resource availability, its geographic and geological features.

In the period from 2012 to 2018, the dynamics of changes in the share of energy resources produced using renewable energy sources in the total amount of energy resources changed significantly, starting from 15.5% in 2012 to 17.4% in 2018. For the period from 2015 to 2018, there was a slight increase in the use of renewable energy sources. This once again proves that the transition to clean energy production in Russia is proceeding at a slow pace.

6. Findings

6.1. Russian management experience in ecological engineering of energy sector

After the comparative analysis of the energy sector development, it is important to understand how dynamically the experience of introducing environmental innovations in this sector of the Russian economy is being conducted, what the features of its implementation are and what the problems of management are. The leaders of generating companies in Russia are ROSATOM and RusHydro companies.

ROSATOM (2020) is one of the largest enterprises in the electric power industry and cooperates with more than 45 countries of the world. ROSATOM's mission is «to maintain national interests in defence, nuclear safety and nuclear power by achieving global leadership in advanced technologies, competencies and innovations». Since 2016, ROSATOM began to use wind energy which had a tremendous impact on the development of wind energy in Russia.

The company carries out many projects in the framework of supporting and developing a comfortable urban environment. Among them, the project «Pure Water» can be singled out, which is aimed at providing the population with high-quality and safe water resources. The programme includes the purification of water resources used at nuclear power plants, as well as water bodies adjacent to nuclear power plants.

RusHydro (2020) is a leader in the use of renewable energy sources in Russia. The company is currently implementing several large state projects to popularize the use of wind, solar, water flows and geothermal sources.

The environmental policy of the company is developed taking into account the sustainable development goals of the UN.

The location of the company's power plants, which use different types of renewable energy sources, is geographically diverse:

- Geothermal energy – the Kamchatka Peninsula;
- Wind energy – the Kamchatka Territory, Sakhalin Oblast, Yamalo-Nenets Autonomous Okrug, Yakutia;
- Energy of small rivers - Siberian and the Far Eastern Federal Districts, the North Caucasus;
- Wave and tidal energy (water's mass movement in channels, as well as tidal motion) - Moscow, Arkhangelsk, Yaroslavl, Murmansk regions, Tugur Bay, the Sea of Okhotsk, Mezensky Bay, the White Sea;
- Solar energy - Yakutia.

The programme for purification of wastewater used for industrial purposes is being implemented (figure 02). Most of the water, after being used in production, goes through the stages of treatment and becomes environmentally friendly. The organization also works to reduce emissions of harmful substances into the atmosphere.

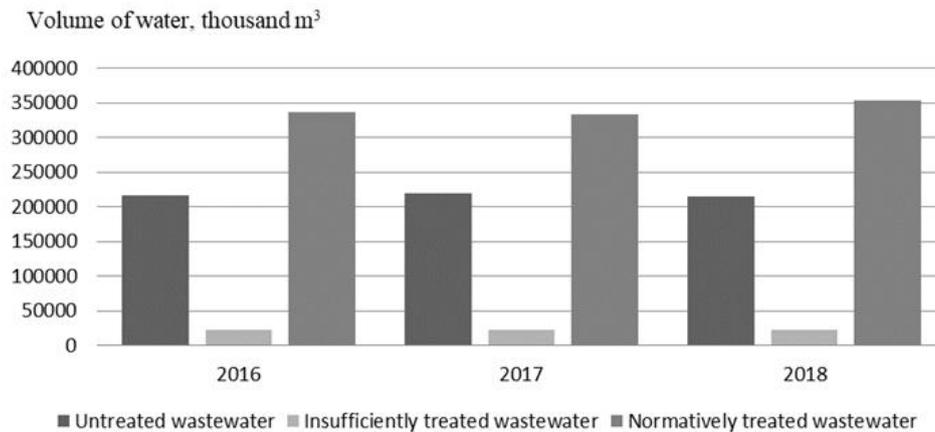


Figure 02. Distribution of various energy sources use in the global space according to 2019 data (%)

For the location of RusHydro stations based on renewable energy sources, the most promising regions are the Far East and Siberia. Now, it is also planned to build new facilities in the Karachay-Cherkess Republic, the Stavropol Territory and Kabardino-Balkaria.

6.2. The experience of using clean energy in other countries

Let us turn to the foreign experience of using clean energy. ENGIE is the largest leading French company specializing in the electric power industry. The Group operates in 20 countries where its branches are located. ENGIE uses second-generation renewable energy and pursues an environmental policy.

The company implements many joint projects with other countries in the field of offshore wind energy conversion. According to EWEA forecasts, in 2030 this type of green energy will reach 11.3% of the total European energy resources. Abramovskiy et al. (2019) mention the increase of importance of electric energy industry as of renewable 'clean' source of energy in different countries.

Earlier, we mentioned geothermal energy sources, but did not consider its production from water. Such a geothermal station is located in Paris on the Seine River. However, ENGIE stepped forward and decided to use not the fresh, but the salty water of the Mediterranean Sea. So, in Marseilles appeared a power plant that uses the temperature difference between the upper and deep-sea layers.

The use of biomass and biogas as an energy source not only solves the issues of electricity supply, but also allows the company to cooperate with agro-industrial complexes and farms, supporting them and processing organic waste.

After receiving clean energy, production waste is an excellent substitute for chemical fertilizers. Compared to organic ones, after each kilogram is applied to the soil, they emit 7 kg of CO₂ into the atmosphere.

Consider what types of clean energy sources this company uses and what their uniqueness (table 01) is. In the electric power industry, ENGIE uses not only the types of renewable sources of the second generation that we have examined. It has a wide network of solar power stations, land wind stations, wave power stations. Of course, the company also uses non-renewable sources, but its mission and vision are aimed at the transition to clean energy and the preservation of the environment.

Table 01. 2nd generation renewable energies used by ENGIE

Type of energy source	Source characteristic
Offshore wind energy	The company installs wind turbines in the sea at a distance of 20 km from land. They are 2 times more effective than turbines located on land, because the wind in the open sea is more stable and stronger than the continental one.
Geothermal energy (including marine one)	Stations built on geothermal sources emit CO ₂ into the environment 10 times less than thermal power plants. Special government programmes support the idea of popularizing geothermal sources.
Biomass	For several years, ENGIE carried out unique projects to use various types of biomass except wood for clean energy. At the moment, the company produces energy from the seeds and pulp of olives, coffee grounds, plant debris and sewage sludge.
Biogas	The company carries out anaerobic transformation of organic, household, agricultural waste, which allows to obtain clean energy without greenhouse gas emissions. Waste from energy production is used as organic fertilizer, which reduces the share of chemical fertilizers.
Hydrogen	ENGIE invests in the production of hydrogen from renewable sources and its use, as its use contributes to decarbonisation of production processes, to obtain environmentally friendly automotive fuel.

7. Conclusion

The study indicates the promising outlook of practical implementation of large-scale environmental reengineering in order to use alternative energy technologies.

A feature of environmental engineering is that it allows not only to upgrade production processes at certain representing enterprises, but also to distribute the results to other industries. The main activities of organizations in the field of environmental engineering are: the creation of environmentally friendly industries, the introduction of a closed-loop economy, environmental protection, environmental control and monitoring.

In Europe and Russia, wind energy is the most competitive clean energy. The market for this energy is expected to grow by 20% each year. Moreover, this has a positive impact not only on the environment, but also on many factors of social life. For example, over the past 10 years, more than 70,000 jobs have been created in Europe through the development of wind energy.

It is important to note one unique geographical feature of Russia: it is among small number of countries, which have the ability to use the heat derived within the sub-surface of the earth. Moreover, according to experts, the reserves of geothermal energy sources in our country are about 15 times more than coal. This is the least developed energy area in Russia, but it has great potential and development prospects. There is also a map of geothermal resources, according to which the most advantageous location of the stations is Kamchatka and the entire Far East, the Stavropol Territory and the Caucasus, as well as partially the Krasnodar Territory.

Within Russia, it is possible to produce clean and relatively affordable energy. There are all necessary conditions for this, but development, support of the state, large corporations, organizations, influential public figures and investors is required.

Now, new enterprises for the production of solar cells are opening in Russia, which helps to promote the idea of renewable energy sources. The transition to renewable sources will help preserve the

environment and prevent the energy crisis. According to experts, by 2040 the share of global clean energy will be about 50%. The transition to 100% indicators will be possible only in the countries of Northern Europe.

On the territory of Russia, it is advantageous to have stations based on renewable energy. In this case, it is necessary to study the maps of wind speed and solar insolation distribution in order to obtain the minimum time intervals between cycles of occurring phenomena at the output. It is also necessary to study the geographical features of the area in order to minimize the cost of building and operating the station.

References

- Abramovskiy, A. L., Shalin, V. V., & Shestakov, S. A. (2019). Wind energy development policy as a type of alternative renewable energy sources. *Journal of Environmental Management and Tourism*, 10-5(37), 947-955.
- Aldieri, L., Paolo Vinci, C., & Kotsemir, M. (2019). Environmental innovations and productivity: empirical evidence from Russian regions, *Resources Policy*, 101444.
- Arefyeva, N. Y. (2018). The role of environmental innovations in ensuring sustainable development of regional entities in the Russian Federation. *EurAsian Journal of BioSciences*, 12, 263-269.
- Bereznev, S., Zonova, O., & Kulpina, E. (2018). Environmental performance index: regional aspect, *E3S Web of Conferences*, 41, 02-03.
- Chikunov, S. O., Gutsunuk, O. N., Ivleva, M. I., Elyakova, I. D., Nikolaeva, I. V., & Maramygin, M. S. (2018). Improving the economic performance of russia's energy system based on the development of alternative energy sources. *International Journal of Energy Economics and Policy*, 8, 382-391.
- Danilovich, P. A. (2018). Energy saving, alternative sources of energy, energy security. *International Journal of Mechanical Engineering and Technology*, 9, 405-412.
- Denissova, O., Kozlova, M., Rakhimberdinova, M., Varavin, Y., & Ordabayeva, M. (2019). International experience in the development of green economy. *Journal of Environmental Management and Tourism*, 9-3(27), 564-575.
- Federal State Statistic Service (2019). The share of energy resources produced using renewable energy sources in the total amount of energy resources. <https://www.gks.ru/>
- Lyapina, I. R., Skobliakova, I. V., Vlasova, M. A., Lukyanchikova, T. L., & Kononova E. E. (2019). Ecological innovations in Russia: peculiarities and mechanisms of realization. *Advances in Intelligent Systems and Computing*, 726, 748-757.
- ROSATOM (2020). company official website: <https://www.rosatom.ru/>
- RusHydro (2020). Official website. <http://www.rushydro.ru/>
- Salnikova, A. A., Slavjanov, A. S., Khrustalev, E. Y., & Khrustalev, O. E. (2019). Environmental effects evaluation of innovative renewable energy projects. *Journal of Environmental Management and Tourism*, 10- 1(33), 100-108.
- Won, A. (2018). Survey on the Operation of the District Energy Supply System in Japan According to Secular Change. *IOP Conf. Ser.: Earth Environ. Sci.*, 192, 012054.
- Xuewei, G., Man, X., Linlin, W., Hui, L., & Siqing, S. (2018) Review on Target Tracking of Wind Power and Energy Storage Combined Generation System. *IOP Conf. Ser.: Earth Environ. Sci.*, 192, 012053.
- Ye, L., Shao, L. Z., Wang, H. B., Liu, Y. F., Zhang, J. Q., & Yao, J. G. (2018) Quantitative model of peak regulation cost caused by wind power generation. *IOP Conf. Ser.: Earth Environ. Sci.*, 188, 012001.