

INNOVATION MANAGEMENT IN THE ENERGY SECTOR: DOMESTIC AND FOREIGN EXPERIENCE

Viktoriia V. Sulym¹, Anastasiia Ya. Pushkar², Ihor I. Rekunenko³

In the global economy, as well as the economy of each country, transformational processes aimed at its intensive development are being activated. According to the model of intensive economic development, it is provided mainly by those components related to competition, innovation and human potential. Strong internal competition encourages enterprises to ensure their own advantages in the competitive market, create a new market outside of it or a new segment in the competitive market. The basis of such processes are innovative changes (innovations). World studies confirm that the innovative activity of enterprises and the conditions created for this by states contribute to the growth of countries' competitiveness. In the 21st century, humanity is constantly striving to discover renewable sources of energy, as well as find new ways to effectively use existing resources. Innovation in the energy sector is increasingly shaped by the need to meet growing demand while reducing emissions. To withstand disruption, energy companies must stay ahead of the curve and overcome increasingly volatile business challenges. To meet the growing demands of today's industrial world, innovation in the energy sector must overcome many significant challenges. Most importantly, it is important to effectively use renewable energy sources such as solar and wind to reduce carbon emissions in a way that is sustainable and cost-effective. Today we are witnessing a situation where the role of innovation and innovative development is becoming increasingly important in creating jobs, sustainable technologies, improving living standards and maintaining the European Union's competitive advantage. Innovation is a key pillar of technological and industrial policy, which is essential in bringing new ideas to market. Innovation is an important driver of a nation's development and economic growth, so it's no wonder that countries sometimes struggle in their efforts to boost it.

Keywords: energy sector, development drivers, innovation management, innovation transfer, innovation management system.

JEL Classification: O17, P24, P44

Introduction. At the beginning of the 21st century, the business world is dynamic and complex, and competition is globalized. As a result of the globalization of knowledge, the shortening of the innovation cycle and the aggravation of the price situation, the spread of innovations in various industries has accelerated.

Today, governments and corporations recognize innovation as a key factor in economic development and business growth. Innovation is not limited to the development of new products, but also includes the development of new services and business practices. Therefore, an essential component of innovation management is establishing the advantage of differentiation with the client and finding ways of interaction with various stakeholders to make these advantages sustainable and long-lasting [1].

The basis of innovation and technology management is the creation of monitoring system technologies that allow timely prediction of technological changes within the competitive environment of an enterprise or organization, which at the same time can expand opportunities for new business development or eliminate risks for existing enterprises [2]. The most difficult step in the development and implementation of new technologies in energy will be the launch of these technologies in extremely complex and competitive markets of a huge scale. Therefore, any program of state support for innovation in these

technologies should be organized around the problem on the way to their introduction to the market.

The analysis of the recent literature. Leading scientists such as V. V. Ivanova [3], T. I. Shchedrina [4], W. Bijker, T. Hughes, T. Pinch [5] and others studied the issue of introducing innovations in the energy sector.

However, in our opinion, a comparative analysis of the features of the introduction of innovations in the energy sector of Ukraine and the countries of the European Union deserves special attention.

The problem statement. Given the significant role of the energy sector and use of energy resources for any state, it is necessary to develop effective mechanisms for regulating the issue of their effective use and preservation of the natural environment. Therefore, the role of innovative technologies in the functioning of this sector is of particular importance. In the countries of the European Union, a number of innovative approaches to the use of energy resources and their frugal consumption have been developed and implemented. Ukraine is on the way to applying such innovations in the energy sector. In our opinion, there is a need to analyze and implement innovations in the energy sector, as well as to find effective tools for their management.

Research results. Despite the existence of a generally accepted idea that the level of innovation development in the EU is quite high, it is uneven, because less developed EU countries have a lower level of innovation efficiency.

¹ Viktoriia V. Sulym, C.Sc. (Economics), Assistant, Oleg Balatskyi Department of Management, Sumy State University

² Anastasiia Ya. Pushkar, Student, Oleg Balatskyi Department of Management, Sumy State University

³ Ihor I. Rekunenko, D.Sc. (Economics), Professor, Head of Oleg Balatskyi Department of Management, Sumy State University

The identification and analysis of different clusters of innovative activity within the EU can intensify efforts aimed at mitigating these differences as barriers to sustainable development. The creation of the Innovation Union has become one of the seven flagship initiatives of Europe in 2020 for a smart, sustainable and inclusive economy. The innovation union is an aspiration to eliminate innovation barriers, restore public and private cooperation and scientific developments. Ultimately, the Innovation Union is the foundation of a single European innovation market with the aim of attracting even more enterprises and firms. To achieve this goal, the EU uses various measures in such areas as patent protection, standardization, and public procurement. Emphasis is placed on private sector investment and increased venture capital investment [6]. However, due to different countries, not all EU members managed to achieve the same level of innovation efficiency. Therefore, it is necessary to research and compare the level of innovation activity throughout the European Union in order to have additional insight into the innovation potential of each country and its role in small and medium-sized businesses.

We will conduct a brief overview of countries with the highest and lowest levels of innovative activity in various industries. According to Eurostat, Romania is the country with the lowest level of innovation use in enterprises (enterprises with 10–49 employees: 11.5%; 50–249 employees: 15%; 250+: 26.9%). The highest proportion of large (250+ employees) innovative enterprises was found in Germany (93.9%), Austria (89.3%) and Lithuania (87.7%). The lowest proportions were found in large innovative enterprises in Romania (26.9%), Slovakia (54.7%) and Hungary (55.1%). The largest share of innovative medium-sized enterprises (50–249 employees) was found in Germany (75.5%), Austria (74.5%) and Belgium (74.2%). The lowest share was found in medium-sized innovative enterprises in Romania (15%), Poland (35%) and Hungary (35.9%). The largest share of innovative small enterprises (10–49 employees) was found in Luxembourg (63.1%), Germany (62.9%) and Belgium (59.4%), and the smallest – in Romania (11.5%), Poland (15.7%) and Bulgaria (20.6%) [7].

Tables 1 and 2 show the results of the cluster analysis taking into account the size of the enterprise and the level of innovative activity.

The results of the analysis indicate that the countries are mainly differentiated according to innovative activity in small ($F = 45.7$) and medium-sized enterprises ($F = 85.8$). The least discriminatory was innovative activity at large enterprises ($F = 21.0$). Table 2 shows the final result.

Table 1 – Analysis of the dependence of the innovation level on the enterprise size

Enterprise size	F test
10–49 employees	45.7
50–249 employees	85.8
250+ employees	21.0

According to the values of the cluster centers, we see that the first cluster of countries has the highest innovation indicators, including 6 countries: Belgium, Germany, Ireland, France, Luxembourg and Austria. Large enterprises have the largest share of innovative enterprises (86.9%), followed by medium (72.35%) and small (58.12%) enterprises.

The second cluster includes countries with the lowest level of innovation, including 6 countries: Bulgaria, Estonia, Latvia, Hungary, Poland and Slovakia (large enterprises: 62.4%, medium enterprises: 38.1%, small enterprises: 21.5%).

The third cluster is a group with an average level of innovativeness of enterprises, consisting of 15 countries: the Czech Republic, Croatia, Cyprus, Denmark, Finland, Greece, Italy, Lithuania, Malta, the Netherlands, Portugal, Slovenia, Sweden, Great Britain and Spain (large enterprises: 78.6%, medium enterprises: 61.6%, small enterprises: 43.6%). The biggest lag in countries with a low level of innovative activity occurs in the segment of small and medium-sized businesses, in particular, in enterprises with less than 50 employees. This can be explained by the low level of allocation of funds for the development and implementation of innovative activities in this segment or the complete lack of funding for this line of activity.

The results of the cluster analysis show that not all countries of the European Union achieve the same level of innovation productivity. Denmark, Italy, Finland, Greece, the Netherlands, Spain, Sweden in some cases are not an example of the highest level of development of innovative activity. Therefore, some countries deviated relatively more from the average level of innovative activity in the designated cluster. Thus, the variations cannot be attributed exclusively to the development of a specific country, it is necessary to additionally investigate the specifics of the development of innovative activity in each country separately. Taking into account the level of development of innovative activities and the number of enterprises that introduce and effectively use innovations in their activities, the countries of the European Union can be divided into 3 clusters: countries with low, medium and high level of implementation and use of innovative activities. At the same time, neither EU membership nor the country's level

Table 2 – Final cluster centers

Enterprise size	Enterprises with a high level of innovative activity, %	Enterprises with a low level of innovative activity, %	Enterprises with an average level of innovative activity, %
10–49 employees	58.1	21.5	43.6
50–249 employees	72.3	38.1	61.6
250+ employees	86.9	62.4	78.6

of development are key factors influencing the development of innovative activity in individual countries.

The results of additional research in this area can help to develop an effective policy for a specific country in order to further increase the efficiency of the use of innovations. The policy should be aimed at improving the efficiency of the use of available resources. Market mechanisms open up great potential in achieving the desired goals, and their failure is a consequence of the inability to meet market demands. The EU has already introduced a number of measures to overcome existing obstacles. However, some countries should continue to develop national policies, potentially resolving certain inconsistencies in their countries. Likewise, policies that increase EU convergence may become the basis of the EU's long-term competitiveness. Future research can focus on specific countries, identifying existing systemic barriers.

In today's Europe, there is an innovation gap that separates it from global competitors. Although the European research base is strong and produces excellent scientific results, the rather low level of use of these research results hinders the development of innovative activities in many industries. This is especially true for projects financed by the state and, as a rule, do not commercialize their results. With the rapid growth of the European renewable energy industry, which increased its annual turnover tenfold from €1.5 billion to €163 billion between 1990 and 2020, it cannot be denied that innovation is successfully developing on a large scale: the renewable sector energy industry mainly includes technology-oriented small and medium-sized enterprises, most of which did not exist 20 years ago.

We offer four main tools for stimulating the development of innovations:

- 1) Stimulate utility enterprises to promote the implementation of innovations with the help of fiscal benefits;
- 2) Creation of mixed financing for startups and inclusive public-private partnerships for financing innovations;
- 3) Access to the market of decentralized resources and provision of services;
- 4) Promoting educational initiatives and thought leadership to change consumer behavior.

The three main drivers of innovation in the energy sector are digitalisation, decentralization and decarbonisation. End-to-end digitization of the enterprise value chain will facilitate the implementation of systems that provide both decentralization and decarbonization. Priority will be given to smart technologies that have a significant impact in the short term and ensure the sustainability of new technological solutions in the long term. For example, implementing a system that increases network capacity and systems that connect more renewable energy sources, eliminating technical risks. In addition, the use of systems that ensure consideration of consumer demand, which will solve the problems of balancing demand and supply for energy resources provided by renewable energy sources.

Today, Ukraine is represented in numerous international ratings, in particular those that are formed as a result of the assessment of innovative activity and technological competitiveness of the economies of countries. The importance of the results obtained as a result of the ranking according to such international ratings consists in the study and comparison of numerous indicators, which provides a complete "picture" of the innovative development of the country's economy and allows determining its place among the countries of the world.

The figure below shows the analysis of Ukraine in the field of innovation according to various international ratings.

As a result of the analysis of the Ukraine positions in international ratings regarding the assessment of innovative activity and technological competitiveness of the countries' economies, we made the following conclusions:

1) In general, Ukraine is characterized by high positions in the ratings when determining the majority of indices for the quality of research institutions and the production of innovations, the level of human capital development, indicators of knowledge creation, costs for computer support, export and implementation of information and communication technology services, the ratio of patents and utility models relative to GDP at purchasing power parity. At the same time, today there is a certain decrease in the country's position in most of the ratings, which is

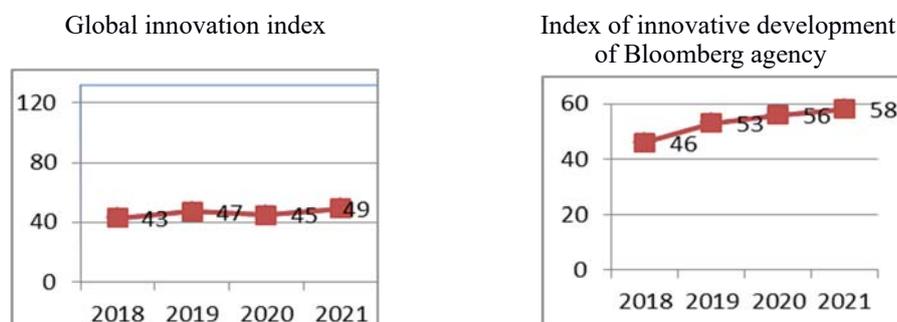


Figure 1 – Analysis of the positions of Ukraine in international rankings regarding innovative activity for the period 2018–2021

Source: developed by the authors on the basis of [8]

associated with a decrease in the level of financing of education and science in relation to GDP, the number of researchers and the specific weight of innovative enterprises in the total number of business structures. There has been a significant deterioration in the indicators of attracting and retaining talent, and the ability to retain qualified personnel. So, there is a significant weakening of Ukraine's positions in those areas that tend to be considered the country's strengths.

2) Ukraine is characterized by fairly high rates of growth in the efficiency of the innovative activities implementation. This is evidenced by the country's position in the ranking according to the Innovation Efficiency Index, which is calculated based on the ratio of the Innovation Output Index and the Innovation Input Index using indicators similar to those used when calculating the Global Innovation Index [9].

3) The weak points of Ukraine are the state of the political and regulatory environment, the level of development of the business environment and the access of enterprises to financing, which is characterized by an extremely negative impact on the development of innovative activity in the economy and contributes to the "conservation" of the technological structure of the times of the second industrial revolution.

In general, the state of innovative activity in Ukraine can be defined as one that does not correspond to the level of innovative processes in developed countries. Among other things, this state is influenced by the extremely uneven development of innovative activity in the regions, which is connected with the specialization and different structure of their economy.

It is believed that such a cluster approach, which was described above, is the key to the effective implementation of innovative activities in the energy sector of European countries, and it will be able to ensure the same successful innovation policy in energy and in Ukraine. Since the cluster approach ensures the creation of special incentives, the distribution of authorities and resources, in addition, it will increase the availability of knowledge and information, providing individual enterprises with certain advantages. In 2008, the Cabinet of Ministers of Ukraine recognized the need to implement a cluster approach in the country. This project was called "Concepts for the creation of clusters in Ukraine", but such a concept was not adopted and the types of energy sector clusters were not defined.

The cluster approach in Ukraine can be implemented using the basic management functions. If we take into account such a management function as planning, then this process will be carried out through the development of industry plans, goals and indicators that directly support the implementation of strategic goals, the application and compliance with general standards and recommendations. As for the function of the organization, for this it is necessary to ensure the effective combination of physical, financial and human resources and the development of productive relations between them to achieve cluster goals. This can also include the division of responsibilities between energy companies and the creation of responsibility and delegation of authority if necessary. The motivation function in the implementation of the cluster approach includes sufficient financial stimulation of employees in energy enterprises, a favorable working environment, possible benefits and most importantly – safety of working conditions. The control function will ensure monitoring and reporting on activities and needs, measuring progress against the cluster strategy and agreed deliverables and recommending and corrective action as necessary.

The application of the principles of the cluster system in the energy activity of Ukraine will allow the use of new innovative methods and methods of industrial use of state or local energy resources to meet the energy needs of the country or region. The main principle of the cluster approach should be the principle of energy self-sufficiency, according to which the structures of the cluster will be formed depending on the potential and power of the local energy sector (this means the presence or possibility of introducing renewable energy sources or fossil fuels), this will make it possible to ensure the development of the energy sector based on structural rationalization [10].

Conclusions. Summarizing the material presented above, it should be said that the development and formation of Ukraine's innovation policy, in particular in its energy sector, requires the formulation of a complete concept and long-term plans for its development in innovations and innovative activities. The "business-science-state" scheme can help to increase the innovative activity of enterprises in the energy sector of Ukraine. Our cluster approach, which will be able to ensure the effect of synergy in the interaction and work of the three subjects of its creation, will be the foundation of the formation of such a future new policy and will allow rational use of the state's energy potential.

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УПРАВЛІННЯ ІННОВАЦІЯМИ В ЕНЕРГЕТИЧНОМУ СЕКТОРІ: ВІТЧИЗНЯНИЙ ТА ЗАРУБІЖНИЙ ДОСВІД

Вікторія Василівна Сулим¹, Анастасія Яківна Пушкар², Ігор Іванович Рекуненко³

У світовій економіці, як і економіці кожної країни, активізуються трансформаційні процеси, що спрямовані на її інтенсивний розвиток. Згідно моделі інтенсивного розвитку економіки, він забезпечується переважно тими складовими, які пов'язані з конкуренцією, інноваціями та людським потенціалом. Сильна внутрішня конкуренція спонукає підприємства до забезпечення власних переваг на конкурентному ринку, створення нового ринку поза його межами або нового сегменту на конкурентному ринку. Основою таких процесів є інноваційні зміни (інновації). Світові дослідження підтверджують, що інноваційна активність підприємств та умови, створені для цього державами, сприяють зростанню конкурентоспроможності країн. У 21 столітті людство постійно прагне відкривати відновлювані джерела енергії, а також знаходить нові способи ефективного використання вже наявних ресурсів. Інновації в енергетичному секторі все більше формуються потребою задовольнити зростаючий попит при зменшенні викидів. Щоб протистояти зривам, енергетичні компанії повинні залишатися попереду всіх і долати все більш нестабільні проблеми бізнесу. Щоб задовольнити зростаючі вимоги сучасного індустріального світу, інновації в енергетичному секторі повинні подолати багато значних проблем. Найважливіше те, що важливо ефективно використовувати відновлювані джерела енергії, такі як сонце та вітер, для зменшення викидів вуглекислого газу таким чином, який є стійким і економічно ефективним. Сьогодні ми спостерігаємо ситуацію, коли роль інновацій та інноваційного розвитку стає все більш важливою при формуванні робочих місць, стійких технологій, підвищення рівня життя та збереження конкурентних переваг Європейського Союзу. Інновації є ключовою опорою технологічної та промислової політики, яка необхідна в донесенні нових ідей на ринок. Інноваційна діяльність – це важлива рушійна сила розвитку держави та її економічного зростання, тому не дивно, що країни іноді ведуть боротьбу у своїх зусиллях підвищити його.

Ключові слова: енергетичний сектор, драйвери розвитку, інноваційний менеджмент, трансфер інновацій, система управління інноваціями.

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¹ Сулим Вікторія Василівна, кандидат економічних наук, асистент кафедри управління імені Олега Балацького Сумського державного університету, e-mail: v.kubatko@biem.sumdu.edu.ua

² Пушкар Анастасія Яківна, студентка Сумського державного університету

³ Рекуненко Ігор Іванович, доктор економічних наук, професор, завідувач кафедри управління імені Олега Балацького Сумського державного університету, e-mail: i.rekunenکو@biem.sumdu.edu.ua