Timchenko, Oleksandr; Nebrat, Viktorija Vasylivna; Lir, Victor et al.

Article

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***Oleksandr Timchenko*[1]**
***Victorija Nebrat*[2]**
***Victor Liehr*[3]**
***Oleksandr Bykonia*[4]**
***Yurij Dubas*[5]**

ORGANIZATIONAL AND ECONOMIC DETERMINANTS OF DIGITAL ENERGY DEVELOPMENT IN UKRAINE

This article concerns digitalization of the energy industry in Ukraine. The authors review the evolutionary aspect of the gradual convergence of ITC and energy technologies and identify the key features and trends in digital transformation of Ukrainian economy. The international experience and the emerging global cooperation in energy digitalization are analyzed. Overall, the energy digitization is discovered to be a universal trend among the most prominent economies despite different prerequisites, interests, and factors concerned. It is shown that the progress in the formation of the intelligent energy supply systems depends on a number of factors. Unique features of specific subtasks that arise during digital transformation of energy industry are analyzed.

The article proposes consideration of the technological platform as a business model for digital development of infrastructure industries. The authors analyze the European experience in the formation and development of technology platforms as a basic tool for implementing innovation policy, economic growth of strategically important industries and technological development of the European Union countries. The potential and role of technological platforms in the process of digitalization of energy are determined. A structure of technological platform suited for the formation and development of the intelligent energy system in Ukraine is proposed. The main tasks and priorities of functioning of the domestic technological platform in the process of digitalization of domestic energy are determined. An organizational and economic mechanism for the formation of the intellectual energy system of Ukraine is developed.

Key words: *digital energy, technological convergence, smart energy systems, ICT, technological platforms*

1 **Timchenko, Oleksandr –** PhD in Economics, Leading Researcher, Digital Economy Sector, State Institution "Institute for Economics and Forecasting, NAS of Ukraine" (26, Panasa Myrnoho St., Kyiv, 01011, Ukraine), timchenko1952@gmail.com

2 **Nebrat, Victorija Vasylivna** – Doctor of Economics, Head, Department of Economic History, State Institution "Institute for Economics and Forecasting, NAS of Ukraine" (26, Panasa Myrnoho St., Kyiv, 01011, Ukraine), victoria_nebrat@ukr.net, https://orcid.org/0000-0002-5419-3181

3 **Lir,Victor Erikhovych** – PhD in Economics, Leading Researcher, Sector of Sectoral Markets, State Institution "Institute for Economics and Forecasting, NAS of Ukraine" (26, Panasa Myrnoho St., Kyiv, 01011, Ukraine), liehr@ukr.net

4 **Bykonia, Oleksandr Serhijovych** – Researcher, Sector of Sectoral Markets, State Institution "Institute for Economics and Forecasting, NAS of Ukraine" (26, Panasa Myrnoho St., Kyiv, 01011, Ukraine), alexbikonya@ukr.net

5 **Dubas, Yurij –** Junior Researcher, Digital Economy Sector, State Institution "**In**stitute for Economics and Forecasting, NAS of Ukraine" (26, Panasa Myrnoho St., Kyiv, 01011, Ukraine), yuriy.v.dubas@gmail.com

In modern Ukraine, politicians and general public usually reduce the problem of digital transformation to the provision of administrative services. In contrast, the leading countries of the world that embrace the innovative technologies of the so-called "Industry 4.0" perceive digitalization as a strategic method for improving competitiveness of economy in the age of globalization [1]. The unique features of the information and communication technology (ICT) make its intensive implementation especially productive for the network structures of economy: communications and media, electricity and gas supply, or transport infrastructure. Meanwhile, effectiveness of infrastructure and security of critical objects are among the most important determinants of economic efficiency and competitiveness of the domestic economy as a whole.

The problems of electrical power grid and its development have traditionally been the focus of scientific research. The role of digital technologies in the innovative transformation of the Ukrainian economy have become the subject of a thorough study conducted by the Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine [2–5]. One of the key economic objectives of Ukraine is implementation of a sustainable energy policy while allowing for an acceptable level of energy security [6]. A number of articles highlight the strategic importance of developed electricity market due to the impact of internal and external challenges [7–10]. Scientific and practical approaches to solving the problems of digital transformation of Ukrainian economy are analyzed in depth in a monograph that conveys the research conducted at the Institute of Industrial Economics of the NAS of Ukraine [11]. The authors, in particular, highlighted the major stages of the digital revolution, described the threats and opportunities that ICT offers to economy and society. The main direction for optimization of power systems functioning at the micro and macro levels is the automation of their management [12, 13]. Under current conditions, energy management is developing towards the transition to digital technologies, formation of intelligent infrastructure and smart networks construction. In particular, the researchers address the peculiarities of the structure and the operation, and the basic functions and characteristics of the automated system of electricity metering with the control of quality indicators [14]. The main provisions of the modern Smart Grid concept and features of the implementation of the concept of "smart efficiency" are defined, as well as policies for the implementation of the concept of Smart Grid in the leading countries. The inquiries also focus on the features of Smart Grid evolution, perspective forms and directions of development of Smart Grid technologies, and their implementation in Ukraine [15].

Creation of technological platforms is similarly a notable topic in the scientific literature about the current mechanisms of economic development and, in particular, electricity supply as one of its basic components [16]. Scientists have addressed this issue in the context of bioenergy development prospects [17] and EU experience in maintaining sectoral innovation and regional development [18–20]. Thus, the introduction of a digital energy technology platform requires scientific justification and appropriate institutional support.

The digital energy is currently branching into a separate research topic because of the need to develop an organizational and economic mechanism to implement an industry-specific policy of digital transformation of Ukraine in the field of energy management and energy efficiency. The purpose of the article is to determine the

preconditions, opportunities, problems, and organizational and economic mechanisms of digital energy development in Ukraine while taking into account the international experience and the progress of Ukraine's integration into the world economy.

This topic is often associated with the three big Ds, that is, the key innovative trends in energy development: decarbonization (reducing carbon emissions), decentralization (development of networks instead of more centralized infrastructure), and digitalization (implementation of digital technologies). The progress in creating digital energy of the future is closely linked to the implementation of these trends in Ukrainian energy systems.

In general, energy digitalization is progressing quickly all over the world and is outpacing many other economy sectors. The high level of competition for the energy resources in global markets contributes to a steady increase in high technology investments and use of advanced digital equipment, both to improve performance and to achieve a higher level of energy efficiency. Moreover, energy efficiency as a factor of economic development is already undermining traditional energy sources. In 2013, in its "Energy Efficiency" reports, the International Energy Agency (IEA) raised the status of energy efficiency from "hidden reserve" to " number one source". Similarly, the World Energy Outlook and Energy Technology Perspectives report shows that about 40% of future energy needs should actually be met by improving energy efficiency.

On the other hand, the Energy Strategy of Ukraine for the period until 2035 (the Strategy), which was approved in August 2017, does not even mention the transition to digital energy as a development goal. In the Strategy, even in the sections on development of the most advanced electricity technologies, there is no clear definition of distributed generation networks that are based on active energy consumers who can act as its producers and collectors. Managing such systems with many thousands of participants to optimize the parameters of its operation and increase the efficiency of electricity use is one of the main tasks of electric-power industry in the world. Also, the Strategy does not even consider the prospect of creating smart grids or the Internet of Energy in Ukraine, which completely changes the paradigm of energy development by making it customer-oriented with connections to the power grid becoming trivial anywhere.

Overall, the creation and operation of distributed electricity systems can be a very important target niche for the use of innovative digital technologies in electric power industry. Internationally the separate sectors of digital transformations are: Distributed Generation; Demand Response; Energy Efficiency Management; Microgrids; and Distributed Energy Resources Management (DERM).

However, none of these areas is identified in the Strategy as priorities for the industry's development. The Strategy does not provide any recommendations for the target niches of digitalization in other sectors of the energy industry. Neither does it identify ICT as a powerful factor in the development of energy networks in Ukraine. This situation shows the lack of purposeful state policy for digitalization of the national energy system.

One of the important niches for the digital technologies in the gas industry is to provide real-time monitoring of the technical status of the gas transmission system (GTS), and to optimize its operation in a stationary sensor system, and to conduct regular observations using unmanned aerial vehicles (UAVs). For processing very

large arrays of relevant information, the Big Data and cloud computing is used widely.

International experience in oil and gas production shows that the ICT could provide a notable contribution to the development of the companies that employ it and the industry as a whole. Overall, the potential advantages of the diligent use of ICT in the fossil fuel sector are associated with the following four specific applications.

First, particular attention could be given to artificial intelligence and the robotization of extraction process. Robotization not only could increase production capacity, but also significantly reduces the risks for operators who would be able to operate the work from outside without being in dangerous production areas.

Second, cloud computing could be used to process large volumes of primary information from sensors and to build the management systems to use this data to full extent.

Third, the process of retrieving information from the sensors, aggregating it, exchanging between individual devices of the system and providing it with operational access could only be possible through the Internet of Things (IoT). It will be able to provide a clear picture of what is happening in any production company in the sectors of production, transportation and processing of gas or oil.

Fourth, the use of artificial intelligence in mining process allows the prediction and assessment of the risks of equipment failure even before it actually happens. A smart control system aided with advance technologies like 3D printing could be able to repair the equipment immediately without the operator's involvement.

The mentioned target niches for digital transformation in the gas and oil sectors remain relevant for the coal industry as well. Moreover, a special niche for 3D printing in coal mining might be using robots to build mining supports just after the actual excavation [21].

Most of the digital technologies that are promising for the energy sector involve the use of a wide variety of digital sensors in wireless exchange systems. In the recent years, a considerable success in designing and creating multi-component systems for collecting information was achieved and such systems have recently become widely used. With the use of microprocessors and wireless networks, such as Wi-Fi, the problem of creating and operating sophisticated cyber-physical systems for an aggressive and desolate environments has largely been solved. There is a current experience in the development and practical implementation of such systems in Ukraine, as well as substantive research for the manufacturing of various digital sensors [22]. A significant contribution to the development of this sector of digital economy was made directly in the process of implementation of the State Target Scientific and Technical Program for the Development and Creation of Sensory Science-Intensive Products for 2008–2017, approved by Resolution of the Cabinet of Ministers of Ukraine No 1395 of 5 December 2007. Unfortunately, by allotting a small amount of public funding for this program and refusing to continue it afterwards, little is done to meet the growing level of needs of the Ukrainian economy for relevant digital components.

Another technological problem of accelerating digital transformation in the energy sector, the need for continuous monitoring of technological equipment in the absence of personnel, significantly hinders the use of sensor devices or detectors

in real-life production and yet remains to be solved wide-scale. A prerequisite for this is powering sensor devices or detectors with high-capacity batteries or using renewable sources at the installation site. The main method to solve this problem is to increase the energy efficiency of such devices by minimizing their consumption of electricity, and a considerable progress has been achieved recently to deal with the problem globally.

The development of Smart Grid in the energy supply systems is considered by the developed countries as a priority for economic growth, as these technologies lay a solid foundation for the domestic competitiveness in the future. The volume of investments directed by industrialized countries in the development of Smart Grid is highly significant (Fig. 1). This trend includes the developing countries as the leader of the energy digitalization is China, which has announced a course to expand the use of renewable energy sources (RES).

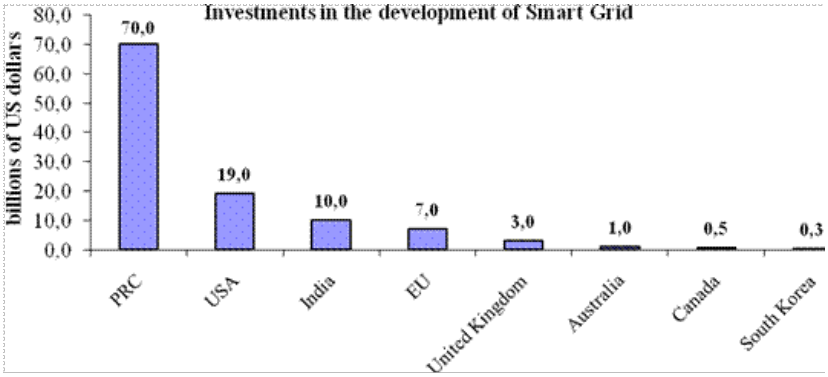

Fig. 1. The planned total investments in the creation of smart energy networks around the world.

Source: according to data from [23].

Given the simultaneous interest of the leading countries in the development of Smart Grid by the initiative of International Energy Agency and Clean Energy Ministerial, a global forum on sustainable energy, the International Smart Grid Action Network (ISGAN), was created in 2011. It is primarily a technical program aimed at accelerating progress in addressing key aspects of energy policy, technology and the development of smart grid standards through voluntary government participation in specific projects and programs. It coordinates international efforts within a number of working groups on the core issues of implementing and evaluating Smart Grid, as well as provides technical assistance and grant funding [24].

At the same time, the schedule and the specific forms of digitalization are driven by the specific features of energy policy and the current structure of energy supply in different countries.

China's energy policy is primarily driven by improving the efficiency and controllability of energy infrastructure to ensure rapid economic development. China rapidly deploys state-of-the-art digital technologies, most notably in the infrastructure sectors, including power industry. The rapid development of the Chinese economy requires developing of a uniquely powerful energy grid and the optimization of its

operation, particularly considering the dynamics between Southern and Northern areas of the country. Moreover, there is an interest in renewable energy, which in turn leads to active bilateral cooperation between the People's Republic of China (PRC) and the EU in the transfer of the most prominent energy-saving technologies. A key element of digital energy in China is development of a network of digital substations using this country's vast manufacturing capacity [25].

In the United States, where less attention has been traditionally paid to environmental impact and carbon footprint, and the grid management is not hampered by the development of renewable energy, the main motive for implementing smart grids is the country's energy independence and concerns about grid reliability in a deregulated energy market with minimal government participation. After the catastrophic power outage in 2003 that affected 55 million people in eight states and most of Canada [26], the government began to make significant efforts to improve the country's power system, which led to the legislative backing of intelligent networks in 2007 [27]. Currently, founds invested by the US energy companies into the Smart Grid projects account for about 3,5% of total investment in energy infrastructure, and its amount is expected to triple by 2024 [28].

In the EU, the need for energy digitalization is driven primarily by sustainable development policy, which is based on the low-carbon paradigm of energy supply systems, as well as the process of liberalization and the integration of national energy markets to form a single European market space. Accordingly, the main EU digitalization measures are implemented within the framework of energy efficiency initiatives [29] (in particular, to optimize consumption and improve energy efficiency) and a number of norms in the field of energy market integration [30]. At the same time, the widespread introduction of renewable energy sources for energy efficiency contributes to the unique challenges in the field of energy grid integration, which requires new intelligent grid management systems and load schedule adjustment. In the face of these challenges, the reliability and security of the functioning of the EU's energy supply systems depends on the creation of a European technology platform for Smart Grid.

The liberalization of electricity and natural gas markets along with the wider use of renewable energy sources is accompanied by emergence of new decentralized electric grid architecture. In these circumstances, improving the operating mode control of powerful traditional power plants and introducing new generators with unstable electricity production schedules is necessary. Therefore, the problem of creating an actively adaptive power grid requires introducing a system to accurately measure energy flows in real time. In the case of electricity meters, where not only the use but also the generation of energy by individual consumers is permitted, the meters are subject to additional requirements: operators must ensure that the meter can account for electricity generated by the end consumer. Additionally, electricity consumption and production data must be available to the consumers or to a third party acting on their behalf to easily compare the fees.

Consistent energy policy requires clear action to modernize the energy system due to the specific national interests and technological features at the state level (the need to improve energy efficiency, and the reliability of the energy grid in terms of its fragmentation or to ensure rapid economic growth) in a more effective international coordination with regard to energy trends in the partner countries. All these factors

create a powerful and universal motive for digitalization of the domestic energy grid.

Technology platforms (TPs) in EU countries are among the most practical options to develop the modern infrastructure. They ensure the priority of innovative technologies and decisions in the development of the territories and industries. The primary objective of creating technology platforms was to identify and develop narrow industries and specific areas according to the EU priorities by funding the research directly related to practical implementation. Despite focusing on commercially significant results and production needs, and maintaining close connections with the private sector, TPs in the energy sector are primarily subordinated to the goals of sustainable social development.

The organizational structure and financing of technology platforms in the EU countries make it possible to speak of the technology platform as a business model. After all, the TPs in Europe have been created on a cost-sharing basis by combining the intellectual and financial resources of the EU and the largest industrial producers to enhance scientific research (in energy sector, specifically, to optimize energy generation, distribution and consumption). TPs are generally initiated by big business, industry associations or industrial producers, whose representatives form so-called High Level Groups.

The main purposes of creating TPs in the European Union include promoting the goals and objectives of the said TP in the European Community and EU structures; developing a Strategic Research Agenda, the main document outlining the characteristics of the research conducted within the platform; and drafting out the Implementation Plan or the Deployment Strategy. The TPs in the EU have been used for almost 20 years so far, and the improved European Technology and Innovation Platforms (ETIPs) are the modern representation of their mechanics.

Technology platforms open up opportunities to bring together key stakeholders and ensure dialogue and collaboration between society and business; promote investment in scientific and technological development; and mobilize and direct the available intellectual and financial resources to the R&D, promoting a more efficient approach to innovation. Moreover, it encourages coordination of European and national research programs and contributes to the economic growth of the member states. In the EU, technology platforms have become the basic tool for implementing innovation policy, the indicators of economic growth for strategic industries, and the practical method to pursue technological development goals [31]. Overall, TPs can be seen as an indirect indicator of the effectiveness of state innovation policy, because through the formation and provision of a technological platform, national priorities in the innovative development of industry-specific directions are implemented.

In Ukraine, clusters and technology platforms are considered a promising mechanism for innovative development. Their application should be based on a combination of national and regional interests and priorities, taking into account the imperatives of sustainable and innovative development. A technological cluster is traditionally associated with a particular geographical location, so it is largely a product of regional policy, whereas a technology platform has a certain specialization and follows national industrial policy [16].

The potential benefits of technology platforms for energy digitalization are driven by the fact that they represents a set of resources and production technologies

that determine the domestic distribution of generating capacities and control systems, specific features of safety mechanisms, and rules of interaction with electrical networks. Actually, a technology platform combines innovative production capacity and scientific coordination, and incorporates human capital into the process as well.

Technology platforms in the energy industry could affect not only the nature of competitive interaction in the energy market, but also increase the sustainability of the energy system in general, allow for new technological solutions, and combine various organizational and economic, production and technological forms of innovative energy industry via its digitalization. Technology platform is effectively a partnership, an agreement between business, scientific establishments and authorities on joint research, and development and implementation of technical initiatives that require a synthesis of ICTs and regulatory measures of public policy.

If the European practice is adapted, the Ukrainian intellectual energy system (IES) should be developed as a technology platform. The purpose of TP IES of Ukraine could be as follows: 1) to create a format for interaction of all participants in the energy sector, identify priority directions of technological modernization and increase its efficiency; 2) to concentrate research and development funding on priority areas for innovative energy development; 3) to attract additional (non-state) resources to the innovation sphere; 4) to select breakthrough technologies and implement them; 5) to create markets of Smart Grid technologies; and 6) to provide new types of services in the market for digital accounting of electricity, heat and energy resources [32].

The main goals of the technological platform "Intelligent Energy and Power Systems" should be taking into account the key problems of domestic energy system. These purposes are twofold:

1. The implementation of innovative smart technologies in the Ukrainian energy sector to ensure an innovative breakthrough in the energy sector of the Ukrainian economy, a sharp increase in the efficiency, and reliability and security of its infrastructure.

2. Indirect results of the said implementation: reducing the risk of system crashes; increasing maintenance efficiency and technological stability; improving cost-effectiveness of generation through "flexible" controls and greater efficiency of equipment; attracting non-traditional renewable energy sources to the energy balance; reducing transportation losses by optimizing supply patterns and managing consumer demand; reducing commercial losses during generation, supply, distribution and sale through the improvement of management systems and more differential payment systems; increasing the electric networks capacity by introducing more active network elements and compensation of reactive power; reducing the energy expenditures of budget organizations, housing and communal services; increasing the resistance to natural and man-made disasters; improving the quality of electricity and ensuring optimal levels of electromagnetic compatibility; reducing the negative impact on the environment; enhancing the competitiveness of the economy by improving its energy efficiency and reducing tariffs; and prolonging the effective use of productive assets over the full life cycle.

The main tactical elements of creating the TP IES should be: forming a strategic vision of the implementation of the concept of intellectual energy systems in Ukraine; determining the basic requirements and functional properties of national

energy on the basis of the concept of intellectual energy systems and principles of their implementation; defining the basic directions of the development of all energy system elements, such as generation, transmission and distribution, consumption, and management; identifying key components, technologies, information and management solutions in all the above mentioned areas; and ensuring modernization coordination (bridging the technological gap) and innovative development of the domestic energy sector.

According to the tasks considered, it is possible to propose a technology platform structure that reflects basic control elements and working groups according to the directions. To coordinate and manage the work of TP, the following governing elements should be established: a supervisory board, a coordinator, a secretariat, and a unit for the interaction with central executive authorities (Fig. 2).

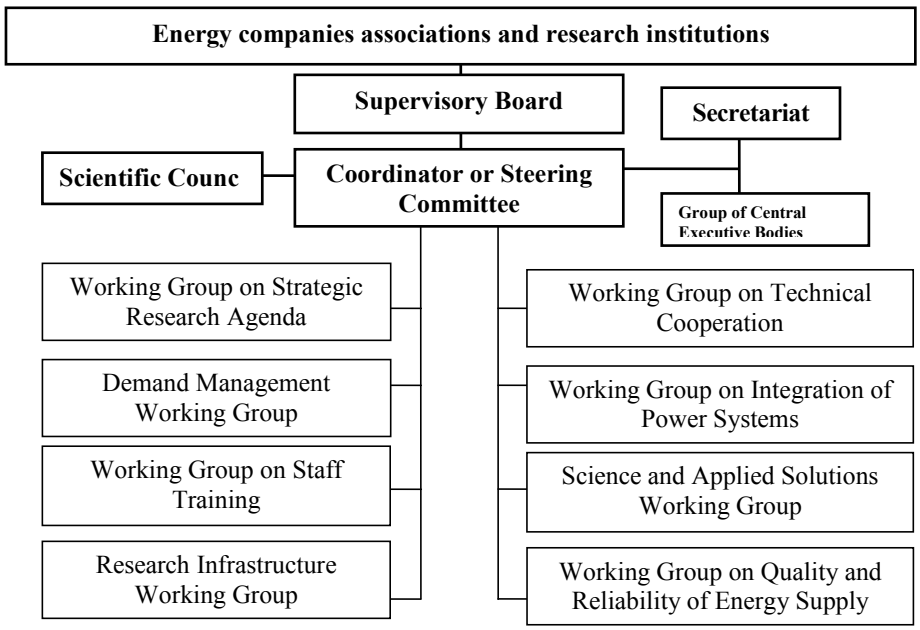

Fig. 2. The structure of TP "Intellectual Energy System of Ukraine"
Source: authors' development.

The short-term goals of the platform should be: documents on strategic vision and a road map for the implementation of intelligent energy systems concept in Ukraine; a list of competitive technologies and equipment to install; long-term visions for equipment and technology, and prevention of technological failures; programs for research and development, technology transfer and production localization; a program for developing standards in the ICT for electric-power industry; and a program for specialized capacity building.

The technology platform functioning requires the development of appropriate legal and regulatory support at both national and regional levels. The Cabinet of Ministers of Ukraine should initiate its creation. Afterwards, the strategic level must be presented to the relevant central executive bodies, since the process is related to the integration of networks and technologies. Therefore, strategic development should be addressed by such authorities as the Ministry of Energy and Environment Protection of Ukraine; Ministry for Development of Economy, Trade and Agriculture

of Ukraine; Ministry of Infrastructure of Ukraine; and Ministry of Education and Science of Ukraine. Additionally, certain regulatory bodies should be included for direct cooperation: National Commission for State Regulation of Energy and Public Utilities of Ukraine and the National Commission for State Regulation in Communications and Informatization. As the networks of different purposes are integrated, participation in the process of the State Agency on Energy Efficiency and Energy Saving of Ukraine is necessary. To coordinate and achieve better coherence, an interagency commission should be set up.

According to the set objectives and conceptual principles of energy development, the technology platform should also improve the interaction between business and scientific institutions, and in the longer term also improve the efficiency and competitiveness of production. Technology platforms will also become a communication mechanism between the state, business, science and education, and will develop priorities for innovative development of relevant industries through the formation of a state support system within strategic programs.

In the context of the longer-term integration, not only Ukrainian, but also an international technological platform should be created, which would significantly stimulate the development of international cooperation and involvement of the leading world scientific centers in the development of the national innovation industry through the expanded exchange of knowledge and technologies [33].

The analysis of the world experience in the implementation of technological projects shows the growing importance of technology platforms in the formation and implementation of innovative public policy. Technology platforms are becoming a powerful tool for government and industry-specific support for innovation [34]. On the other hand, initiating technology platform still requires solving a number of problems, including legal ones.

Currently, the procedure for creating a technology platform is not well-defined in Ukrainian legal system. To form a technology platform approved by the central executive body, the tasks and principles of forming technology platforms should be specified. There is also a mention of the mandatory coordinating organization that provides organizational and informational support for the interaction of technology platform participants. Thus, it is difficult to determine the real legal entity that operates the technological platform, as well as the legal form of the technological platform in general.

In our opinion, to create a unified and effective mechanism for managing a technology platform, its members need to create a partnership. In this case, the most convenient form is the organizational and legal form of non-profit organization, as it can combine both commercial and non-profit organizations.

First, it is necessary to regulate the organizational and legal form of creating a technology platform, which will clearly define the rights and obligations of its participants, as well as their share of the technology platform and responsibility for the results. Secondly, the creation of a technology platform must have a strong administrative support from the government so their coordinators should be either state institutions or government-owned entities. It is advisable for ministries to develop appropriate methodological materials for drawing up a plan for the participation of a state-owned joint stock company or a state-owned enterprise that implements the program of digital energy innovative development for the medium and long term

prospects. At the same time, it is necessary to promote an extensive representation of private business.

Encouraging private business participation in the technology platform can only be done by guaranteeing benefits of two types. First, it is the opportunity to implement the innovations developed and tested by the technology platform. Second, it is the reduced taxation granted to active participants in the technology platform, as provided by law. In this regard, it is assumed that the main benefits for the economy as a whole and for participants in such platforms will be related to supporting innovation, improving regulation, providing the conditions for the creation and diffusion of advanced technologies, and the formation of new scientific and industrial complexes. Thus, defining and regulating the mechanisms for stimulating the participation of private capital in the future technology platform is one of the most important priorities.

Conclusions

International experience in energy industry shows that digitalization of energy infrastructure is a universal and powerful trend, although it is driven by very dissimilar economic motives in different countries. Digitalization is a key way to meet a number of critical energy needs: improving energy efficiency and environmental friendliness of the national economy, ensuring the reliability of the energy grid given its growing complexity, and providing additional energy required for more aggressive modernization of the economy. Therefore, it is one of the most important modern trends in the development of the largest energy systems in the world and a subject of wide international cooperation.

The characteristics of the energy industry show a clear need for digitalization of the energy system, motivated both by the global trends in energy market integration, and by the unique domestic features of the network: a large proportion of nuclear power, excess generating capacity, maneuverability deficit, deficit of energy storage, and poor interregional delivery capacity. The Ministry of Energy and Coal Industry of Ukraine is suggested to include digital energy into the strategic priorities listed in the Energy Strategy of Ukraine for the period until 2035.

To prioritize the implementation of such promising and narrow digital transformation, energy industry should be recognized among the most prepared for a digital transition. In the gas sector, due to a recent significant increase in gas tariffs, investment funds can potentially be used to implement a digital metering system in gas production and consumption. In fact, the solution to the problems of digitalization in the gas extraction is still expected beyond the end of this decade at least and will perhaps be postponed even to the next decade. Substantial digitalization in the oil and coal industries due to a number of factors is also unlikely at the moment.

To make effective use of scarce investment opportunities, it is appropriate to allocate specific niches where digitalization can provide the greatest and fastest effect. In the electric power industry, such priority areas include issues related to the creation of smart grids for optimal control of distributed generation. In the gas industry, it is advisable to introduce artificial intelligence systems to improve the unmanned extraction technologies with the local use of 3D printing.

A promising institutional mechanism for the digitalization of domestic electricity industry is the formation of a domestic technology platform (TP). International

experience has already demonstrated the potential results of TP in securing smart energy management and digital development of infrastructure industries. To implement TP as a business model of innovative development of digital energy, it is necessary to create a domestic regulatory framework for stakeholder interaction and coordination of their activities; to identify the directions, mechanisms of research and sources of supply for the main components; to organize operational management of certain tasks and the mechanics of scientific, organizational and financial support of the technological platform operation by the state and non-governmental bodies; and to ensure an inclusive and positive balance between socially relevant goals and commercial projects.

Thus, it is appropriate and necessary to adopt a legal act that would stipulate the general principles of the technology platform, as well as its functions, goals and objectives. In the absence of clearly defined conditions for the TPs and their responsibility for the failure to achieve goals, this organization form is not yet a generally available legal entity, nor it is attractive for private businesses. To address these issues, a number of well-coordinated measures are necessary to effectively create this mechanism, which may further contribute to the implementation of advanced technologies in the energy industry.

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Тімченко, Олександр Миколайович
канд. екон. наук, провідний науковий співробітник відділу цифрової економіки ДУ "Інститут економіки та прогнозування НАН України"
вул. Панаса Мирного, 26, Київ, 01011
timchenko1952@gmail.com

Небрат, Вікторія Василівна
д-р екон. наук, завідувачка відділу економічної історії
ДУ "Інститут економіки та прогнозування НАН України"
вул. Панаса Мирного, 26, Київ, 01011
victoria_nebrat@ukr.net
https://orcid.org/0000-0002-5419-3181

Лір, Віктор Еріхович
канд. екон. наук, провідний науковий співробітник сектору галузевих ринків ДУ «Інститут економіки та прогнозування НАН України»
вул. Панаса Мирного, 26, Київ, 01011
liehr@ukr.net

Биконя, Олександр Сергійович
науковий співробітник сектору галузевих ринків ДУ «Інститут економіки та прогнозування НАН України»
вул. Панаса Мирного, 26, Київ, 01011
alexbikonya@ukr.net

Дубас Ю. В.
молодший науковий співробітник сектору цифрової економіки ДУ «Інститут економіки та прогнозування НАН України»
вул. Панаса Мирного, 26, Київ, 01011
yuriy.v.dubas@gmail.com

ОРГАНІЗАЦІЙНО-ЕКОНОМІЧНІ ДЕТЕРМІНАНТИ РОЗВИТКУ ЦИФРОВОЇ ЕНЕРГЕТИКИ В УКРАЇНІ

Проаналізовано існуючі національні практики та досвід міжнародного співробітництва у сфері цифровізації енергетики. Визначено, що цифровізація енергетики є сучасною тенденцією розвитку енергетичних систем провідних країн світу, хоч передумови, чинники та мотиви її реалізації можуть значно різнитися залежно від національних особливостей. Доведено, що прогрес у формуванні інтелектуальної системи енергозабезпечення національного господарства залежить від низки факторів організаційно-економічного характеру. Проведено секторальний аналіз особливостей процесу цифрових трансформацій у вирішенні окремих завдань розвитку енергетики країни. Визначено необхідність впровадження нового механізму ефективного розвитку перспективних галузей економіки. Проаналізовано європейський досвід формування та розвитку технологічних платформ як базового інструменту реалізації інноваційної політики, економічного зростання стратегічно важливих галузей та технологічного розвитку країн Європейського Союзу. Запропоновано розглядати технологічну платформу як бізнес-модель цифрового розвитку інфраструктурних галузей економіки, зокрема цифровізації енергетичної інфраструктури.

Розроблено структуру та представлені можливості технологічної платформи впровадження інтелектуальної енергетичної системи в Україні. Надано пропозиції щодо реалізації концепції інтелектуальної енергетичної мережі в рамках цифрової трансформації економіки України.

Ключові слова: цифрова енергетика, конвергенція технологій, інтелектуальна енергетична система, інформаційно-комунікаційні технології, технологічна платформа

Тимченко, Александр Николаевич
канд. экон. наук, ведущий научный сотрудник сектора цифровой экономики ГУ «Институт экономики и прогнозирования НАН Украины»
ул. Панаса Мирного, 26, Киев, 01011
timchenko1952@gmail.com

Небрат, Виктория Васильевна
д-р экон. наук, заведующая отделом экономической истории ГУ «Институт экономики и прогнозирования НАН Украины»
ул. Панаса Мирного, 26, Киев, 01011
victoria_nebrat@ukr.net
https://orcid.org/0000-0002-5419-3181

Лир, Виктор Эрихович
канд. экон. наук, ведущий научный сотрудник сектора отраслевых рынков ГУ «Институт экономики и прогнозирования НАН Украины»
ул. Панаса Мирного, 26, Киев, 01011
liehr@ukr.net

Быконя, Александр Сергеевич
научный сотрудник сектора отраслевых рынков ГУ «Институт экономики и прогнозирования НАН Украины»
ул. Панаса Мирного, 26, Киев, 01011
alexbikonya@ukr.net

Дубас Ю. В.
младший научный сотрудник сектора цифровой экономики ГУ «Институт экономики и прогнозирования НАН Украины»
ул. Панаса Мирного, 26, Киев, 01011
yuriy.v.dubas@gmail.com

ОРГАНИЗАЦИОННО-ЭКОНОМИЧЕСКИЕ ДЕТЕРМИНАНТЫ РАЗВИТИЯ ЦИФРОВОЙ ЭНЕРГЕТИКИ В УКРАИНЕ

Проанализированы существующие национальные практики и опыт международного сотрудничества в сфере цифровизации энергетики. Определено, что цифровизация энергетики является современной тенденцией развития энергетических систем ведущих стран мира, хотя предпосылки, причины и мотивы ее реализации могут значительно различаться в зависимости от национальных особенностей. Доказано, что прогресс в формировании интеллектуальной системы энергообеспечения национального хозяйства зависит от

ряда факторов организационно-экономического характера. Проведен секторный анализ особенностей процесса цифровых преобразований в решении отдельных задач развития энергетики страны. Определена необходимость введения нового механизма эффективного развития перспективных отраслей экономики. Проанализирован европейский опыт формирования и развития технологических платформ как базового инструмента реализации инновационной политики, экономического роста стратегически важных отраслей и технологического развития стран Европейского Союза. Предложено рассматривать технологическую платформу как бизнес-модель цифрового развития инфраструктурных отраслей экономики, в частности цифровизации энергетической инфраструктуры. Разработана структура и представлены возможности технологической платформы введения интеллектуальной энергетической системы в Украине. Внесены предложения по реализации концепции интеллектуальной энергетической сети в рамках цифровой трансформации экономики Украины.

Ключевые слова: цифровая энергетика, конвергенция технологий, интеллектуальная энергетическая система, информационно-коммуникационные технологии, технологическая платформа