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| DIGITALIZATION OF THE ELECTRIC POWER INDUSTRY AS A FACTOR OF INTENSIVE DEVELOPMENT OF THE INDUSTRY | |
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| **ЦИФРОВИЗАЦИЯ ЭЛЕКТРОЭНЕРГЕТИКИ КАК ФАКТОР ИНТЕНСИВНОГО РАЗВИТИЯ ОТРАСЛИ** | |

*Abstract. The growing inefficiency of the traditional way of life in the electric power industry is becoming a limiting factor for the development of the country's economy. Digitalization is a current trend for improving the efficiency of industries, including energy. The article discusses the problems of digital transformation of this industry and possible ways to overcome the associated difficulties.*

*Keywords: energy transition, digitalization, fuel and energy complex*

*Аннотация. Растущая неэффективность традиционного уклада в сфере электроэнергетики становится сдерживающим фактором для развития экономики страны. Цифровизация – актуальная тенденция для повышения эффективности работы отраслей, включая энергетическую. В статье рассмотрена проблематика цифровой трансформации данной отрасли и возможные пути преодоления связанных с этим трудностей.*

*Ключевые слова: энергетический переход, цифровизация, топливно-энергетический комплекс*

**Problem statement.** Today, an investment increase in digital infrastructure and in the digitization market is observerd in the world. This trend is explained by the huge advantages offered by the introduction of digital technologies: reduced costs, increased efficiency of business processes, and as a result, increased competitiveness of companies.

**Analysis of previous research and publications.** Digitalization is called a fundamental part of the architecture of the fourth industrial revolution, the so-called «Industry 4.0». Already in 2017, the digitalization of the economy was included in the list of the main directions of strategic development of the Russian Federation until 2025. At the same time, in the summer of 2017, the government approved the «Digital economy» program, which implies both the transition to fundamentally different principles of interaction between subjects, and the development of Russian high-tech companies. Such authors as T. A. Mitrova, I. V. Danilin, R. M. Khaziakhmetov and others are engaged in digital transformation of industrial sectors, including energy.

**Purpose of research.** The purpose of the article is to study the process of digital transformation of the electric power sector as a factor of intensive development of the industry.

**Main results of the study.** Many countries are currently implementing scenarios of the so-called energy transition – a new technological structure in the electric power industry, which is facilitated by active automation of production processes, the development of digital technologies, etc. The energy transition paradigm is focused on the large-scale use of distributed renewable energy [1,2], the involvement of private investment and the formation of decentralized markets, the intellectualization of infrastructure and the transition of consumers to active Pro-consumer behaviors (table 1).

Table 1

The contents of the energy paradigms

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| **The current (dominant) energy paradigm** | **The coming energy paradigm** |
| Dominance of power sources based on hydrocarbon fuels | "Clean energy" of renewable energy sources.  Deep decentralization of energy production.  Growth of the role of electricity in the structure of fuel and energy resources consumption |
| Large vertically integrated energy companies with powerful power units, large deposits, and large processing plants | Decentralized markets, private investment |
| Centralized electrical networks | Intellectualization of basic infrastructure, development of smart grids technologies |
| Unidirectional flow of electricity – from the generator to the consumer | The transition of consumers to the active modelsbehavior (active consumer in the center  power system) |
| Simultaneous processes of electricity production and consumption | Energy storage technologies – energy as a "stored" commodity.  The increase in the efficiency of energy use |
| The widespread use of fossil fuels in industry and transport. | Deepening the electrification of industry and vehicle. |

A key factor of the necessity to digitalize the energy industry is the growing inefficiency of the domestic electricity sector, which leads to higher tariffs and prices for electricity for consumers. This can likely inhibit the development of the economy, a significant part of which is based on energy-intensive production. It is important for the fuel and energy complex in general and industry companies in particular to maintain their leading positions in global energy markets and enter new markets with high-tech products. In this regard, the task is to form their own competencies and the necessary technological base.

Digital transformation of the fuel and energy sector is not just the introduction of individual solutions , but a change in the technological structure, which entails a change in the entire business environment. According to experts, the first to take advantage of the opportunities of digital transformation will become a valuable supplier of innovative solutions and will gain an incomparable advantage over other players, including the international level.

For example, the development direction of the «Digital power» in Russia is included in the program «the Digital economy of the Russian Federation» and covers all key areas energy: oil and gas, coal industry and power industry. In the last one the departmental project «Digital transformation of the Russian electric power industry» is being developed. Industry strategic and forecast documents of the Russian Federation rely more on an evolutionary scenario for the development of the electric power industry, which largely preserves the environment familiar to the Russian fuel and energy sector with fairly high world prices and demand for energy resources, and in terms of technological policy sets a priority for ensuring the technological independence of the energy sector and sufficient competencies in all critical activities for sustainable energy development [3]. A more revolutionary scenario, focused on the transition to a new technological order, and the creation of technological prerequisites for it, is considered unlikely or relevant beyond the horizon of 2025.

At the same time the industry has formed an understanding that the implementation of the innovative scenario is necessary – not so much to meet global trends, but to reduce the risk of losing Russia's competitiveness in the emerging global markets for new electric power, as well as to solve some internal problems.

To increase efficiency through digitalization, it is necessary to learn how to use all the information that the power industry produces. According to estimates from the Ministry of energy of the Russian Federation, a thermal power plant produces about 2 terabytes of data, only 1-2% of which are structured and used. Digitalization should make these data available for analysis in order to apply better and faster management decisions based on them.

Digitalization of the electric power industry in contrast to other technological trends that support the traditional, extensive development of the industry, allows you to reduce significantly the pace of this development without compromising the reliability and cost of energy supply. In other words, we are talking about a transition to a new technological paradigm in the electric power industry, which represents the organization of energy supply in the retail sector as an ecosystem of energy producers and consumers who seamlessly integrate into the overall infrastructure and exchange energy. This approach is also called «Internet of Energy».

The result of this digital upgrade of the electric power industry should be a «smart» or intelligent energy system (IES). Representing a synthesis of electric power and information systems, the IES will have unique properties:

- minimum restrictions for integration through a common electric network and a common electric mode of any types of objects of production, storage and consumption of electricity, optimal use of available energy sources based on centralized and distributed generation;

- maximum observability of the state of the network and the system as a whole, flexibility (adaptability) of functioning and development, forecasting the state in conditions of high uncertainty of modes, changes in the technological and spatial structure of electricity production and consumption under the influence of technological and economic (market) factors;

- customer orientation, i.e. the priority of individual consumer requirements for efficiency , reliability and quality of energy supply , which implies taking into account their interests and behavioral strategies, active participation in market competition, the formation of flexible market demand for electricity, system and grid services.

Unlike previous approaches to the development of electric power transition smart grid is more efficient to start from the bottom, from the consumer and the local energy supply systems, creating a distributed cluster of new energy industry, new market environment in the industry. And the experience of the world's largest economies shows the success of such initiatives.

Intensive advances in the transition to digital, or rather, to intelligent electric power, which are carried out with the active support of the state in Europe, the United States, the BRICS countries, Japan, and Korea, leave a very narrow window of opportunity for implementing their unique national project in this area, creating appropriate technological competencies and ensuring their global competitiveness. The main outlines and technological directions of changes were included in the concept of implementation of the national project «Intelligent energy system of Russia», developed by the Ministry of energy of the Russian Federation in 2015. Probably as part of the strategy of transition to the digital economy these suggestions can and should receive a new sound and impetus for implementation, through the joint efforts of the state and leading industry corporate players.

An obstacle to the implementation of the strategic maneuver is that in the current institutional environment, the main market players and infrastructure organizations are mostly not interested in moving to a new technology package and a new architecture in the industry. At the same time, retail consumers and distributed energy entities often remain outside the field of competitive mechanisms and face regulatory barriers to the implementation of new technological approaches to energy supply.

In this regard, the determining condition for the development of new domestic power industry should be a change in the architecture of the retail sector of the electricity market, deregulation of economic relations of its subjects, the creation of simplified interfaces of technological and information interaction of distributed generation with the unified energy system, the establishment of distribution mechanisms system economic effect.

These actions should lead to the emergence of a new class of market actors – active consumers and prosumers, operators of micro-energy systems and aggregators of distributed energy facilities, and various service organizations. This class of subjects will be interested in using new technologies and will create a demand for high-tech equipment and services. Consumers will have the opportunity to choose energy supply options, which will contribute to the development of competition in the industry. In addition, special attention can also be paid to the intensification of the processes of creating, testing and implementing new technologies and practices in the industry. The result of the strategic maneuver should be an increase in the attractiveness of the domestic electricity sector for investors.

In order to implement the digital transformation of the energy sector, the government should develop measures to encourage the use of modern innovative solutions in the power industry, and develop a long-term program to support the export of high-tech products and services in the power industry. This will create prerequisites for curbing the growth of electricity prices by increasing the efficiency of using generating and network capacities, significantly reducing the need for new capacity, reducing energy losses, and reducing the cost of ownership of the basic infrastructure. In addition, scientific, technological and industrial potential will be formed for large-scale export of equipment, systems and services to global markets.

The emergence of new technologies in the financial sector (Blockchain, Smart Contract, Decentralized Autonomous Organizations) creates opportunities for large-scale attraction of private investment in the energy sector, monetization of consumer services, and the formation of various energy exchange practices.

Thus, ignoring the facts of change in the technological model of electricity generation and the associated challenges and developments in the industry may entail a risk to more expensive and less flexible power generation compared to other industrialized countries, to lose a number of new markets (for example, market of energy storage), can significantly limit the development of new (digital) industries, as well as the risk of not finding high-tech jobs in the area of advanced energy technologies, industries and services.

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