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Digitalization of the Energy Sector as A Current Trend for Improving the Efficiency of Technological Work in Industries

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Abstract

Goals of the research are to present the analysis of the key areas of digital energy and smart electric networks for the current and up to 10 years, a review of modern hardware and software solutions for the implementation of integrated information systems. To process the primary information, general scientific methods including an abstract-logical research method were used. This includes examples of best practices worldwide from analytical reviews and databases.

The digital electric power system forms a single distributed space of information technologies, combining information from primary sensors of energy system objects and its users to common technological, economic, forecasting and behavioral models. Integration of management solutions through digital platforms provides fast, flexible, reliable, safe and cost-effective adaptation of all types of relationships between objects and subjects of the energy system. This optimally satisfies the ever-changing energy needs of resources.

The direction of energy systems in the world contributes to their "digital transition", a fundamental change in the internal institutional architecture and strategic management. In Kazakhstan, the inefficiency of the electric power industry is becoming a limiting factor for the modernization of the economy in the context of globalization. The terms "digital energy" and "digitalization" appeared in the context of the formation of a digital economy. Digital energy is the assembly and development of a combination of industrial and economic relations in the industry

based on digital approaches and tools. From many definitions of the digital economy, it follows that its special subject is economic activity, commercial operations and professional interactions, built on new principles using information and communication technologies.

Keywords: digital transformation, intelligent data processing, digital energy, information and communication technology, energy consumption, renewable energy sources.

Introduction

The concepts of "digital economy", "knowledge economy", "information society" form a new socio-economic system that replaces the industrial paradigm. In the new economic conditions, all economic entities striving for stable functioning are forced to go through the process of digital transformation. It implies not only the installation of modern equipment or software, but also fundamental changes in approaches to management, corporate culture, and external communications. As a result, the productivity of each employee and the level of customer satisfaction increase, and the company gains a reputation as a progressive and modern organization. In practice, this means creating a system of end-to-end business processes, which can be called a digital business ecosystem. Digitalization can unlock these innovative solutions that should not only help transform our energy system, but should also be beneficial to consumers (Dumin, 2017). This will allow for more efficient and effective network management and optimization, leading to increased response demand and the ability to integrate the growing shares of renewable energy sources. Support for research and innovation in society and a private domain, both nationally and in the EU, is the key to digitalizing the market.

Research Methods

In the research process, scientific methods were used. To process the primary information, general scientific methods of analysis and synthesis were used, as well

as an abstract-logical research method. This includes examples of best practices from around the world, which are gathered from analytical reviews and databases.

The projects we financed in the past show what the future might look like and how digitalization can help transform the energy system:

the flexibility of energy consumption is much higher when it is automated: on the island of Bornholm in Denmark it was shown that when half of the consumers in the test were provided with an automatic demand response, and the other half had to personally respond to the price signal, 87% of the total demand response came from automated consumers;

we can better use renewable energy connected to the network using information and communication technology (ICT) and remote control. Using smart inverters next to solar panels on the roofs of consumers in Belgium, the network operator was able to increase the hosting capacity of renewable energy sources by 50%, only 10% of the cost of "traditional" equipment investments.

Results and discussion

Energy consumption accelerated in 2019 (+ 2.3%). This is due to high growth in demand for electricity and gas. In 2019, global energy consumption increased significantly due to sustained economic growth and growing demand in China, which has been the largest energy consumer in the world since 2009.

Kazakhstan accounts for 88.6% of coal, oil - 86%, gas - 32% of the total reserves explored in the region. But even this reserve, if not today, then tomorrow will exhaust itself, therefore we need to use what nature gives us, that is, alternative sources of inexhaustible energy. m. Administrative maps of the Republic of Kazakhstan were compiled with the distribution of long-term wind speed, maps of the energy infrastructure of the Republic of Kazakhstan. The plan for the development of renewable energy sources until 2020 includes the creation of 13 wind power stations and 4 solar power stations.

The share of renewable energy sources (RES, including hydropower) in the global energy balance in 2019 increased by almost 1% (+0.8 pounds) and amounted to almost 26%. The growth is mainly due to the emergence of new wind and solar power plants, facilitated by the ambitious climate policies of the European Union, the United States, China, India, Japan and Australia, as well as the sharp decline in recent years on the development of solar and wind energy, which allows developing countries expand your renewable energy base. Favorable hydraulic conditions have contributed to the growth of renewable energy production in Europe, Brazil, India, Thailand, Australia and New Zealand (Danilov & Saraeva, 2019).

The main condition for accelerating Kazakhstan's economic growth is the implementation of innovative investment projects with high profitability - relatively quick payback, acceptable investment sizes for the development of territorial regions, the study of their potential capabilities in terms of wind strength and solar intensity lighting.

In contrast to the automation of the technological process of distribution and transport of electricity, which in itself is not able to reduce the cost of ownership of company assets, digitalization allows us to achieve this goal by creating and implementing a single trusted digital environment (Bodrunov, 2017). The key problem of automation in the electric grid complex should be considered the difficulty of integrating information systems of different manufacturers and the impossibility of significant changes in the already working automation scheme. The goal of digital transformation in the economy as a whole and in the energy sector is to develop a single information space as an environment and a common interaction language for various platforms and technologies. Such an approach will allow: - to organize the end-to-end transmission of primary digitized technological data in the volumes required for the provision by electric power entities; - reduce administrative obligations of electric power industry entities in assessing readiness for the autumn-winter period; - create a digital information platform as a single trusted environment that will be used in activities by electric power industry entities; - go to the purchase of production assets for the needs of the electric power

industry, based on the cost of the life cycle; - create the possibility of using statistics accumulated on a single industry trusted platform for scientific purposes; - introduce risk-based approaches to the management of energy systems in Russia; - increase the level of reliability with minimal costs for maintenance and repair of network infrastructure by creating a federal center for monitoring reliability; - develop a system of consolidation of industry orders to stimulate the mechanical engineering and microelectronic industry of Kazakhstan.

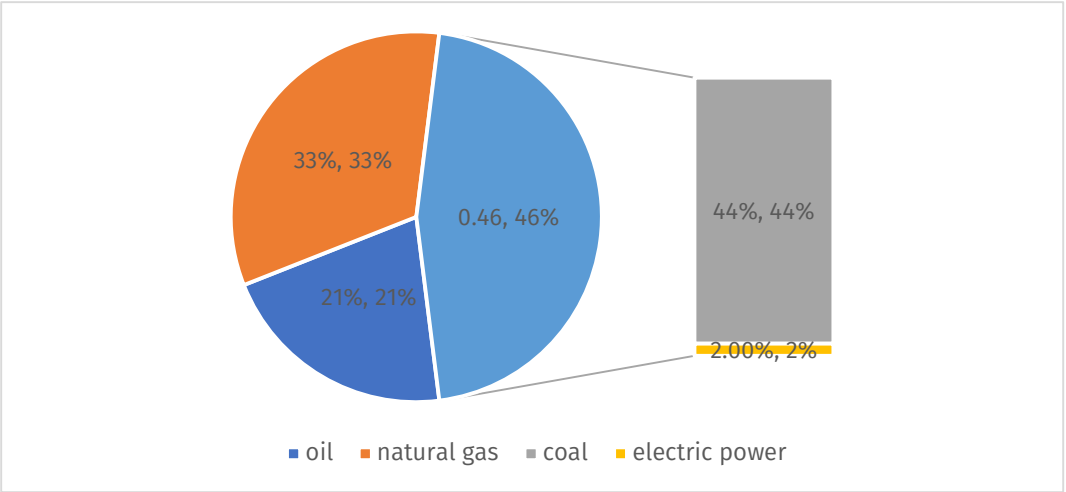

Figure 1. Breakdown by type of energy in Kazakhstan
Source: compiled by the authors based on Statistics World Energy Yearbook 2019, https://yearbook.enerdata.ru

The digitalization of the electric grid complex involves, firstly, an increase in observability, controllability, automation and diagnostics at regional grid facilities (we are talking about digital substations and an active adaptive distribution network). Secondly, the development of information and telecommunications infrastructure for the technological and corporate data transmission network, including cybersecurity issues, the development of integrated information management systems. Thirdly, the digitalization of the company's business processes, the development of innovative and engineering activities. Fourth, the development of human capital, the construction of landfills and network laboratories for the formation of new professional competencies among the company personnel (Istomina, 2018).

The idea of ubiquitous digitalization is to create a new model of the power grid and the energy market of the future that meets promising challenges. In the digital energy ecosystem, energy producers and consumers seamlessly integrate into the common infrastructure, both technical and information, and exchange energy and information. The architecture of digital energy is formed on the following world trends: - the creation of digital information platforms and solutions in the field of energy efficiency to meet the needs of modern and future consumers; - reduction of maintenance and management costs through digital monitoring and predictive analytics; - increasing the efficiency of production, distribution and conservation of energy; - the use of a wide range of external data along with energy consumption data to improve energy efficiency; - system optimization (for example, an increase in the effective capacity of networks due to better control of the power flow).

In the market of energy-efficient solutions for the electricity consumer, home-based energy management systems, smart meters and sensors, and mobile energy services are very popular. The market of intelligent metering devices (smart mereting) is now booming in Russia and Eastern Europe, Central Asia and Latin America1. Today, technologies are widely spread in these countries, giving consumers the opportunity to become active actors in the energy market. Renewable energy sources, microgeneration, energy storage, load control, smart contacts create new opportunities and modern models of consumer behavior. To take advantage of modern technologies, it is necessary to transform the rules and mechanisms of the functioning of energy markets (Baykov, Bezmelnitsyna and Grinkevich, 2007). The introduction of smart grid technology (smart grids) helps to reduce the cost of electricity and the formation of reserve capacity among end users. Improving the technology of smart grids, smart cities and towns is aimed at increasing the reliability and security of power supply, increasing the automation of technological processes in production, introducing digital devices in everyday life, and reducing the cost of repairs and maintenance.

Intelligent energy systems of the future should contribute to the growth of controllability, reliability, and energy efficiency of all known energy systems:

electric, gas, thermal. Energy will allow you to create a fundamentally new architecture of electric networks, based on actively adaptive principles, which will be formed based on consumer requests, and not be imposed by suppliers or authorities. In the next 5–10 years, consumers from both B2B and B2C will shift their focus towards integrated solutions in the field of electric power, distribution, management and monitoring. Flexible multi-functional solutions with program control elements and big data analysis will be in demand.

The terms "digital energy" and "digitalization" appeared in the context of the processes of formation of the digital economy, and it makes sense to consider them only in this connection. From the many definitions of the digital economy, it follows that its special subject is economic activity, commercial transactions and professional interactions built on new principles through the use of information and communication technologies. Therefore, the essence of digital energy is the reassembly and development of the totality of production and economic relations in the industry based on digital approaches and tools (Ang, Xu and Su, 2015). In total, in the phrase "digital economy" (and hence "digital energy"), the defining word is "economy", and the adjective "digital" only indicates the means of achieving the goal. The essence of digital energy is the reassembly and development of a combination of industrial and economic relations in the industry based on digital approaches and tools.

The main objective of digital energy is to eliminate the sharply rising costs of integrating distributed energy and market transactions. The advent of a digital platform in any industry significantly reduces transaction costs. A project in the field of digital energy always involves a new model of interaction between economic entities (Worrell et al., 2007). Many digital business models have been developed: demand aggregators, virtual power plants, virtual distributed energy storage, energy hedging, etc. Digital transformation (digitalization) in the energy sector is primarily the creation of new business models, services and markets, relying on the possibilities of digital economics. A simple example from another industry: the creation of an automated dispatch control

system for a taxi fleet is automation, but Uber, which essentially creates a new business model for the same service, without being a taxi fleet and not owning a single machine, and this makes it cheaper, more convenient and safer is digitalization.

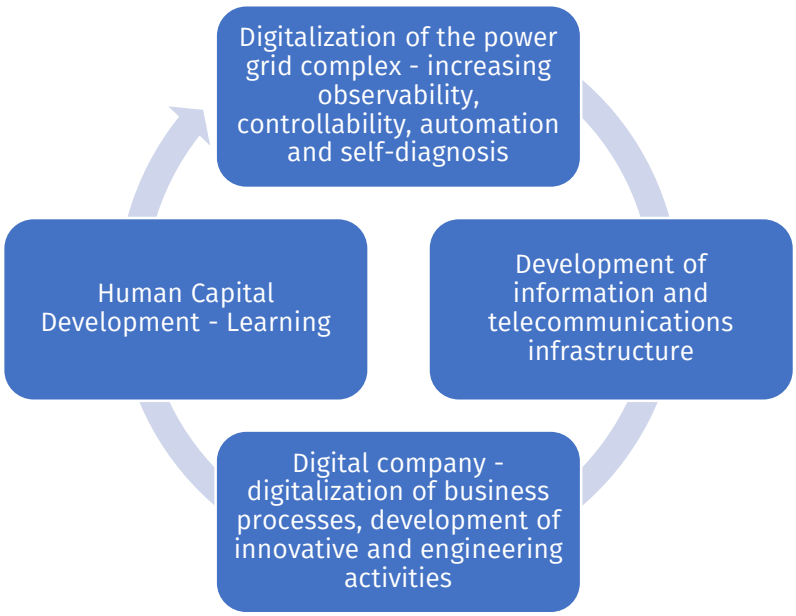

Figure 2. Power grid company digitalization concept
Source: compiled by the authors based on Statistics World Energy Yearbook 2019, https://yearbook.enerdata.ru)

A digital electric power system, the target state of which is using digital technologies that form a single distributed information technology space, combining information from primary sensors of the state of energy system objects and its users, to common technological, economic, forecasting and behavioral models, with the integration of management solutions through digital platforms that provide fast, flexible, reliable, safe and cost-effective adaptation of all types and types of relationships between objects and subjects of the energy system, to optimally meet the ever-changing needs for energy resources and how to use them, in the conditions of constant development of new technologies (Mozokhin, 2018). Digitalization of energy is a fundamental change in the internal architecture and management based on digital technologies. This is a current trend aimed at increasing the efficiency of the energy industry and creating a technological

environment that will qualitatively improve the industry's performance, as well as make significant changes to production ecosystems (Khokhlov et al., 2019). The decisive factor for success in transforming the energy industry is the willingness of organizations and their employees to master digitalization tools and gain digital value - the benefits that new technologies offer. The directions that concern this in the first place: electric power, oil and gas complex, coal industry.

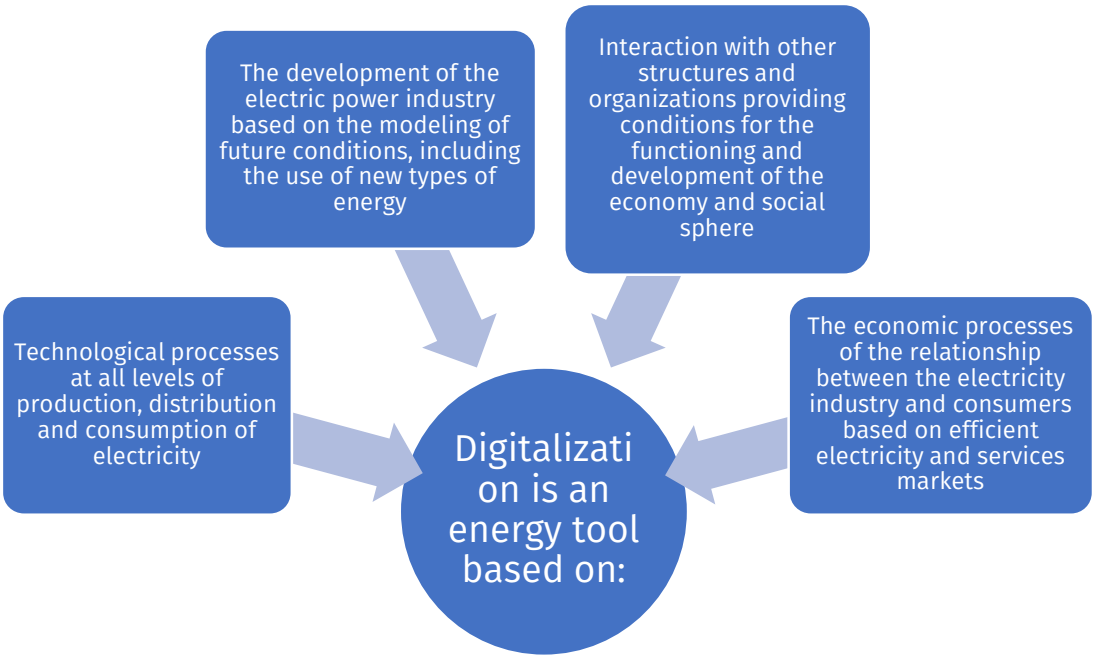

Figure 3. Digitalization - an energy tool.
Source: compiled by the authors based on Statistics World Energy Yearbook 2019, https://yearbook.enerdata.ru)

Conclusions

Since digitalization applies to the entire energy sector, accordingly, it gives new opportunities to all participants in the electrical market: operation, manufacturers, design organizations, the UES system operator, etc. Therefore, I will briefly say about some of the participants. So, for design organizations, digitalization accelerates design processes and reduces the number of errors in projects. For operation, this reduces operating and maintenance costs, transparency of work processes and the choice of more reliable equipment with a lower life cycle cost.

For equipment manufacturers - increasing the serviceability of products, self-diagnosis of products. To achieve a systemic effect from the digitalization of energy, only an administrative instruction is not enough. The transformation of the industry occurs when more efficient use of data leads to an increase in the profits of companies and opens new market opportunities for them. Of course, in some issues, digitalization is more ready in some - less. We propose first to talk about the opportunities that energy has for digital transformation.

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