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Prospects for the IoT in the Electricity Industry

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Abstract. Currently, strategic changes are taking place in the energy sector of Russia, the main vector of which is the transition to digital control mechanisms, the introduction of IoT technologies and the creation of new models of the digital energy market. The number of “connected” devices is growing rapidly in the world. The introduction of IoT («IoT») into energy industry will fundamentally change the rules of the game in the industry. New technologies will significantly reduce losses in the transmission of electrical energy from the generator to the consumer, multiply the reliability of power supply, optimally redistribute energy flows, thereby reducing peak loads. This, finally, will enable the end consumer to take part in the process of transmission and sale of electricity, which will transfer it to the class of "prosumers" - active consumers.

1 Introduction

Gradually, the global Internet, in which data exchange previously took place, is turning into the «Intertnet of things » («IoT»). «IoT» is a communication infrastructure between intelligent objects that are equipped with a control system.

The number of “connected” devices is growing in the world and, along with it, the number of examples of using the “«IoT» ” (IoT) in the economy: energy, industry, housing and communal services, agriculture, transport, health care, etc. practice knows successful examples of IoT implementation initiated by both the state and business. For example, with the support of the state in the countries of the European Union, South Korea, China and India, smart city technologies are being introduced, which make it possible to improve the efficiency of energy consumption and traffic management. In the UK and the US, large-scale programs have been implemented to introduce smart meters for remote monitoring of energy consumption in households.

The history of the development of the «IoT» began in 1989 on the basis of M2M inter-machine interaction technologies, which ensured the interconnection of technical devices with each other without human intervention. Thanks to this technology, one of the devices could collect data about the other, as a result, systems for monitoring various factors of production began to appear in the industry.

At the next stage of the development of the «IoT», technologies made it possible to completely abandon human intervention, if earlier devices could only exchange and collect data, now the system itself analyzes the information received and self-regulates.

Today, the «IoT» is a multitude of disparate networks. The next step in its development will be the transition to the Internet of Everything, which will integrate various processes, objects, data and people.

The «IoT» is becoming a reality. The constant and increasing exchange of data requires the development of new services that should connect us to the physical world around us. These services must also be built on completely new business models and provide new financial flows. With the help of the «IoT», the interaction of objects, the environment and people will be intertwined in many ways, which promises to make the world “smart” - more comfortable for humans.

2 Materials and Methods

2.1 Brief Literature Review

At the moment, there are two types of «IoT»:

- consumer (mass Internet), for example, smart watches, cars and smart home devices;

-corporate (business) Internet, it includes sectoral verticals and cross-sectoral markets - industry, transport, energy (Smart Grid).

The industrial «IoT» is a system of interconnected computer networks and connected industrial (production) facilities with built-in sensors and software for collecting and exchanging data, with the possibility of remote control and management in an automated mode, without human intervention [1].

The main advantages of the «IoT» are:

1. Saving labor resources due to automation;
2. Increasing the database, simplifying its use in various fields, including in the energy sector;

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3. Improving the environment by optimizing the consumption of natural resources;

4. Reducing risks to human health and life in hazardous industries.

However, the introduction of any new technology has negative consequences:

1. Reduction of jobs;

2. Significant material costs for equipping the enterprise with various sensors and equipment;

3. Problems related to security

The development of «IoT» provokes the fourth industrial revolution (hereinafter - Industry 4.0), which will be marked by the transition to fully automated digital production, the use of cyber-physical systems and cloud computing. The processes will be controlled by "smart" devices online.

Table 1. Stages of industrial revolutions.

Period	Major trends	Result
1st industrial revolution. The turn of the XVIII-XIX centuries.	- steam energy - invention of mechanical devices (motors, weaving machines, etc.) - development of metal mining	- the transition from an agricultural economy to industrial production - development of the transport network
2nd industrial revolution. Second half of the 19th - early 20th centuries	- Electric Energy - invention of the telephone / telegraph - development of the oil and chemical industry	- mass production - division of labor - the emergence of railways
3rd industrial revolution. End of XX century - present time	- the emergence of electronic systems - development of infocommunication technologies - digitalization of the economy	- automation of production processes - robotization of production

2.2 Methods

The empirical base of the study is data from the Federal State Statistics Service and its territorial bodies, materials from the Ministry of Economic Development of the Russian Federation, the Ministry of Economy of the Republic of Tatarstan, Rating Agency RIA Rating LLC, RAEX Rating Agency JSC (Expert RA), as well as conceptual foundations risk management organizations developed by the Committee of Sponsoring Organizations of the Treadway Commission (COSO), the methodology of the Project Management Guidelines (PMBOK Guidelines), etc. The work was carried out on the basis of collection and generalization (synthesis method), systematization (systemic method) materials obtained from official information resources, analysis of practical experience.

3 Results and Discussion

The «IoT» in the energy sector is needed by both the State and the Ministry of Energy, first of all, it will help to reach a new level of automation, as well as monitor and analyze data. Based on the results of monitoring, the state can make changes at the legislative level in the energy sector and provide strategic messages for the development of the industry. After all, energy belongs to strategic areas, and the state is directly interested in its unification and optimization [3].

In addition to monitoring the «IoT» in the energy sector, it will allow:

• increase income growth by optimizing power supply;

• reduce losses on power lines;

• save resources;

• accelerate the planning of network loads;

• to speed up the replacement of out-of-order equipment, due to sensors tracking the life cycle of this equipment (to form an application for the supply of spare parts, new equipment in time).

These technologies are especially relevant in Russia, which has a huge centralized power supply system.

At the level of management of the system, balances and modes and in the electric power industry, the «IoT» will make it possible to more efficiently plan the loading of generating capacities and their volume.

There are some examples of «IoT» implementation in Russia, mainly in the electric power industry.

In the electric power industry, the «IoT» can bring about significant changes by transforming the traditional electromechanical energy system into a digital one. In the power industry, the definition of the «IoT» usually includes “smart” or “smart” grids (smart grids) and meters (smart meters). New technologies are especially relevant for Russia, which has a historically established large-scale centralized power supply system, which is over 2.5 million km of power lines, about 500 thousand substations, 700 power plants with a capacity of more than 5 MW. However, today the penetration of the «IoT» into the Russian energy sector is at an initial level [4].

At the level of management of the system, balances and modes in the electric power industry, a step towards digital binding of assets can make it possible to more optimally plan the loading of generating capacities and, most importantly, their volume. Since the Russian energy system is built on redundancy, the creation of an intelligent distribution model would make it possible to remove some of the inefficient generation from operation and partially solve the issue of overproduction of generating capacities. At the same time, it would allow more widespread adoption of modern incentives to reduce energy consumption: for example, demand response

In the electric grid sector, the wider introduction of intelligent technologies, especially taking into account the length of linear facilities, could lead to increased reliability and lower operating costs. This would finally make it possible to switch to network management “on condition”, rather than to carry out repairs in accordance with strict regulatory deadlines.

In Russia, there are a number of successful examples of the introduction of intelligent network technologies, for example, in the regions where PJSC Rosseti operates, Tatarstan and a number of other regions. Most of the new equipment (transformers, circuit breakers) already has remote diagnostic systems.

There should also be no problems with the transfer of information, since the network complex, in fact, is the largest communications operator in Russia: for example, all 110 kW substations (SS) have communication channels (overwhelmingly fiber optic), all new 35 kW substations have Internet access. The smart grid will also allow the integration of various power generation facilities, including those based on renewable energy sources (RES - sun, wind, etc.), distributed generation.

While the volume of renewable energy in Russia is insignificant, and the volume of distributed generation is about 5.5% of the installed capacity (just under 13 GW), however, the experience of other countries shows that these indicators will grow. In North America and Western Europe, smart grids also allow electricity to flow in two directions, making it possible to sell surplus electricity generated by households (mainly solar panels on rooftops).

In generation, the elements of the «IoT» are also used - these are asset management systems of the APCS class (automated process control systems). They are installed in various combinations at all power plants in our country and allow remote control and information on the operation of key systems. At the same time, the share of domestic equipment, which is gratifying, is quite large.

With the aim of developing «IoT» in generation, the Ministry of Energy, together with RUSNANO and Rostelecom, is forming a national project on the Industrial Internet based on a pilot project for the development of a system for remote monitoring and diagnostics of combined cycle plants. Some private utilities are also actively equipping their facilities with remote monitoring and diagnostics systems to improve reliability and reduce operating costs.

At the level of consumers of energy resources in Russia, the possibilities of the «IoT» are truly endless. Smart meters, for example, save not only energy supply companies (due to the absence of costs for verification of meter readings and obtaining data in real time), but also consumers - by managing the consumption profile and various energy-consuming devices. At the same time, if the intelligent management of generation and network assets is the lot of equipment manufacturers and large IT companies, then “smart” devices and “smart meters” provide an opportunity for the development of the business of small players and Internet startups. However, the introduction of “smart meters” in Russia today is limited by the fact that they are owned by citizens and it is rather difficult to create incentives for their replacement.

IoT technologies have a number of features and limitations of their use in Russia, associated with the economic, technological, legislative, geographical and cultural specifics of the country. Three markets for the application of IoT technologies can be distinguished: the mass market (B2C), the market of commercial companies (B2B), the market of government agencies and state-owned companies (B2G): each of them has limitations and opportunities for the use of IoT technologies that are inherent in our country.

The mass market (B2C) is traditionally susceptible to new innovative technologies and products based on these technologies. Individual consumers often make purchases based on momentary impulses or under the influence of trends; they are ready to save several months to buy the latest version of a smartphone, tablet or other digital gadget (especially in Russia: for example, the iPhone share in the smartphone market in Russia continues to grow and is more than 10% of sales in kind).

But this picture is significantly aggravated by the low average income of the population (for example, the average salary in the Russian Federation is 75% lower than in the countries of the European Union [2]), which is gradually decreasing. In this situation, the average consumer prefers to spend money on basic services that cannot be refused (food, transport, housing, communications), and postpone purchases of advanced goods or services at a later time.

Most likely, in the mass segment in the medium term, there will be demand for products based on "cloud" «IoT» solutions, such as monitoring public transport, monitoring the load of public infrastructure (roads, subways, etc.), etc. Such products will be monetized through selling related services (for example, ordering a taxi), advertising, gaining access to large arrays of user data. Of course, solutions focused on niche consumers will be further developed, for example, such as “smart car insurance”, “smart home”, life monitoring, telemedicine.

The market for commercial companies (B2B) is more inert than the market for private consumers, as companies need time to analyze the external environment, realize the need to apply new technologies, coordinate investments and implement projects. This process can often take several years.

At the same time, Russia has a number of specific factors that complicate decision-making in favor of «IoT». For example, the lack of return on investment on the horizon of 2-3 years is likely to lead to a negative decision - no one will invest in technology that does not pay off in the short term, since top management wants to show shareholders quick returns and results today, and not on the horizon for five or more years.

Additional restrictions are imposed in terms of the complexity of changing internal processes, regulations, workflow, approaches to receiving and processing information. Traditionally in Russia, real sector companies are cautious about changing processes, especially if new processes are to integrate online intelligence. On the one hand, the availability of such information is a blessing, but, on the other hand, it immediately imposes requirements for more efficient management decisions and for the transition to a new level of interaction between the company's divisions within the framework of new processes. Many companies are not yet ready to increase flexibility because it requires a cultural transformation of managers, staff, partners and contractors.

In addition to changing processes, the integration of «IoT» technologies into the existing IT landscape is required, which will also be a test for Russian companies, which often prefer patchwork or "manual" integration of information systems. But to get the full value from «IoT», companies need to integrate new technology into an end-to-end process.

The specificity of our country is clear to everyone - a vast geography, different climate and landscape, different population density, market characteristics, etc. For companies operating in several districts (such as retailers, telecommunications operators, transport companies, energy companies) and wishing to integrate «IoT» technologies into their processes, this means the need to think over, take into account and implement solutions that take into account regional specifics. This can dramatically increase labor costs and the investment required.

The state manages a colossal infrastructure: roads, housing and communal services, buildings and structures, electricity and heating networks, etc. The market of government agencies and state-owned companies (B2G), perhaps, has the maximum economic potential for the introduction of «IoT» technologies in terms of improving energy efficiency and reducing maintenance costs production assets, but at the same time this market is the most inert. The main reason is the often worn-out infrastructure, which requires significant costs for renovation, repairs and maintenance. In the context of sequestering investment budgets and limiting the growth of tariffs for services provided (for example, in 2014, tariffs of natural monopolies were frozen, including for rail transportation, oil transportation, utilities) many companies remain within traditional technologies. There is no talk about the introduction of «IoT», since the financing of new technological solutions is carried out on a leftover basis.

The development of «IoT» technologies in Russia should take into account the above-mentioned country features and restrictions.

4 Conclusions

Currently, the Ministry of Energy of Russia is working on a national project on the industrial Internet based on a pilot project for the development of a system for remote monitoring and diagnostics of combined cycle plants. The main goal is to optimize all repair programs and thus obtain a certain unification of the equipment life cycle in order to form an order for the supply of spare parts on time. The Industrial Internet is expected to help drive greater optimization in the electricity sector and significantly reduce operating costs.

The following conclusions can be drawn from the above:

1. The «IoT» will optimize power supply, reduce power losses, perform monitoring and, using the data obtained, modernize the power supply system;

2. Russia has great prospects for the development of the industrial Internet in the energy sector, since many projects have already been launched in pilot mode;

3. The complexity of the transition lies in the high cost of equipment, and mainly in the conservatism of the energy sector, which primarily ensures safety and reliability.

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