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Socio-Economic Aspects of the Development of Energy Companies in the Arctic Region

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ABSTRACT

The energy complex is an important part for the development of the economy of any country. At the same time, the Russian electricity sector is one of the most problematic. Therefore, the work considers the socio-economic aspects of the development of energy companies in the Arctic zone. To achieve this goal, the authors used systemic, structural, analytical, comparative methods. It has been established that the current technical and economic condition of the Russian electric power industry should be improved in order to develop ways to overcome it from the crisis. The paper analyzes normative acts that provide solutions to the energy problems of Russia in general and the Arctic in particular. It was determined that in the Arctic region, the priority in the construction of energy facilities based on renewable energy sources is the development of power plant construction projects using innovative technical solutions that provide minimal environmental risks and reliable operation in various climatic conditions.

Keywords: Energy Saving Potential, Public Sector, Power Plants, Modernization
JEL Classifications: A14, H10, Q40

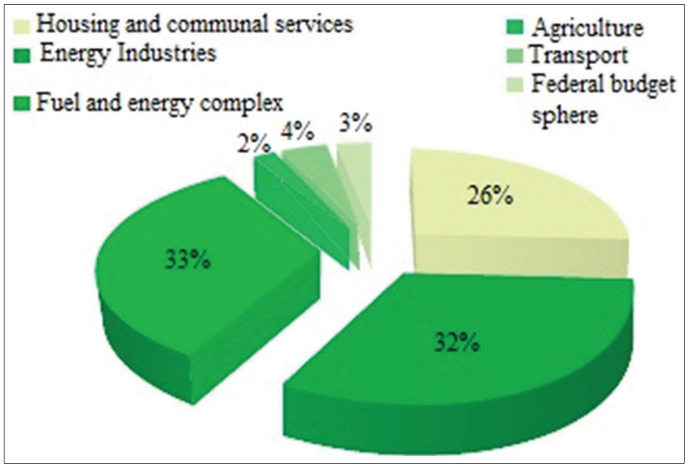
1. INTRODUCTION

Electricity is an important part of the economy, because without it the population and sectors of the economy of any country cannot exist. In this area, the network component (which is actually a natural monopoly) and the production of electricity are important. If the state loosens control over the production of electricity and heat during a long transitional stage of development of the national economy, this could result in irreparable losses for it. As experience shows, energy in the modern world plays a key role in providing resources for economic development and enhancing the competitiveness of the economy of any state, and global political processes are substantially determined by relationships in the global energy community (Figure 1).

Electricity generation is associated with negative environmental impacts. According to the degree of influence, energy objects are among the most intensively affecting the planet's environment. Electric power facilities, primarily thermal power plants, affect atmospheric air by emissions of pollutants, natural waters by discharges of polluted sewage into water bodies, use a significant amount of water and land resources, and pollute surrounding territories with ash and slag waste (Patriota et al., 2016; Plaskova et al., 2017; Krechetov et al., 2018; Nosova et al., 2018; Satelles et al., 2018; Penido et al., 2018). As for the transmission of electricity through power lines, compared with the transportation of various types of fuel and their transfer through piping systems, it is environmentally friendly (Kupatadze and Kizilöz, 2016; Kuznetsova and Makarenko, 2018).

At the present stage, the problem of the interaction of energy objects and the environment has acquired new features, affecting vast territories, rivers and lakes, the atmosphere and hydrosphere of the Earth. More significant energy consumption in the foreseeable future determines the further expansion of the area of impact on all environmental components on a global scale.

Figure 1: Energy saving potential in the Russian economy, %



Source: Ministry of Energy of the Russian Federation, 2019

The government's plan of transformations in the electric power industry, which would create incentives to increase the efficiency of energy companies, allowed to significantly increase the volume of investments in the industry and to ensure reliable uninterrupted energy supply to consumers in the future, including changing the state regulation system of the industry, creating a competitive electricity market and restructuring the industry as a whole (Movchan and Yakovleva, 2014; Akhmetshin et al., 2018a; Akhmetshin et al., 2018b; Akhmetshin et al., 2018c) The goals and objectives of the reform were determined by Government Decree of July 11, 2001 No. 526 "On reforming the electric power industry of the Russian Federation." The RF Government also defined the strategic task of the reform: "transfer of the electrical energy industry into the sustainable development mode based on the application of progressive technologies and market principles of the operation, and on the basis of it ensuring reliable, economically viable satisfaction of effective demand for electricity and heat in the short-term and the long-term perspective" (Arkhipova, 2011) and chose the reform based on vertical disintegration.

The required conversions were successfully completed between 2001 and 2008. Currently, there are wholesale and retail electricity markets in the Russian Federation, whose prices are not regulated by the state, but are formed on the basis of supply and demand (Sakulyeva and Kseniia, 2019). The structure of the industry has also changed: the separation of naturally monopolistic (transmission of electricity, operational dispatch control) and potentially competitive (production and marketing of electricity, repair and service) functions was carried out; Instead of the former vertically integrated companies that performed all these functions, structures specializing in certain types of activities were created.

2. LITERATURE REVIEW

The established approach to the reform of the industry has for many times provoked negative evaluation by the energy scientists Platonov (2009), Kutovoy (2016), Baryshnikov (2017), Baubinaite et al. (2017) who underline the groundless cost escalation in the operation of both the entire Unified Energy System, and its structural elements, decrease in the reliability of the energy system, lack of financial transparency, and other destructive aspects of the reform.

The completion of the reform period in the electrical energy industry of Russia in 2012 became the edge of the formation of competitive relations on the wholesale and retail markets of electrical energy (Fitsak et al., 2019). The market relations during 5 years of the post-reform period were supposed to affect the arrangements for pricing electrical energy towards its growth rates reduction or stabilizing, which was not reflected in the reality (Order of the Federal Antimonopoly Service of the Russian Federation "On the Limit Tariffs for Electricity (Capacity) for 2017," 2016; Order of the Federal Antimonopoly Service of the Russian Federation "On the marginal minimum and maximum levels of tariffs for electricity (capacity) for 2018," 2013) (Figure 2).

The reform of the electrical energy industry based on vertical disintegration caused the change in the industry structure: the organizations with new "functions" appeared: Last Resort Suppliers (LRS), the status of which is legally determined (Federal Law "On Electric Power Industry," 2003). The Federal Antimonopoly Service of the Russian Federation keeps the Federal Information Register of the Last Resort Suppliers.

"Last resort supplier of electrical energy (hereinafter – last resort supplier or LRS) is a commercial organization, which is, according to the legislation of the Russian Federation, assigned the status of last resort supplier, implementing power supply and obliged, in compliance with the applicable Federal Law, to conclude the agreement for energy supply, for sale and purchase (supply) of the electrical energy (power) with any resorted consumer of electrical energy or with a person acting on one's own behalf or on behalf of the consumer of electrical energy and willing to acquire the electrical energy" (Amirgaliyev et al., 2019; Kholod et al., 2019).

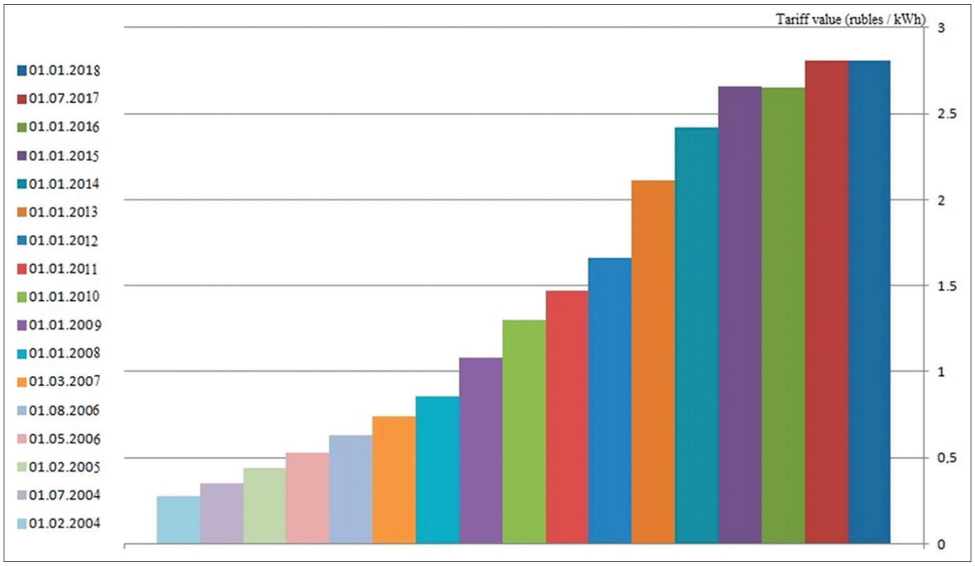
3. METHODOLOGY

The methodological basis of the robot is to become the system of methods, which are enriched by what is posed by the method and the completion of the agreement. The activeness, oborudovanie and the reliability of the scientific results of the prejudice were secured by the complex zosuvanny of the mainstream science and the special science methods. The questionnaire of formal formal logical and legal methods allowed us to achieve better economic efficiency. System – structural analysis, analytically – synthetic and matrix methods are used for visualization of internal links between the Russian Energy and the Arctic zone.

The energy supply is "the activities on the sales of the generated and (or) acquired electrical energy, implemented on the retail markets within the Unified Energy System of Russia and in the territories lacking the technological connection with the Unified Energy System of Russia" (Voronkova et al., 2019).

The analysis of the LRS performance in the post-reform period (since 2012 inclusive), as a basic component of the wholesale and retail market, will allow making an objective assessment of the established market mechanisms of the electrical energy industry in Russia

Figure 2: The increase in electricity tariffs in the Russian Federation



Source: Akhmetshin et al., 2018b

(Hernández et al., 2018). The formation of the analysis methodology for the LRS activities considering the operation of the similar energy organizations may be conducted based on the statistical and rank analysis. To assess the LRS performance, one may use the indicators of profit margin, operating profit margin, and net profit margin.

4. RESULTS

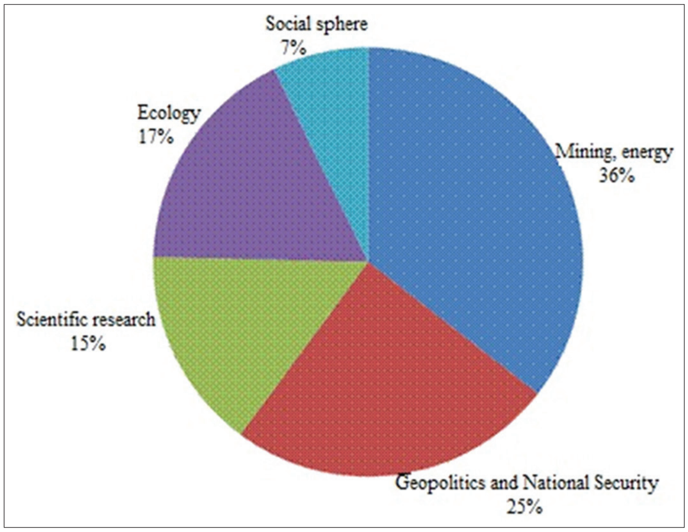
The energy strategy of Russia involves fulfilling the tasks of meeting the needs of socio-economic development of the country with energy products and services in volume, nomenclature and quality, guaranteeing the country's energy security and the reliability of the energy production structure (Intima, 2017; Portella et al., 2017; Villa et al., 2017; Salvo et al., 2018). The task of improving the territorial and production structure of the transport and energy complex involves harmonious energy development of the Russian regions, the creation of new fuel and energy and energy industrial complexes that stimulate the development of Russian regions, the economically sound development of distributed generation, the use of local energy and renewable energy sources and ensuring technological independence of the energy sector in Russia involves stimulating innovative import substitution, developing the national market for high-tech products and technologies, increasing the technological competitiveness of the Russian transport and energy complex, up to Russia's active participation in shaping global technology trends.

The current technical and economic state of the Russian electric power industry undoubtedly requires the development of ways to overcome it from the crisis. Therefore, in order to increase the efficiency of using the production potential of the electric power industry and developing market relations, a decision was made in 1997 on a new structural reform. Its main provisions were defined in the Decree of the President of the Russian Federation dated April 28, 1997. It envisaged restructuring of the industry by organizing a number of new generating companies in Russia and creating a non-profit organization – the wholesale market operator to form a new system for organizing trade in electricity and capacity. It was planned to continue improving the pricing policy and forms of state regulation of tariffs for electric and thermal energy, taking into account differences in the costs of power supply for different groups of consumers and regions of the Russian Federation. Attention was focused on increasing the effectiveness of the implementation of state powers and state regulation of the natural monopoly in the electric power industry by improving the regulatory framework, especially at the regional level (De Boni, 2017). In accordance with these provisions, the Decree was supposed to carry out structural and organizational transformations in the electric power industry, which provided for the systemic reliability and efficiency of the UES of Russia, which had been achieved by the beginning of the 90s. However, work on the implementation of the provisions of this Decree was soon suspended. The beginning of a new stage in the preparation of government and copyright documents on the structural reform of the electric power industry was the developed draft restructuring of the electric power industry. In December 2000, the Ministry of Economic Development of the Russian Federation, together with interested executive bodies, prepared and submitted to the Government of the Russian Federation a package of documents "On the main directions and principles of structural reforms in the electric power industry" (Ilynykh et al., 2018).

After the analysis of literature sources in the Arctic region, the social problems of the Arctic were identified (Figure 3). Among which are scientific research, the social sphere, national security, ecology, mining of raw materials, energy.

The Arctic region is 93% provided with energy resources based on imported fuel. In connection with the growing interest in the development of the territories and resources of the Russian Arctic, the issue of the integrated development of the region's energy infrastructure, providing comfortable working and living conditions and minimizing anthropogenic environmental impact, is becoming increasingly relevant. The basis of energy in the

Figure 3: Problems of the arctic region



Source: Murzagaliyeva, 2018

Arctic region is fossil fuel imported from other regions. The lack of developed transport infrastructure and difficult climatic conditions of the Arctic greatly complicate the organization of logistics processes, so the possibility of communication with the region for fuel delivery is very limited (Agarkov et al., 2018). The difficulties of transporting fuel entail high transport costs that affect the final cost of energy generated.

Obviously, in the Arctic region, the priority in the construction of energy facilities based on renewable energy sources is the development of projects for the construction of power plants using innovative technical solutions that ensure minimal environmental risks and reliable operation in various climatic conditions.

In general, in the Arctic region, when planning adaptation measures to global climate change, of course, it is necessary to provide for the possibility of a two-threefold increase in the frequency of strong winds, squalls, storms, etc. And all these indicators affect the energy of the Arctic (Iosifov and Ratner, 2018). It is believed, for example, that in the next 20-30 years, while maintaining the current climate change trend, the duration of navigation through the Vilkitsky Strait (the most difficult place on the Northern Sea Route in terms of navigation) may increase to 120 days (now it is about 1 month). Ice masses with an area of tens of square kilometers can be torn off from a continuous mass of ice covering the North Pole and drift separately. All this will undoubtedly affect the development opportunities of the mining, transport, construction and energy infrastructure of the Arctic region. According to the estimates of American scientists, the cost of adapting to the impact of climate change on state infrastructure (roads, seaports, airports, transmission lines, etc.) in Alaska can lead to an increase in financial investments in infrastructure development for the period until 2030 by about 13 billion. At the same time, the savings from adaptation will be greater with faster warming than with slow climate change.

Despite the importance of resource risks in the Arctic, where there is a high spatio-temporal variability of the resource characteristics of renewable energy sources, the greatest danger is the emergence of technological risks. The reasons for the occurrence of technological risk factors, expressed in equipment malfunctions, may be associated with errors made in the selection and design of technological equipment, and violations of technological processes. This may be due to the peculiarities of the operation of renewable energy equipment in harsh climatic conditions. Avoiding this type of risk is possible through the implementation of security measures, the use of certified technological equipment, timely repair and implementation of adaptation measures. So, for the operation of wind power plants, the greatest danger when operating equipment in the Arctic can be: – reduced wind energy production due to icing of the blades and equipment; – increase in equipment vibrations due to imbalance from frost; – the occurrence of short circuits when moisture gets into electrical equipment; – The threat of breakdown of supports, towers and blades (Nagaj and Zuromskaitė, 2017). To protect the equipment from the impact of harsh climatic conditions, the block-modular principle of the basic equipment is used with the placement of diesel generators, drives and electronic matching and control equipment in containers with a high degree of protection against external environmental influences, and in some cases with the internal climate system - control.

The authors noted that in the Far East, "green energy" is actively developing and a number of wind farms are already operating. In the village of Tiksi in the Republic of Sakha (Yakutia), a unique wind farm began to operate. The wind farm is unique not only for Yakutia, but also for Russia as a whole. Three unique wind turbines with a total capacity of 900 kW are made in the Arctic version to work in the harsh conditions of the Arctic. They can operate at temperatures up to –50 degrees and are able to withstand wind speeds of up to 70 m/s. The wind-diesel complex will increase the reliability of energy supply to the isolated polar village of Tiksi, in which more than 4.600 people now live, and reduce its dependence on expensive imported fuel. At the Chukotka Cape Observation, the largest wind generator station in the Arctic zone of Russia is operating. In addition to this station, according to a number of agreements signed under the WEF, similar ones will be built in several more districts of Chukotka.

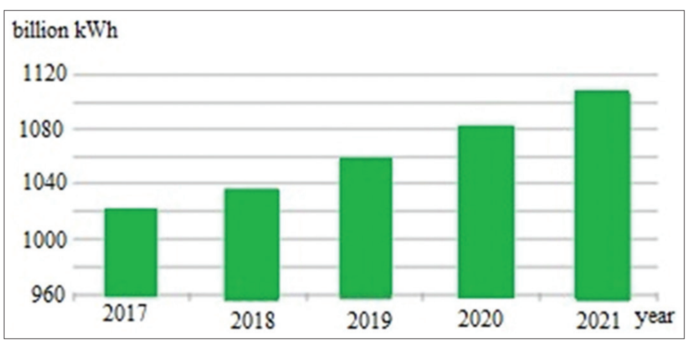
The main directions of energy saving in the Arctic are related to the modernization of energy sources, the enlargement of small boiler houses, the reconstruction of worn-out sections of heating networks, and the transfer of energy sources in decentralized energy supply zones to local fuels and renewable sources. Modernization of housing stock (energy saving potential ~50%) Implementation of pilot projects in the budget sphere (Figure 4). The reduction and consumption of electricity is facilitated by the installation and use of automated control systems. In particular, street lighting is one of the target sectors for the introduction of smart energy-saving technologies – it accounts for up to 40% of city budgets for electricity, and smart technologies can save up to 30% of these costs.

In Russia, there is great potential for a renewable, but poorly used energy resource – biomass formed by urban and rural waste, agricultural production, forest waste and peat. At the same time, in Russia about 12% of electricity is consumed for lighting, and the world average is 20%. The energy consumption for lighting parks, squares, embankments, courtyards, decorative and advertising lighting is taken in the amount of 20-30% of the energy consumption for lighting streets and squares. More than 50% of the energy consumed by artificial lighting systems comes from commercial and industrial buildings. In such regions of Russia as the Moscow Region, the Udmurt Republic, Vladimir, Leningrad, Belgorod, Murmansk Regions, Perm Territory, Samara Region, Stavropol Territory, Krasnodar Territory, Omsk, Irkutsk Regions, Khabarovsk Territory, pilot projects for the creation of biogas plants are already being implemented today.

For processing agricultural waste into biogas, electricity and heat, with the accompanying production of fertilizers. In 52 regions, work is underway to prepare business plans for the implementation of such projects. For the further development of bioenergy, it is necessary to develop a comprehensive program, including measures to subsidize this area and to develop an appropriate regulatory framework (Verma, 2015). Without these measures, bioenergy in Russia has no future. On the part of the state, a decree of the President of the Russian Federation "On some measures to increase the energy and environmental efficiency of the Russian economy," which provides for the allocation of budgetary allocations for the implementation of pilot projects in the field of renewable energy and environmentally friendly technologies, has become a fundamentally important document.

An order of the Government of the Russian Federation (January 2009) determined the main directions of state policy in the field of development of the electric power industry based on the use of renewable energy sources for the period up to 2020 and set targets for the use of renewable energy sources in the electric power industry. In the process of analyzing the main documents, we can conclude that there is insufficient coordination of strategies and programs both in the administrative (between programs and strategies of the federal and regional levels), and in the socio-economic context (between programs and strategies for the development of energy and industry). The weak correlation of the main documents is confirmed by Decree of the Council of the Federation of the Federal Assembly of the Russian Federation of May 26, 2010 No. 199-SF "On the report of the Council of the Federation of the Federal Assembly of the Russian Federation of 2009 "On the state of legislation in the Russian Federation" that a significant part of the legislative decisions on problems of the North and the Arctic is not implemented or is not fully implemented (Kaur, 2017). The "Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period until 2020," which is being developed, should solve a number of problems voiced above and lay the foundation for creating balanced regional programs for the socio-economic development of the Arctic territories. The dependence of the cost of generated electricity on the cost of fuel (coal) in the Arctic is shown in Figure 5.

Figure 4: Dynamics of electricity demand in 2012-2013 and forecast for 2014-2016, billion kWh



Source: Ministry of Energy of the Russian Federation, 2019

5. DISCUSSION

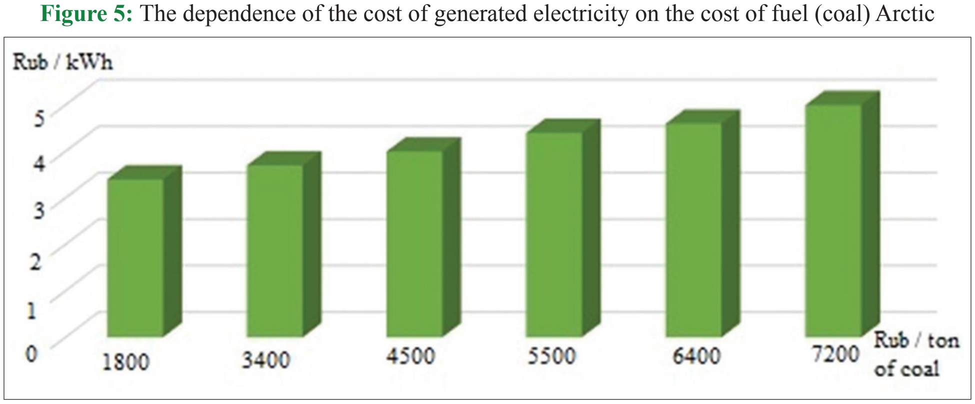
Rank analysis as a component of the theory of stable distributions formed by the French mathematician Paul Levy and developed by the Soviet mathematicians A.N. Kolmogorov, A.Ya. Khinchin, B.V. Gnedenko, V.M. Zolotarev (Burak et al., 2015), started to be actively applied by the scientists of various scientific branches, including science studies, astronomy, economics, energetics (Kuznetsova and Makarenko, 2018) and others over the recent 5 years. The rank distribution looks as follows:

$$H(r) = A_1 / r^{\infty} \quad (1)$$

Where r – 1,2,…– rank; for $r = 1$ first point A_1 – element with the maximum value of the parameter; α – rank ratio characterizing the rate of rising of the distribution curve (usually $0.5 \leq \alpha \leq 1.5$).

The design of the commercial proposals for the consumers regarding the complex solution of the electrical energy supply

Figure 5: The dependence of the cost of generated electricity on the cost of fuel (coal) Arctic



Source: Ilynykh et al., 2018

Table 1: Internal problems of the electric power industry development in the Arctic region and Russia as a whole

Internal problems	Actual tasks of development
Slowed down post-crisis development of the Russian economy and electric power industry	Growth of financial stability of industry entities and reliability of power supply
Aging and high level of wear of the main power equipment, low rates of its renewal. Operation of power equipment beyond the regulatory time frame with a lack of incentives to decommission or upgrade it. Limited opportunities to attract long-term financial resources	Development and implementation of new mechanisms for attracting investment in the development of the electric power industry, modernization and updating of energy equipment, decommissioning or modernization of economically inefficient, physically and morally obsolete equipment with the introduction of the necessary volume of new capacities
High level of energy and electricity consumption of GDP, low energy efficiency of the industry	Development of the potential for energy conservation and energy efficiency. Decrease in the level of energy and electricity intensity of GDP
Low share of renewable energy sources and small distribution generation in the structure of electricity production, the need for structural transformation of the electric power industry	Optimization of the power industry structure by types of generation and types of energy resources used, effective combination of centralized energy supply, distributed generation and renewable energy sources
Negative impact of the electric power industry on the environment	Reducing pollution indicators to the technological and economic limit
Incompleteness of the functioning model of domestic energy markets, insufficient competition in the electricity and capacity market. The problem of cross-subsidization and the establishment of economically reasonable prices (tariffs) for electricity. Lack of mandatory requirements for subjects and objects of the electric power industry, their creation and operation, technical characteristics, personnel	Enhancing competition and efficient functioning of energy markets. Development of energy infrastructure. Elimination of all types of cross-subsidization and the transition to full-fledged long-term pricing. Improving the state regulatory system, the formation of a regulatory framework that protects the rights of investors. Removing unreasonable administrative barriers
Lack of qualified personnel	Full provision of qualified personnel

Source: Compiled by the authors

issues including the use of the distributed energetics technologies will become an innovative direction of the LRS development. The organizations rendering services on the optimization of the energy supply costs are focused on the consumer’s goal, create their value and ensure the increase in the cost based on the electricity consumers’ interests support and support the growth of the energy efficiency both of the sector and of the Russian economy in general (RF Government Regulation “On approval of the state program of the Russian Federation Energy Efficiency and Energy Development,” 2014).

At the same time, the electric power industry of Russia, including the Arctic, is faced with a set of internal problems, which, in conjunction with the tasks of developing the electric power industry of Russia, are systematized by us in Table 1. The author investigated the internal problems of Russia’s energy development on the basis of an analysis of key indicators characterizing the state of the industry, which include the volumes of generated and consumed electricity, the utilization rate and structure of the installed capacity of power plants, the level of depreciation of fixed assets, and others. The Russian energy system includes thermal power plants, nuclear facilities and hydropower.

An important reason for the low level of efficiency of power plants is the significant amount of obsolete energy equipment. Therefore, the main internal challenge to the energy policy of Russia is the need for deep and comprehensive modernization of the electric power industry. Information on the degree of depreciation of fixed assets of commercial organizations in Russia, with the exception of small businesses, in comparison with indicators on the type of activity of production and distribution of electricity, gas and water for 2004-2015. Presented by us according to the Federal State Statistics Service of Russia.

The statistical analysis of profit margin showed some commonality in the LRS corporate policy, which may be elaborated during the rank analysis allowing estimating the structural stability of the last resort suppliers’ system.

The strategies of the organizations selling electrical energy should be based on the integration of the theoretical developments and the applied aspect in the sphere of the energy management, support a wide range of services aimed at the optimization of the energy sector operation and the increase of its energy efficiency.

6. CONCLUSIONS

Thus, the energy sector at the present stage needs economic and legal support: favorable conditions for investing in small energy facilities, attracting various sources of investment and creating a favorable tax and credit environment, supported by law. These measures are able to provide favorable conditions for the work of independent electricity producers and the implementation of competition mechanisms in the electric power industry. Consequently, energy should be much more actively developed in Russia, since it allows solving many problems of the country’s energy supply and is: an important specific area of energy conservation for heat and electricity producers; one of the ways to save energy at the consumer; a means of solving energy supply problems for many regions of the country that are problematic in terms of energy; a source of clean energy, which helps to reduce harmful emissions of energy and improve the environmental situation in the regions; an attractive investment area for various programs, including through "emission quotas"; one of the ways to commercialize the electricity industry; an important means of supporting small and medium enterprises and independent energy producers. In addition, it allows you to have additional capacities in energy systems and optimize equipment loading schedules at power plants, taking into account their seasonal use. It is important to emphasize that the development of small energy, as never before, is actively supported by the population, the administrations of many, especially energy-deficient regions.

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