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EFFICIENCY OF THE ELECTRICITY MARKETS IN RUSSIA

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Abstract

A detailed analysis of the restructuring processes in an individual country requires the knowledge of the initial physical and organizational state of the electric power sector. Each country is concerned about the efficiency of its power sector and is interested in the application of positive experience gained by other countries. The paper describes the main characteristics of the power sector in Russia, as well as the concepts of the power sector restructuring and market organization. The paper summarizes the achievements and current challenges of the sector. Among existing problems are weak competition in the retail markets, reduction in electricity production at combined cycle power plants, existing excess of generation capacity and high level of the transmission rates. Relevant future activities for the sector modernization in Russia can be helpful for the improvement of electricity markets in other countries.

Keywords: Current problems, Electricity market, Power sector, Regulatory framework, Sector reform.

1. Introduction

Development and modernization of electricity markets have become an important policy trend in many countries. If the electricity market is not sufficiently effective, it can be a reason of unfair electricity pricing, reduction supply quality deterioration, and decline of investment inflow in the power sector.

Following the positive market experience that has proved successful in some developed countries can help in improving the national economic climate in countries with still immature markets. Implementation of such experience can accelerate expansion into new and development of existing markets. However, the success in the market reforms depends on the development of the local market-based institutional frameworks. Therefore, similar approaches and actions toward market modernization should be adapted to the formal and informal institutions existing in each country.

There is a significant number of publications related to the analysis of electricity markets shaping and development. Market configurations and properties are considered for developed, transition and developing countries. Market properties were studied from different points of view, including the aims of reforms, starting conditions, government interposition, electricity price levels and investment attraction.

The approaches to the liberalization of the electric power industries were appreciably different in the various countries. The reforming experience and effects depended on economic and technological characteristics of the industries, evolution in regulatory systems and a variety of ownership structures. Since monopolies frequently resulted in the price rising, governments accepted two basic models for the electric power industry: 1) Industry is the State integrated monopoly, and 2) Industry combines regulated private companies. Many countries (e.g., Ireland, France, Greece and Italy) consolidated and nationalized their electric power industries as State monopolies, supposing that State companies will operate in the public interests instead of maximizing their profit. In Germany, there were regional state monopolies, as a variant of the first model. The second model of the sector organization was chosen in the USA and Japan, where private companies were regulated based on production costs and profitability of investment capital [1].

In those countries, that included privatization in their plans of reform, the order of privatization and liberalization also varied. In England and Wales, privatization preceded liberalization, whereas in the Scandinavian countries liberalization preceded partial privatization. As a whole, however, there is a tendency to privatize the generation and selling of electric power, both through active programs of sector privatization and through market access for new private generating companies [1].

The driving forces for the sector reforms in developed and developing countries were different. In developed countries, the main aim of the reforms was to improve the performance of relatively efficient systems. Developing countries had to reform less efficient electricity systems with less developed private sectors, weak economic and political institutions [2]. Against the negative background of many developing countries, a new standard model for power sector liberalization was formulated. Realization of the standard model included the following steps [3, 4]:

- Corporatizing and commercializing the state-owned utilities.

- Enacting laws to create independent regulatory agencies.
- Separating potentially competitive activities from the natural monopolies.
- Introducing independent power producers to facilitate investment in generation.
- Designating an independent system operator to direct safe, reliable, and economically efficient operation of interconnected electricity systems.
- Introducing the wholesale and retail markets based on trading arrangements for voluntary energy and ancillary services.

There were clear pre-requisites for introducing wholesale and retail competition, also known as the culmination of the standard model [4].

Following generally the standard model, the liberalization process is successfully developing in China [5]. The main steps of the standard model are extended in China by additional elements appropriate to a low carbon transition, which involves subsidies in lower carbon generation technologies [6]. Main elements of the Chinese sector reform are based on market restructuring and ownership changes; supportive secondary market arrangements; appropriate economic regulation; and, efficient promotion of low emission technologies.

Reforms in the developing non-OECD (Organization for Economic Co-operation and Development includes 36 member countries) in Asia were implemented in spite of chronic electricity shortages, weak institutional capacity, and complex political factors. Consequently, the viability of the standard model for Asian developing countries was debated extensively [4, 7, 8]. It was postulated that restructuring towards greater competition could improve technical performance, maximize economic welfare and transfer the surplus to consumers [9].

Sen et al. [7] submitted the results of the investigation on the effectiveness of the standard model for non-OECD developing countries in Asia:

- Measures of restructuring (or structural reform) carried out earlier appear to have had a greater influence on the outcomes of electricity reforms.
- There is a tension between economic and welfare impacts. The measures associated with positive economic growth are often associated with negative effects on welfare indicators. For the Human Development Index (an indicator of per capita income) electricity sector reforms have no significant associations with welfare.
- Country-specific institutional factors have strongly influenced the outcomes in non-OECD countries. Therefore, the uniform application of the standard model without reference to the specifics features of the countries is unlikely to have positive indices in the anticipated outcomes.
- Competition in the generation (as opposed to monopoly) has helped to lower costs and introduce new capacity. This implies a much greater role for competition in order to meet public policy objectives.
- In many non-OECD developing countries, marginal costs were above average costs when liberalization took place. This implies that prices had to rise during some period after liberalization and that governments should be active in regulation.

Initiating and transforming the electricity market have been the key efforts in the Russian power sector during the last two decades. As was the case in many other countries, Russia's power sector was based on vertically integrated state-

controlled regional power companies. The problems of cross-subsidies and lack of incentives to reduce production costs encouraged industrial and State authorities to introduce a competitive electricity market. During the time of the reforms, the vertically integrated companies were broken up into competitive generation and supply sectors. Network business remained under state regulation. Deregulation of relationships in the generation sector was expected to create a competitive market environment, stimulate efficiency enhancement, and result in fair electricity prices for consumers. This paper gives an overview of the Russian electricity market characteristics and discusses the unsolved problems of the market organization.

Russia is drawing on the international experience of liberalizing the electricity power sector, but it is a long and complicated process. In addition, no well-defined system exists for creating an optimal electricity sector. The results of liberalization in different countries are often controversial [10]. This attaches special importance to consideration and analysis of international experience in devising reformation policy and sequencing implemented measures. Russia's experience of the electricity sector reform could be helpful for many countries developing electricity markets.

2. Electricity Power Sector in Russia

The electric power system in Russia consists of the Unified Energy System (UES) and generating and network facilities of industrial enterprises. Generation facilities in the UES run synchronously on a vast territory spanning almost 4000 miles from east to west. The UES in Russia covers 9 time zones and creates significant economic benefits for both residential and industrial consumers. According to the System Operator of UES [11], power plants of the UES produced 94.3% of total electricity generated in 2016 in Russia. Industrial companies share in consumption was 5.7%. Power plants of the UES produced 1048.5 bn. kWh. Consumption of electricity this year amounted to 1026.9 bn. kWh.

The total installed capacity of power plants in the country reached 244 gW in 2016. The capacity of the plants in the UES was equal to 236.3 gW. Most of the generation capacities (67.8%) are concentrated at the fossil fuel thermal-electric power plants. Hydroelectric plants contribute 20.3% and nuclear power plants 11.8% of the total installed capacity. Renewable energy sources of wind and solar electric farms maintain only 0.04% of the total capacity within the UES [11]. More than half of installed capacities at thermal-electric plants generate heat and electricity simultaneously in combined (cogeneration) cycle.

Extensive transmission network in Russia operates a range of equipment of voltages from 220 to 1150 kV, which helps to reduce the demand peaks in winter. UES owns 96% of the transmission and distribution system. Open Joint-stock company Federal Grid Company (FGC UES) was established in 2002 for the purposes of the transmission system maintenance and operation. The national electric network of Russia consists of seventy-four regional power networks. Sixty-nine of them are integrated into the Power Grid of the UES and are combined into seven Integrated Power Systems (IPSs). Six IPSs work in parallel and one IPS (the Eastern IPS) operates separately. The country's transmission grid remains under state control. The Russian government owns the main block of shares in the capital of FGC UES (no less than 75%). As of September 2012 government had 79,55% of shares [12].

The control of the huge and synchronously operating system in Russia is a complex engineering task, which has no precedent anywhere in the world. The stock company "System Operator of UES" (SO UES) operates the Russian UES. The system operator forms the main technological infrastructure for the power sector. It performs a full range of activities necessary for the functioning of market mechanisms and for reliable operation of the UPS. The system operator technically organizes and performs competitive capacity selection, provides all information for the on-line operation and control. At the system services, SO UES formulates the technical requirements to the suppliers of services, technically organizes and performs the competitive selection procedures, signs contracts for supply and provision of these services [13].

The market council is an entity established for the fulfilment of the legislative requirements; it is a non-profit self-regulatory partnership, consisting of representatives of all parties of the Russian electricity market. Its main aims are to support and develop the operation of the wholesale market-trading infrastructure, create favourable conditions for attracting investment. The market council takes part in the formulating market rules, maintains the register of wholesale market participants, and carries out market dispute resolution, integrating all groups of market entities [13]. The Trading System Administrator (Commercial Operator) is a subsidiary structure of the market council. It administers the wholesale market and facilitates the trade by bringing together sellers and buyers.

Russia exports considerable quantities of electricity to the countries of the former Soviet Union, as well as to Mongolia, China, Poland, Norway and Finland [12, 13]. UES also has plans to export electricity to Iran, and possibly, to Afghanistan, from two hydroelectric plants, which are currently under construction. A separate company for electricity import and export was established for the development of international cooperation.

3. Electricity Sector Reform and Establishing Market in Russia

Common problems for many countries in the 1990s were ageing infrastructure, large distribution losses, inefficient management and increasing price pressure on the end consumers. These reasons encouraged many countries to embark on reforms to liberalize their power sectors and increase its cost-effectiveness. Some countries initiated power sector reforms as early as the late 1980s and early 1990s. In Russia, the reform started later in 1992.

As was the case in most countries, Russia's electricity sector was dominated by a vertically integrated, state-controlled monopoly. Electricity was also deemed increasingly important in facilitating industrialization and economic growth. The aim of the Russian reform was to replace a state-controlled subsidized monopoly with competitive private enterprises in order to secure the reliable and efficient supply of electricity to domestic consumers. Like elsewhere, the core of the reform consisted in unbundling the vertical monopoly into potentially competitive segments, and in the attraction of new private and possibly foreign investment. The reform included privatization of generation infrastructure, the introduction of new investment mechanisms, encouraging fairer pricing, and creation of key market and regulatory institutions [14].

The power companies were first unbundled into two segments: competitive and monopolistic. The competitive segment was to include generation and power sales, whereas dispatching, transmission and distribution were defined as partially monopolistic businesses, not suitable for market competition. Central dispatching and system operations, as well as the high-voltage transmission grid, were transferred to new state-owned companies. Generation assets were restructured into a number of competitive wholesale and territorial generation companies. New electricity sales companies were formed in the regions.

As a result, the Russian power sector has a fully state-owned System Operator, SO UES and a state majority-owned high-voltage Federal Grid Company, FGC UES. The Russian State is also a majority shareholder in 11 regional distribution grid companies. Each of them combines a considerable number of local distribution networks. The local distribution networks belong to the municipal governments, industrial enterprises or are private. The state retains its complete control of nuclear power generation through a state-owned company, RosEnergoAtom [12].

After a detailed analysis of achievements and problems in the first stage of the reform in 1992-2001, the Russian government approved a new plan for the next stage reform continuation. The basic principles of the new plan included unbundling the incumbent monopoly, creation of an independent regulator, privatization of generation, and liberalization of electricity prices [15]. Finally, two types of generation companies were formed. Wholesale electricity generation companies (OGC) consist of power plants specialized in electricity generation. Their plants are located around the country to prevent the creation of local electricity monopolies. Regional generation companies (TGC) generate both electricity and heat. Their assets consist mainly of Combined Heat and Power Plants (CHPP). TGCs' assets are typically located in neighbouring regions. By the end of 2006, seven wholesale and fourteen regional generation companies were created.

Russia's reform of the electric power sector is widely recognized as one of the most ambitious reform processes ever undertaken by any country. The outcome of this process not only affects substantially the energy sector but also on Russia's long-term economic performance.

The federal wholesale and regional retail markets were designed and launched in 1996. The wholesale market covers a huge geographical area from the western border of Russia to Eastern Siberia [14]. Due to its size, the wholesale market is split into two price zones: European and Siberian parts of the country. The price zones provided almost 95% of the total electricity consumption in 2016. The areas with regulated prices and off-grid power systems supplied less than 5% of the total amount. In addition to these two price zones, there are some regions in the Russian Far East and Northern European part of the country with regulated electricity pricing. These regions are called "non-price zones" of the wholesale market. Large territory in the Northeastern part of Russia has very small residential and industrial consumption. This territory is supplied by off-grid power systems, which are not connected to the UES. Electricity provision of this territory is not carried out by the wholesale market.

The structure of the wholesale market is conditioned by the unique and very sophisticated combination of two markets. One of them is the electric energy (electricity) market, and another one is the generation capacity market. The electricity market is designed to cover the operating costs of electricity generation,

whereas the proceeds from the capacity market should cover the fixed costs of generation. Anyone buying electricity on the wholesale market has to buy both electric energy and capacity. Therefore, every electricity market participant has to participate in the capacity market as well.

The participants of the wholesale market are generation companies (OGC and TGC), state-owned nuclear company RosEnergoAtom, technological (SO UES) and trading (commercial) operators, retail suppliers, transmission and distribution grid companies, electricity import-export operator, and large consumers [14].

The wholesale electricity trade in Russia has several forms including regulated contracts for delivery, free bilateral contracts, a day-ahead market, and the balancing market.

Electricity delivery at regulated prices is used in the non-price regions as well as in isolated areas. In two price zones, electricity is traded both at free prices and according to Regulated contracts. Regulated contracts in the wholesale prices zones may only be signed for the supply of electricity to the population. Prices under-regulated contracts are set by the federal executive body responsible for price regulation. Electricity volumes not covered by regulated contracts are sold at non-regulated prices through other means. Regulated contracts in the price zones took almost 15% of the total consumption in 2016. Under free bilateral contracts, market participants may choose their own counterparts, contract period, prices, and supply volumes. Only 4% of electricity was sold in 2016 through free bilateral contracts.

Power plants and electricity suppliers can participate in the Day-Ahead Market (DAM) based on a competitive selection (auction) of price bids with delivery on the day following the day of the auction. The trading operator carries out the selection of bids. Prices and supply volumes are determined for each hour of the next day. Locational marginal pricing is used at the DAM. Based on studies by Palamarchuk [14], the locational prices are determined for each of the roughly 8000 nodes in both price zones and are published daily on the trading operator website. Locational prices include the marginal costs of energy, losses and transmission congestions.

Electricity amounts traded under bilateral contracts and at the DAM determine the forecasted consumption of electricity. However, the actual consumption often differs from the forecasted volume. Trade of the deviations from forecasted production/consumption is carried out at the Balancing Market. It is a real-time market organized by the System Operator (SO UES). On the balancing market, the participants' offers are auctioned by the SO twelve times during the day of actual delivery of electricity. Three hours before each delivery hour the System Operator makes an additional competitive selection of suppliers' bids, considering cost-effective plants dispatching and system reliability requirements. Figure 1 demonstrates the interaction between different kinds of markets [16].

Guaranteed reliability of electricity supply is a strategic objective of any power sector. The capacity market is designed to meet this objective and to provide generation companies with necessary investments for their development. The market system was organized by the System Operator and launched in 2010. Generation capacity is traded based on Competitive Capacity Selection (CCS) considering generation bids. Not all available capacity is selected through CCS, which increases competition among capacity suppliers. Consumers are required to pay for all capacity selected at the CCS.

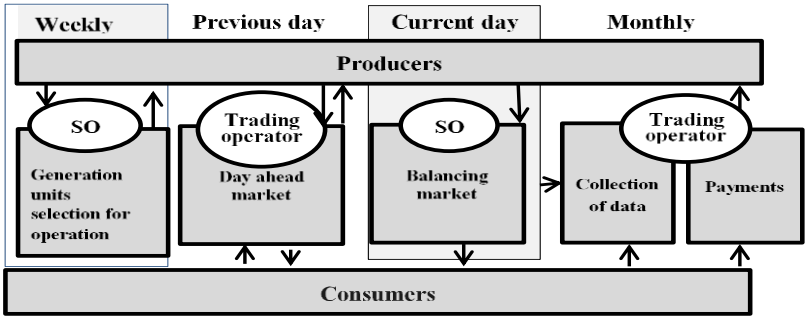

Fig. 1. Interaction of markets within wholesale electricity market.

Capacity not selected at the CCS is not paid for, except for the capacities that must run in order to support technological requirements or to supply customers with heat ("must-run generators"). The capacity of the "must-run generators" is paid for at individually regulated rate.

There are two kinds of capacity markets. An annual one selects the bids submitted for each month. A long-term market selects generation capacity for 4 years ahead. Long-term market guarantees capacity payments during the construction of new generating facilities. CCS in the long-term capacity market is conducted based on the system operator's demand forecast for the relevant delivery period.

Regional retail electricity markets trade electricity and capacity purchased on the wholesale market, along with electricity produced by small regional generating facilities. The main participants in the retail market are electricity consumers, retail suppliers, municipal services providers, and distribution network companies, operational dispatch offices at the retail level, and generators that do not have the right to participate in the wholesale market.

Electricity and capacity prices for retail customers depend on the situation in the wholesale market. Prices for the end customers include non-regulated prices for electricity bought on the wholesale market, capacity prices, grid services, and infrastructural and retail payments (municipal management, dispatching and trading administration). Correlation of price components is shown in Fig. 2 [16].

The residential prices, however, remain to be established by the federal and local regulating entities. Household consumption prices remain below the industrial prices. Consumers in the retail market are free to choose their supplier and to change their previously selected supplier.

Network prices for electricity transmission and distribution, as well as the cost of technological connection to the networks of the Unified National and territorial grid companies, are subject to government regulation. The transmission and distribution prices are set according to a "cost-plus" method. Once a year the regulator determines the following year's rate based on the anticipated transmission loss amounts and operating costs.

Transmission and distribution rates are different for the networks of different voltage classes. The "cost-plus" strategy is not economically efficient. It does not

provide sufficient incentives for network owners to reduce maintenance costs and increase the efficiency of network operation.

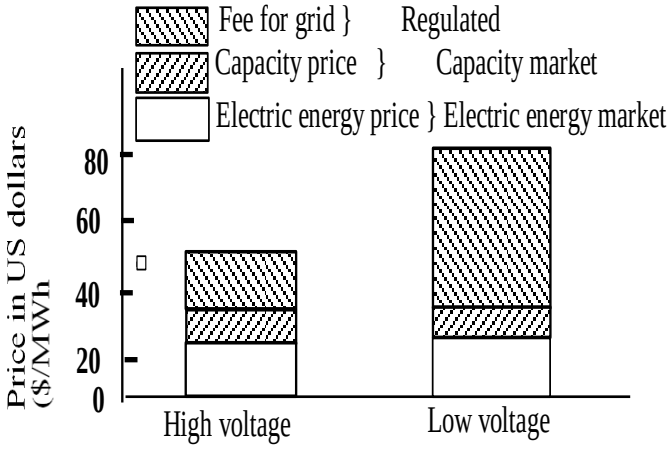

Fig. 2. Price breakdown as of December 2016 in Moscow.

Urgent need for new capacity in 2008-09 forced the Russian government to follow a direct administrative approach rather than utilizing a market mechanism. Since 2010, the government was looking for a tool that would both ensure the generation companies were responsible for investing in new generation capacity and provide them with a guaranteed rate of return on investments. The solution came in the form of 'Capacity Supply Agreements' (CSA) - a type of formal obligation for generation companies to build new generation units. In return, the companies were given compensation above regular capacity market prices for the new capacities plus a certain rate of return on invested capital.

Capacity supply agreements were launched in 2010. Over 100 investment projects were implemented across Russia. This brought about 30 GW of new generating capacity. Apart from renewing ageing assets, the agreements also had a positive effect on the energy equipment manufacturing and construction industries.

At the same time, capacity expansion under CSAs has had some drawbacks. The first issue relates to the over-optimistic forecast for electricity demand that was approved by the government in 2008. Under a base scenario, the annual demand growth was expected at 4.1 per cent from 2006 to 2020. However, the economic crisis in recent years has resulted in the stagnation of economic growth and the demand forecast has not been achieved. Actual consumption of electricity grew much more slowly. Between 2006 and 2017 the annual demand growth reached only 0.7 per cent and in 2016. Fortunately, not all the proposed new capacity had been build. Yet even the 30 gW that were eventually added contributed to significant surplus (20-25 GW) of capacity in the system. Additionally, there is no efficient mechanism to choose old generation facilities for elimination from the market [17, 18]. Consumers had to pay excess capacity fees, while utilities ended up with lower utilization of their assets.

Excess in generation facilities and overinvestments in generation capacity results in rising electricity and capacity prices. This promotes large consumers investing in self-generation and going off-grid. This would reduce demand from the central grid and would transfer the burden of supporting the fixed grid costs to other consumers. Reduction the electricity consumption from UES raises maintenance costs of existing electrical networks and creates disastrous effects for small business and weak commercial enterprises.

Due to lower industrial demand, the heat supply has decreased by roughly half during the last 30 years. The number of small municipal boilers has increased by more than 20 per cent since 2000 [16].

4. Results and Discussion

The successful result of the power market reform in Russia was the creation of the competitive wholesale market. Electricity prices reflect the supply-demand balances much better than, for example, gas prices, which remain largely under government control. This was particularly evident in the global financial crisis of 2008, when the power consumption decline put on a break on energy price growth, despite the fact that fuel costs (especially for gas power stations) continued to rise. The behaviour of the electricity prices in the years 2008-2017 is shown in Fig. 3 [16].

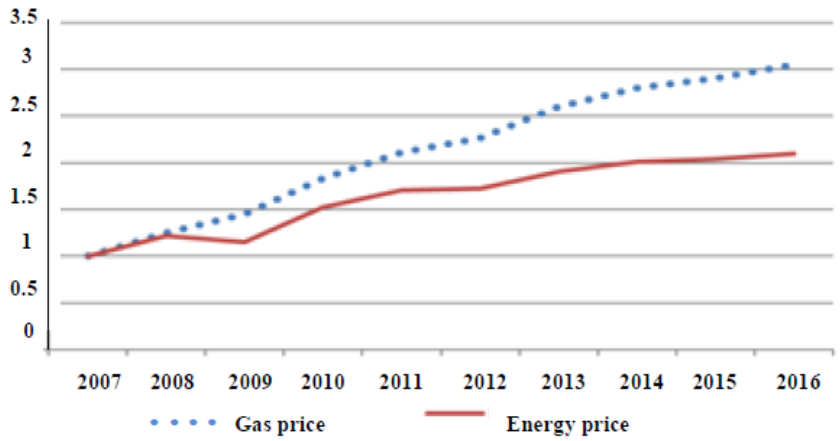

Fig. 3. Electricity and gas prices as multiplies of their 2007 levels.

Russian Government in Resolution #526 of July 2001 formulated current aims and difficulties of the electricity sector reform, "On Restructuring the Electric Power Industry of the Russian Federation". Among the most important objectives were:

- Development of competition in generation and supply spheres.
- Establishing financial transparency of electricity markets and regulated sectors in the electric power industry.
- Cost reduction in generation, transmission and distribution of electric energy.
- Attracting investments to competitive businesses and developing networks.

In spite of significant structural and managerial transformations, not all of the necessary goals have been reached in the last 15 years. The most evident and significant problems are as follows:

Reduction in electricity production from combined (electricity and heat) cycle at Combined Heat and Power Plants (CHPP). Power generation at CHPP is being pushed out from the market by traditional (condensing) thermal (steam-power cycle) power plants. The centralized heat supply is replaced by small heat-only boiler stations.

In Russia, 67.8% of generation capacities are installed at thermal power plants. Almost 37% of these capacities are concentrated at CHPPs. Large-scale CHPPs cater for 70% of all heat demand in the country [11]. Combined electricity and heat production noticeably improves fuel utilization efficiency.

However, over the last years, CHPP's share of the heat supply to local heating systems has been constantly decreasing. The reason for the decrease is the expansion of small-scale distributed heat sources. Industrial enterprises construct their own boiler stations and force the power systems to shut down inefficient obsolete CHPPs. In 2014 alone, nine large-scale public use CHPPs were closed. The total number of such plants reduced from 537 to 528. Consumers' refusal of centralized local heating supply results in low utilization of CHPP heat capacities. In many cities, these capacities are used only to 30-35% of their nominal capacity. Low load reduces the efficiency of combined heat and electricity production.

Many inefficient CHPPs are hardly ever chosen in the process of competitive capacity selection in the capacity market and appointed as "must-run" generators. The regulated prices established for them increase the overall prices for end-users. The following measures are being taken to increase the loading of CHPPs and strengthen the role of the centralized district heating:

- Heat leaks from heat pipelines are being eliminated,
- Temperature parameters of heat supply to consumers are being optimized,
- Improved automatic pressure and temperature regulation systems in the heat distribution equipment are being introduced.

A large share of electricity is sold at prices that incorporate various extra charges and subsidies. They are related to the regulated price setting for "must-run" generators, subsidies to compensate for higher costs of renewable energy sources and lower prices for some territories of the country due to an increase in prices for the other territories. Josefson and Rotar [19] explained that artificial increase or decrease in prices is a form of the cross-subsidies of different kinds of activities and territories.

Available excess generation capacity while there is no clear mechanism in place for old and ineffective generation facilities elimination from the market. Excess capacity occurred in 2010-2013 due to electricity consumption lagging behind the forecasted values. By early 2017, the actual capacity surplus (over the reserve margin) on the market is estimated to be almost 20-25 GW (or 15 percent of the total capacity requirement) and it is unlikely to decrease significantly in the next five years [17, 18].

The excess capacities are often classified as "must-run" generators or long-term capacity reserves. Maintenance of such facilities increases generation costs and therefore, increases the prices for industrial electricity consumers. Excess capacities reduction first requires the development of the rules for the identification

of ineffective capacities. Over the past years, the plans for putting new generation plants into service have been adjusted depending on the rates of the actual consumption growth. Consideration is given to search for the funds to remove generation units from service and to form a long-term reserve.

Withdrawal of large-scale electricity consumers from the system of centralized electricity supply. Rising electricity and capacity prices, as well as elevated electricity transmission rates, forces major consumers to build their own generation facilities. The reluctance of consumers to receive power from UES leads to a reduction in the utilization of power plants in the generation companies (OGCs and TGCs). This raises maintenance costs of existing electrical networks. Consumers' decisions to disconnect from large-scale power systems decrease the reliability and quality of power supply. In addition, it reduces the efficiency of fuel utilization and forces consumer prices up.

Weak competition in generation and sales sectors in the retail markets. The rules of the wholesale and retail markets in Russia require that electricity generated by power plants with a capacity of 25 mW and higher must be sold only in the wholesale market. This requirement constrains the development of distributed generation near consumption areas, increases prices for retail market consumers and virtually excludes competition among power plants for power supply to retail consumers. Moreover, this requirement looks particularly absurd when generation is connected to distribution networks and does not have any direct connection to the transmission network of UES.

If the ban on electricity deliveries by large-scale power plants to retail markets is lifted, the transmission rates and payments for System and Commercial operators' services will reduce. The end consumer will be able to make direct contracts with local power plants for power supply at lower prices. Apart from the big power plants (with 25 mW and higher) ban on participation in the retail markets other problems still remain unsolved. These include:

- A small number of independent competing retail suppliers. Consumers of retail markets are virtually deprived of any possibility to choose beneficial retail suppliers.
- Absence of direct contracts for electricity supply within retail markets. The requirement to remove power plants with a capacity of above 25 mW to the wholesale market deprives retail consumers of the possibility to use the cheapest electricity generated by local power plants.
- Consumers' failure to pay for consumed energy. Imperfect rules of retail market do not ensure timely interaction between end consumers and retail suppliers and necessary payment for the transmission and distribution services.

It should be kept in mind competitive environment has not been completed for retail markets. Currently, the Ministry of Energy jointly with the market council is developing a packet of legislation to substantially improve the operation of retail electricity markets in Russia.

High level of rates for electricity transmission and distribution services. In many areas of the country, these rates reach 50% of the final electricity price. The level of transmission rates in Russia considerably exceeds the best world indices [20].

One of the reasons for the high costs in the network sector is the low quality of investment planning. Under the influence of local administrative bodies, the plans

of electrical network expansion often include redundant lines and substations. This leads to the construction of under-loaded lines and an unreasonable rise in their maintenance costs. At present, there is a need to change the legislative framework and mechanisms for developing network expansion plans. New practice should increase the stimuli for network companies to improve the efficiency of their operation, including the introduction of payment for excess transmission capabilities. The regulation of transmission rates should be based on advanced indices of personnel numbers, equipment rent and labour productivity levels. The transmission rates should be imposed on the basis of "reference cost levels" that correspond to the best practices for similar developmental and operational conditions. Introduction of new principles of investment planning and rate regulation will lead to a decrease in consumer prices and make network companies be more interested in reducing the costs.

Existence of cross-subsidization of consumer groups and territories. The cross-subsidization distorts pricing signals in the sectors of the national economy and makes the pricing system non-transparent. Subsidization in Russia favours domestic consumers, some individual consumers benefitting from imperfect transmission rates setting, and some large territories, such as Northern Caucasus, Crimea, Kaliningrad region and others [21]. Plans for the next stages of the electric power industry reforms include reduction of various types of cross-subsidization. However, withdrawal of subsidies will affect the interests of the population and various groups of consumers. For that reason, the total amount of cross-subsidies has not been reduced in recent years.

5. Conclusions

During the period of Russia's power industry liberalization, the regional power companies were restructured, ownership forms were changed, the wholesale and retail electricity and capacity markets were launched, the federal and regional managerial bodies were formed, and anti-monopoly and rate regulation systems were established. Competition development and regulatory practice improvement are equalled important to the success and efficiency of reform. However, to date, the process of reforms has not been completed. Moreover, it requires further structural and organizational transformations.

The most evident and significant problems in the power sector are:

- Reduction in the combined cycle electricity generation at combined heat and power plants.
- The great amount of extra charges and subsidies in the process of electricity and capacity price setting. Retention of cross-subsidization of consumer groups and territories.
- Excess generation capacity and the absence of clear mechanisms for ineffective generation elimination from the market.
- Withdrawal of large-scale electricity consumers from the system of centralized power supply. Reduction in the utilization of power plants, which belong to the wholesale and territorial generation companies.
- Weak competition in generation and retail sectors in the retail markets.
- High level of transmission and distribution services rates.

In order to overcome the problems, technical and organizational innovations, enhancing the efficiency of the wholesale electricity and capacity market, increasing the load of centralized electricity and heat supply systems, developing competition in generation and retail sectors of the regional retail markets need to be implemented.

The success of market-oriented electricity sector reforms depends on the development of the institutional framework and implementation of prioritization the necessary measures. The liberalization policy, structural reorganization and analysis of current problems in the Russian electricity sector could be helpful for many countries developing modern electricity markets.

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Abbreviations

CCS	Competitive Capacity Selection
CHPP	Combined Heat and Power plants
CSA	Capacity Supply Agreement
DAM	Day-Ahead electricity Market
FGC	Federal Grid Company
IPS	Integrated Power System
OGC	Wholesale Generation company
SO UES	System Operator of UES
UES	Unified Energy System

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