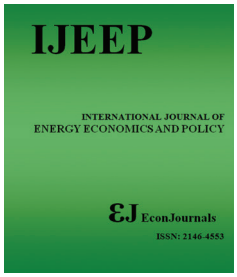

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Status of Electric Power Sector Reform in Russia

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ABSTRACT

Restructuring and deregulation of the electric power sector have had a long-term history in many countries. The sector management and Government of each country endeavor to apply positive experience gained by other countries, taking into account technical and economic conditions and features of their own power sector. The paper describes the main characteristics of the power sector in Russia, as well as concepts and principles of the power sector liberalization. The main components of the liberalization process, such as the principles of privatization, structure of property, competition promotion and regulation practice are described and can enhance policy learning. Current challenges and urgent trends in following sector modernization are presented.

Keywords: Power Sector, Electricity Market, Regulatory Framework
JEL Classification: L5

1. INTRODUCTION

The spread of the power sector reforms across both developed and developing countries has become an increasingly important policy trend over the last two decades. If the sector is not reformed, it is likely that the existent inefficiencies will hinder development of national economy and decline sector's efficiency due to lack of available resources for necessary investments. If reforms are successfully implemented there are prospects for efficient and high-quality power supply.

The major elements of the reform consist of vertical and horizontal unbundling of the production chain, in other words, separating generation, transmission, distribution and retailing functions. The other key elements of the reform include the adoption of a regulatory principle of incompatibility between competitive and monopoly businesses, as well as third party access to transmission and distribution networks. An important requirement for success of reform is efficient privatization when the business units are created from public sector companies under federal control. The only exceptions are nuclear plants and large power stations that remain in federal property.

Hunt indicated in her book (2002) that the reform measures are focused on the enhancement of (i) Energy trade and security, (ii) financial viability of energy supply entities and the sustainability of energy services, (iii) social protection in the energy sector, (iv) sector restructuring and commercialization, (v) sector regulation, (vi) promotion of private sector participation; (vii) cooperation in international energy resources utilization, (viii) littoral agreements, (ix) alternative and renewable energy options, and (x) energy efficiency and initiatives under clean development mechanism. The choice and sequencing of these policy measures depend on the situation in each country and optimal forms of cooperation.

The reforms of power sectors over the last 30 years have yielded valuable experience for policy makers in many countries. There has been growing evidence that privatization in the context of liberalization and effective regulation can bring efficiency benefits for consumers. Bringing the positive experience of some developed countries into the power sector transformation and effective regulation can accelerate expansion and improvement of new markets. However, the success of market-oriented electricity reforms depends on the extent to which the local market-based institutional framework is developed. Therefore, similar approaches to power sector reform lead to different outcomes depending on the formal and informal institutions existing in each country.

Reform of the power sector has been one of the key policy challenges facing Russia for the last two decades. As it was the

case in many countries, Russia's electricity sector was dominated by a vertically integrated, state-controlled monopoly. The problems of ageing infrastructure, large distribution losses, very low retail tariffs, and lack of market incentives to reduce production costs encouraged Russia to embark on large reforms to liberalize the power sectors in the 1990s.

It was essential for Russia to draw on the positive international experience of the sector reforms. The reform roadmap envisaged a breakup of vertically integrated structures into competitive generation and supply sectors and regulated transmission and distribution businesses. Deregulation of generation and supply was expected to create a competitive market environment, incentivize efficient production of electricity, and reveal fair economic costs of production and to improve the attractiveness of the Russian power sector to strategic investors.

This paper provides an overview of the power sector characteristics and reform results in Russia.

The objectives of this paper are to:

- Provide a comprehensive review of electricity sources, characteristics of the existing markets and regulatory policy to determine the current status of Russian power sector.
- Describe the current problems and challenges in electricity supply to define the main targets and trends in the Power sector modernization.

2. LIBERALIZATION OF THE ELECTRICITY SECTOR IN RUSSIA

2.1. Background

Russia has a unique electric power system. The installed capacity of power plants reached 240 GW and electricity production amounted to 1046 bill. kWh in 2014. Most of the generation capacities (68%) are concentrated at the thermal-electric power plants with fossil fuels, hydro-electric plants have 20.8% and nuclear power plants (NPPs) 11% of the total installed capacity. Renewable energy sources supplemented 0.2% to total electricity production. As noted earlier (Palamarchuk et al., 2001) the nuclear and hydroelectric power plants as well as the major transmission facilities are controlled by the state.

The Russian electric power system consists of the interconnected (unified) and disconnected parts. More than 90% of the generation capacities run synchronously on a vast territory spanning almost 4000 miles from east to west. Off-grid electric systems supply customers on the Russian Far East and north territories of the country. The transmission network covers 10 time zones and helps to reduce the demand peak in winter.

This part of the paper describes distinctive features of the Russian electric power sector, including electricity and capacity market transformations, main market participants, regulatory services, international links and foreign ownership. Analysis of the main characteristics makes it possible to compare the sector's status with reforming processes in other countries.

2.2. Overview of the Electricity Market in Russia

Liberalization of the Russian electricity sector has continued for almost 23 years. At the first stage (1992-2001) State property of the regional power utilities was privatized. A wholesale and regional retail electricity markets were launched in 1996.

The wholesale market covered a large territory from the western border of the country to East Siberia (Palamarchuk et al., 2008, 2009). The market realized the second model (Hunt, 2002) of the market organization. Power producers sold electricity to a single buyer. The prices in the electricity sector were fully regulated by the State. Regional utilities bought electricity from the single buyer and supplied their assigned customers without any competition at an average price regulated for certain territory.

A new stage of the sector liberalization lasted from 2001 to 2011. The State and sector legislation was renewed substantially. Vertically integrated regional utilities were unbundled into separate companies for generation, transmission, distribution and supply businesses. The wholesale electricity market was transformed into the market with competition among generation companies. Locational marginal prices were introduced for the wholesale buyers. The prices at the power market were gradually liberalized during the new stage of the reform. Currently about 80% of electric power is traded at non-regulated market prices (King and Spalding, 2013).

The participants in the wholesale market are generation companies, technological and trading operators, retail suppliers, transmission and distribution grid companies, electricity import/export operator, and large consumers. Technological (dispatch) operation and management of the electric power system in Russia is exercised by the system operator.

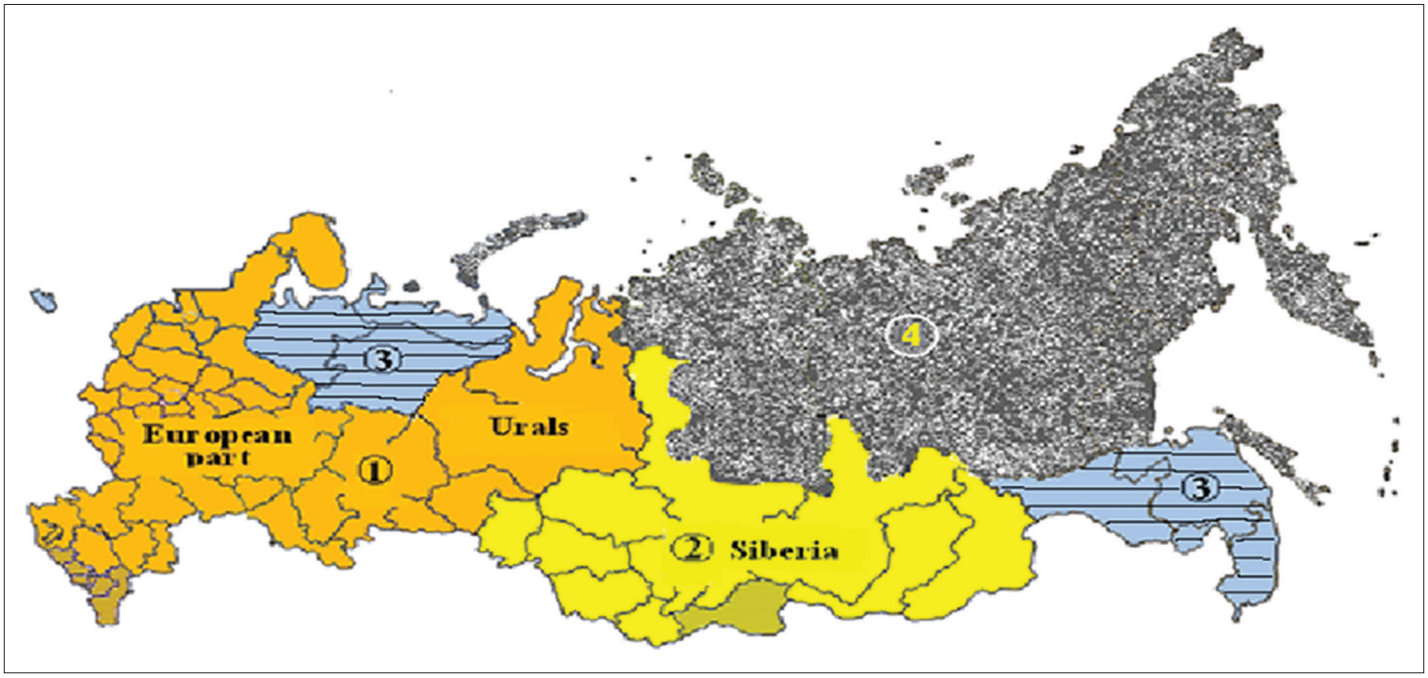
Two commodities are traded in the wholesale market: Electricity and capacity. The wholesale market functions in the regions consolidated into two price zones. Figure 1 shows that the first price zone includes the territory of the European part of Russia and the Ural region, the second price zone covers Siberia. In the non-price zones, where it is currently impossible to create competition, electricity and capacity are sold at regulated tariffs. There is no wholesale market in the off-grid power systems that are not connected to the entire Power System. Electricity is also supplied at regulated prices.

The wholesale electricity market is divided into several segments: The regulated contract (RC) segment, the free bilateral contract segment, the day-ahead market (DAM) and the balancing market.

RCs in the wholesale market prices zones may only be concluded for the supply of electricity and capacity to the population. Prices (tariffs) under RCs are calculated by the federal executive body responsible for tariff regulation. Electricity volumes not covered by RCs are sold at non-regulated prices through other segments.

Under free bilateral contracts, market participants may choose their own counterparties, contract period, prices and supply volumes.

Figure 1: Price zones of the wholesale market. (1 and 2) The first and the second price zones, (3) non-price zones, (4) off-grid power systems



In the DAM suppliers and consumers are selected on a competitive basis a day before actual electricity supply is to take place. Selection of bids is carried out by the trading operator, with prices and supply volumes being determined for each hour of the day. Locational marginal pricing is used at the DAM. 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.

Electricity volumes traded under bilateral contracts and at the DAM determine the forecasted consumption of electricity. However, the actual consumption inevitably differs from the forecasted volume. Trade in deviations from forecasted production/consumption is carried out in real time at the balancing market. 3 h before each delivery hour the system operator makes an additional competitive selection of suppliers' bids, considering cost effective plants dispatching and system reliability requirements.

The balancing market penalizes the market participants responsible for the deviations of actual consumption and production on their own initiative and rewards the participants that adhere to their planned volumes and are accurate in fulfilling the system operator's orders.

The market for electric capacities was launched in 2010. Generation capacity is traded in the capacity market based on a competitive capacity selection (CCS) made by the system operator. Not all available capacity is selected through CCS, thus increasing competition between capacity suppliers. Consumers are obligated to pay for all capacity selected at the CCS. Capacity trade imposes the obligation of generating companies to maintain a certain level of generating capacity. Capacity not selected at the CCS is not paid for, except for the capacity of generating facilities that must run in order to support the power system's technological requirements or to supply heat ("must-run generators"). The capacity and electricity produced by must-run generators is paid for at the individually regulated tariffs.

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

Regional retail electricity markets were organized with several competing supply entities. The main participants in the retail market are electricity consumers, suppliers, distribution companies 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. The residential tariffs, however, remain to be established by the Federal and local regulating entities. Consumers in the retail market are free to choose their supplier and to change their previously selected supplier.

2.3. Regulatory Framework for Electricity Sector in Russia

The regulatory services in the electricity sector are carried out by several Government controlled structures.

The Ministry of Energy is a regulatory authority responsible for the implementation of state policy in the electricity sector and for the elaboration of regulatory acts for that purpose.

The Federal Tariff and Antimonopoly Service is an executive body exercising control over price regulation for goods and services (for example, tariffs for transmission services or residential tariffs). It also regulates natural monopolies, where its functions encompass price (tariffs) determination. The body can issue

mandatory orders or penalties to the companies violating the anti-monopoly regulations in the electricity market (for example, non-discriminatory access to transmission services, avoidance of monopolistic prices, and so on).

The federal service for ecological, technological and nuclear supervision is a regulatory body responsible for implementation of and monitoring the compliance with the health, safety and environment requirements.

While the authorities described above are responsible for the overall regulation of the Russian electricity sector, the physical operation of the electric power system and markets is administered by the following infrastructure bodies:

- Market council. This is a non-commercial partnership of market participants supervising the market operation and preparing the documents used in the markets. The Market council is governed by a supervisory board that comprises representatives of market participants, the Russian Government and other market infrastructure bodies.
- Trading system administrator. This is a non-profit company established as a fully owned subsidiary of the market council. The trading system administrator administers the wholesale power and capacity market and facilitates the trade by bringing together sellers and buyers.
- Trading system administrator comprises Centre for financial settlements. The Centre acts as an intermediary for payments in the wholesale market.
- System operator. The system operator is established as an open joint-stock company to oversee the dispatch of electricity and the stable functioning of the unified electric system. The system operator is currently 100% state-owned.
- Federal grid company "Rossetti" provides operation, maintenance and development of electric networks. It supervises both the national transmission grid and inter-regional distribution networks. Currently the State owns more than 85% of the company's stock capital.

The legislative framework for the electric power sector in Russia consists of a significant number of legislative acts. These are Federal laws and Government Resolutions for general regulation, for the wholesale and retail markets organization, for regulation of access to the transmission and distribution networks, and price setting. There are also numerous special regulations that apply to other aspects of the electricity markets, such as nuclear power and hydropower utilization, energy efficiency, etc.

2.4. Main Companies Involved in Electricity Generation, Transmission, Distribution and Supply

2.4.1. Generation

Most of the generating assets are concentrated in 6 wholesale thermal generation companies (WGCs). The federal hydroelectric generation company (OJSC "RusHydro") operates more than 60 hydro-electric and pumped-storage plants. Thermal power plants (TPP) with mixed (heat and electricity) production are combined in 14 territorial generating companies (TGCs). 10 nuclear electric power plants in Russia are combined in the state-owned concern "Rosenergoatom."

The power plants for WGCs were selected so as to limit the possibilities of exercising market power in electricity market. This predetermined the application of an extraterritorial principle when each WGC represents an association of several large-scale power plants, located in different regions. Another requirement was to ensure comparable starting conditions on the market (in terms of installed capacity, average age of the equipment, expected profitability, etc.). Apart from electricity and capacity trade the TGCs are also involved in heat supply.

2.4.2. Transmission and distribution

Operation and development of the transmission and distribution networks are coordinated by the Federal grid company "Rosseti." The largest distribution company is the OJSC "Interregional distribution grid companies holding." The Holding includes 12 regional Distribution Companies. In addition, there are numerous small private distribution companies operating low-voltage network facilities.

2.4.3. Supply

The supply sector is represented by independent retailers and the Guaranteeing suppliers (Suppliers of Last Resort). The independent companies compete in prices with other suppliers for the right to provide the retail customers with electricity and capacity. Supply tariffs of the independent retailers are unregulated. The Guaranteeing suppliers prevent discrimination in access to power supply. They are obliged to provide service to any customer within their territory if there are no technical restrictions. Supply tariffs of the guaranteeing suppliers are regulated by the local regulation entities. The guaranteeing suppliers are appointed under an open tender organized by local authorities.

The State-controlled vertically integrated holding company OJSC "RAO power systems of the east," generates, distributes and sells electricity in the non-price market zone of the Russian Far East regions.

2.4.4. Export-import

The joint stock company "Inter RAO" provides export-import operations of electricity. The company also holds generating assets in Russia and abroad.

2.5. Foreign Ownership in the Electricity Sector in Russia

There are no direct restrictions on foreign ownership of electricity companies in Russia. However, certain restrictions can be applied under:

- The strategic investment law (as defined below)
- The regulations applicable to civil nuclear industry.

The Federal Law "On the Procedure for Making Foreign Investments in Entities of Strategic Importance for the National Defense and Security," (Strategic Investment Law) states that acquisition of shares by foreign investors in the companies of strategic importance is subject to state approval. Any foreign investor should obtain a prior consent from the Governmental Commission. The companies of strategic importance include, for example, the companies with the status of natural monopolies

or those using nuclear materials, and so on. Therefore, under certain circumstances electricity companies can be deemed to be of strategic importance to the state and therefore their acquisition by a foreign investor should be subject to state approval.

In addition, special rules are imposed on transactions involving legal entities that form part of the Russian civil nuclear industry. The alienation of shares of a company included in the official list of Russian organizations authorized to own nuclear materials must be approved by the President of the Russian Federation (Josefson and Kotlyachkova, 2013).

Transmission, distribution and dispatch operation are treated as the national monopolistic businesses. This is why the foreign companies invest their money in the Russian generation sector. Among active foreign investors are E.ON Concern of Germany, ENEL of Italy, FORTUM Co. of Finland, and Integrated Energy Systems Ltd. of Cyprus.

2.6. International Links and Trade

Electric power system of Russia has transmission links with a number of neighboring countries. Among them are participants of NORDEL pool (Norway and Finland), the Baltic countries (Lithuania, Latvia and Estonia), western neighbors Belorussia and Ukraine, the countries of the Caucasus region (Georgia, Azerbaijan, South Ossetia, Abkhazia), and the countries of Middle and East Asia (Kazakhstan, China, Mongolia). Electric systems of the Baltic and Caucasus countries, as well as Belorussia, Ukraine and Kazakhstan, are operated synchronously with the Russian power system.

The programmatic goals of the international cooperation are:

- To exploit advantages of integrated operation of the electric systems,
- To restore high capacity of the inter-state transmission lines,
- To develop and strengthen electrical connections with western, central and northern Europe and also with the countries in the Asian part of the continent.

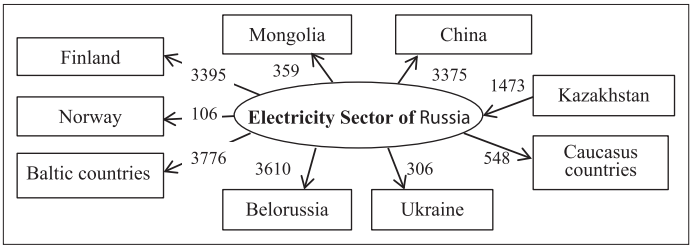
One of the important areas of the Russian Electricity Sector activity is the pursuit of an effective foreign trade policy. Inter RAO Group is a leading energy export and import operator in Russia. The Group supplies electricity to all connected countries. In 2014 Inter RAO exported 14 billion kWh and imported 3.5 billion kWh of electricity. According to the annual report of the Russian System operator directions and amounts of exports were as shown in Figure 2.

Inter RAO Group manages generation assets in Russia, Europe and the Eastern states, apart from the international trade organization. The total installed capacity of the Group's generation facilities was about 35 GW in 2014.

2.7. Main Sources of Electricity Generation in Russia

The majority of existing TPP in Russia run on fossil fuels such as natural gas, coal and fuel oil. Proportions of the different kinds of fossil fuel utilization in 2014 were: Natural gas 54.7%, - coal 44.9%, and fuel oil - 0.4%.

Figure 2: Export-import transfers of electricity in 2014, billion kWh



The largest TPP on the Russian territory is the Surgut TPP-2 with the installed capacity of 5600 MW. This power plant uses natural gas. Several large TPPs utilize coal. Among them are the Reftinsk TPP (3800 MW), the Kostroma TPP (3600 MW) and other.

Construction of the gas-fired TPP is much cheaper, in comparison with power plants burning other kinds of fuel. The efficiency coefficient of gas-fired TPPs is practically twice as high as of coal-fired plants. Natural gas is a "cleaner" fossil fuel and emits much less amount of harmful discharges into the atmosphere.

TPP in Russia provide 68% of total electricity demand. It means that the greater the demand for electricity, the larger the amount of the fossil fuel consumption at power stations. The amount of coal burnt in the boilers, and therefore the amount of carbon dioxide and other gases emitted by TTPs is determined by energy demand.

Another important source for electricity generation is the potential energy of accumulated water. Russia has 9% of the world storage of water. This forms a significant hydro-power potential and a good possibility to develop the hydro-electric generation. Currently the Russian potential for hydro-electric production is estimated as 2900 bl. kWh.

Hydro power plants (HPPs) generate almost a fifth part of the total generation in Russia. They are important providers of auxiliary services in electric systems. HPPs maintain energy and capacity reserves, regulate frequency and voltage levels. HPPs damp dependency of the Russian electricity sector on changing prices of fossil fuels. Electricity generation at HPPs saves annually about 50 Million tons of equivalent fuel. The largest HPPs are located in Siberia. The cascades of HPPs on Volga and Kama rivers play an important role in electricity production and river navigation. HPPs in the Russian Far East stimulate industrial and agricultural production in that region.

Nuclear power engineering in the power sector in Russia plays a leading role in the development of nuclear technologies. There are now 10 active NPPs with 34 different types of nuclear power reactors. Capacity of the Russian NPPs in 2014 was 25.26 GW, and electricity generation almost 180 billion kWh (World Nuclear Association, 2015).

Nuclear power is a non-renewable energy source. But nuclear resources can be used significantly longer than some fossil fuels. Currently, this source of energy is considered in Russia as the most viable one for electricity generation for the next 50 years.

Also, NPPs do not emit carbon dioxide into atmosphere, but create radioactive wastes.

In February 2010 the government approved the federal target program designed to bring a new technology platform for the nuclear power industry based on fast reactors. The long-term program up to 2030 involves the shift to inherently safe NPPs using fast reactors with a closed fuel cycle.

2.8. Government Targets and Incentives to Encourage Development of Renewable Resources

Russia has substantial and diverse renewable energy resources - wind, geothermal, hydro, biomass and solar. Practically all regions have at least one or two forms of renewable energy that are commercially exploitable. Concerns related to global warming and a need to reduce carbon emissions require increasing introduction of renewable energy.

Geothermal plants are commercially viable in the northern part of the Russian Far East and the North Caucasus. Large-scale wind projects can compete in the coastal areas of the Russian Far East, in the steppes along the Volga River and in the North Caucasus. Small HPPs construction is attractive in the North Caucasus, the Urals and in Eastern Siberia. Large-scale use of biomass for energy purposes is cost-effective in many Russian regions, especially in the north-western part of Russia, where the pulp and paper industry is well developed.

There are some territories in Russia not connected to electrical grid and are currently served by stand-alone generation systems using either diesel fuel or gasoline. Most of these systems are expensive and unreliable because of fuel delivery problems and high fuel cost. Utilization of renewable energy would provide the joint benefit of making electricity cheaper, as well as improving reliability of supply by switching to local resources (OECD/IEA, 2003).

It is likely that the alternative energy will replace less ecofriendly kinds of generation but not nuclear energy. For instance, the alternative energy can replace coal-fired power generation. Nevertheless, such renewable energy projects face serious challenges competing with conventional fossil fuel power plants. For now power supply cannot be fully switch to renewable energy sources due to several reasons. First, alternative technologies are still evolving, and it is still rather expensive to create generation facilities. Second, the alternative energy cannot provide electricity 24 h a day. Therefore, it is wiser to rely on a certain combination of different kinds of generation in the energy supply.

The abundance of fossil fuels in the Soviet Union and the Russian Federation has resulted in postponed development of renewable energy sources. Russia's current use of renewable energy is very low (except for large hydro). Nevertheless, the Russian government has passed several normative acts in 2013 which stimulate investments in renewable energy sources. According to the Energy Strategy, Russia will produce 18 GW of generating capacities from renewable energy sources until 2035, which will increase the share of these sources in the energy mix from 0.2% to 2.2%.

33 new projects for helio-electricity generation have been selected for the nearest decade. The total capacity of new photo-voltaic devices is 505 MW. 5% of the total capacity were put into operation in 2015, 8% will be introduced in 2016, 31% in 2017, and 56% in 2018. Generation company RusHydro is going to build 3 small HPPs with a total capacity of 20.6 MW. These plants will be constructed in 2017.

2.9. Perspectives in NPP Development

Russia looks ahead with optimism to its nuclear power program, despite a recent diminishing both power demand and available capital. Electricity generation at NPPs increased by 11% during the latest 6 years. Installed capacity of NPPs increased by 9%. Six new nuclear power reactors are under construction currently. Russia takes part in building new NPPs in India, Iran, and China. Agreements for development of nuclear electricity generation are signed with Belorussia, Hungary, and Finland.

Russia is among the world leading countries in invention of new technologies for civil nuclear energy utilization. Particularly, Russia is leading in development of the fast neutron reactors for NPPs. The technology of the fast neutron reactors is able to provide the close fuel cycle of uranium utilization and ensure the problems of nuclear fuel reproduction, waste disposal, and weapons nonproliferation.

Currently four different kinds of nuclear power reactors are under operation and construction: The well proven VVER-1000, the VVER-1200 is development of this, the world's largest fast neutron reactor - BN-800, and the first floating NPP with a pair of 40MW reactors (Asmolov, 2014).

The pressurized water reactor VVER-1000 is the main reactor being deployed until now. It has a 30-year basic design life. Advanced versions of the reactor with western instrumentation and control systems were built in Tianwan plant in China and are being built in Kudankulam NPP in India, with a 40-year design life.

A third-generation standardized VVER-1200 is an evolutionary development of the reactor VVER-1000. It has longer life (50 years and aiming for 60), greater power, and greater thermal efficiency (36.56% instead of 31.6%). The lead units are built at Novovoronezh-2 and at Leningrad-2 power plants in Russia.

The BN-800 fast neutron reactor is intended to replace the BN-600 units at Beloyarsk NPP in Russia. Two of the BN-800 reactors were sold to China. A new BN-1200 reactor is developing currently as a next step towards the BN-1800 reactor. The pilot BN-1200 reactor is approved for Beloyarsk NPP with the planned start in 2020.

The Energy Strategy of Russia commits an expansion of nuclear capacity in the electric power sector. The federal program is based on the VVER technology at least to about 2030. But it highlights the goal of moving toward fast neutron reactors and closed fuel cycle. The program announces building of new power units and dismantling of old facilities.

3. CURRENT CHALLENGES AND URGENT TRENDS IN THE POWER SECTOR MODERNIZATION

Achievements in the electricity sector reform in Russia are impressive. Former regional vertically integrated monopolies were unbundled and privatized. The wholesale and territorial generation companies were assembled. The government retained control of all network companies, the system operator, nuclear and hydro power generation. The wholesale and retail markets for electricity and capacity have been established. Several segments in the wholesale market provide stable balancing of generation and consumption. The capacity market provides sufficient commissioning of new generation facilities.

However, there remains a set of challenges affecting the efficiency of State regulation and rational development of generating and network facilities in Russia. The challenges relate to market design, competition support, pricing, investment provision and existing regulation. Elimination of negative aspects of reforms defines urgent trends in the governance policy enhancement and markets modernization.

The evident problems of the Russian power sector are the following:

1. Weakening of the State control of the industry
   Over the years of reforms the number of employees in the Russian Ministry of Energy that were related to the control of the electric power industry considerably decreased. Unbundling the vertically integrated regional power utilities led to the emergence of independent energy companies that pursue their individual goals. The decision on the expansion of energy systems and improvement in electricity and capacity market is made by the Government of the Russian Federation and newly established entities including System Operator, Market Council and Federal Antimonopoly Service. The functions and responsibility of these entities are not always well coordinated. Regional administrations in many territories are poorly motivated to provide reliable energy supply to consumers.

Weakening of the State participation in operation and development of the electric power industry resulted in:

- Deteriorated quality of strategic planning of the industry development;
- Weaker coordination of actions among the executive bodies at the federal and local levels;
- Lower effectiveness of interaction between the electric power industry and related industries, such as energy machine manufacturing, instrument engineering, transport, etc.;
- Lower effectiveness of scientific research and training of working and engineering personnel.

To improve the effectiveness of the State control of the electric power industry it is necessary:

- To recreate the federal center to manage the operation and development of the electric power industry, which could make effective strategic decisions and provide their implementation;
- To legislatively separate the notions of federal and regional energy systems; to identify their functions and activity boundaries, authority and responsibility of the executive bodies for the regulation of tariffs and commodity circulation.

2. High level of electricity prices for industrial consumers
   Over the last 10 years the electricity price growth rates on average for the country were higher than the inflation growth rates by 1.2 times. Average electricity price for industrial consumers exceeds such prices in the USA by 1.63 times and in the countries of European Union - by 1.2 times. High prices make large industrial consumers refuse from centralized electricity supply and build their own generating capacities. This increases the price of electricity for small and medium-sized consumers. Due to high electricity prices Russian enterprises lose competitive advantages in the world markets.

The reasons for the high electricity prices are:

- Continuing operation of obsolete equipment at power plants at a general surplus of generating capacities;
- High costs of the electrical network operation and expansion, leading to high electricity transmission tariffs;
- Emergence of many private small-sized network companies in the regions that have high transmission tariffs due to high operation and transaction costs.

To decrease electricity prices it is necessary:

- To develop criteria and procedures for removal of inefficient generating capacities from service. The costs of their temporary shutdown and disassembly should not exceed the existing prices for the end consumers;
- To establish electricity transmission tariffs for the existing consumers for the period up to 5 years with their possible correction no earlier than in 3 years;
- To introduce state regulation of prices for electricity generated by hydro and NPPs. Free marginal pricing in the wholesale market should be applied only to electricity of TPP and gas turbine units.

3. Imperfection of organization of the wholesale and retail electricity markets.
   The rules of the wholesale and retail markets are periodically revised and updated. At the same time there are obvious flaws in the organization of the markets that decrease the effectiveness of market relations. The imperfection of markets manifests itself in the fact that:
   - The wholesale market trade system is oriented to the interests of electricity and capacity suppliers. The interests of consumers are taken into consideration insufficiently;
   - In the retail electricity markets there is virtually no competition among suppliers for direct contracts with consumers. Retail customers have no possibility to choose an effective supplier. The competition among retailers is weak due to a monopoly position of one of them;
   - Electricity markets accumulate failures to pay for consumed electricity. There is still cross-subsidization of certain groups of consumers and territories;
   - The interaction between retail electricity markets and regional heat markets is poor. There is no rational

procedure for allocating the electricity and heat generation costs at cogeneration plants. There is no differentiation of prices for electricity generated in the combined and condensing cycles;
- Retailers are unable to provide high reliability of electricity supply to consumers, since they do not possess and do not operate the existing power facilities.

To eliminate the drawbacks of the electricity market organization it is necessary:
- To develop a new model of wholesale market trading system, putting priority on the wholesale and retail consumer interests;
- To lift the existing requirement for mandatory sale of electricity generated by the plants with an installed capacity of 25 MW and more only in the wholesale market. Afford the retail market consumers the opportunity to buy electricity from local producers;
- To constantly reduce the amount of cross-subsidization of population and consumers equated to the population. Exclude the impact of cross-subsidization of certain territories on the prices in the wholesale and retail markets in the other territories;
- To stop establishing the prices of electricity generated by TPP in a combined cycle according to the price bids of condensing power plants. Introduce differentiation of prices for electricity generated in combined and condensing cycles;
- To provide the opportunity for the network companies to perform the functions of retailers;
- To entitle the network companies with a voltage below 220 kV to own generating capacities. The extension of the network company functions will decrease the load of transmission lines, make voltage control easier, and increase the electricity supply reliability.

4. Emergence of redundant generating capacities and lack of funds to expand electrical networks.

Long-term forecasting of changes in demand and inflow of water to the hydropower plant reservoirs contains uncertainties. Supposition on the too high consumption growth rates leads to the surplus generating and network capacities. Lack of investment from the large consumers increases the wholesale and retail prices in the markets.

In the last years Russia's electric power industry has encountered the following problems:
- A great amount of un-demanded and under-loaded generating capacities have popped up. A decline in the cost-effectiveness of generation because of surplus new units and operation of obsolete units increases the level of prices in the wholesale market;
- Expansion of electrical networks for connection of new consumers causes a rise in the electricity prices for the existing consumers;
- There are no administrative and economic mechanisms for attracting investment from the industrial companies in upgrading and construction of new capacities;
- Emergence of several thousands of small-sized network companies in the regions increased the transport tariff and loss of coordination in the expansion of distribution networks.

To improve the mechanisms of expansion and price reduction in the generation and network sectors it is sensible:
- To develop a road map for removal from operation of obsolete generating capacities for the time horizon of 3-5 years. The costs of equipment disassembly and temporary shutdown should not affect the prices of the existing wholesale market for electricity and capacity;
- To fund the programs for the expansion of electrical networks to connect new consumers at the expense of these (new) consumers and additional investors. The costs of network expansion should not affect the prices of existing consumers.
- To legislatively provide the network companies with the opportunity to issue infrastructure bonds and sell them to potential investors;
- To increase the requirements for licensing small-sized private network companies. Unify technical requirements for operation of equipment and reliability of small-sized network companies.

Following modernization of the wholesale and retail markets is an important and urgent goal for the Russian economy. Establishment of transparent and competitive electricity markets, which will create strong incentives for efficient and innovative investment, reliable and efficient operation of power systems and adequate end-user responses is crucial success.

4. CONCLUSION

Restructuring of electric power industry in Russia lasted for more than 20 years and today it is formally completed. Over the years of reforms the state ownership was transformed into the corporate ownership. Vertically-integrated state-controlled energy companies were divided into activity-specific businesses. The wholesale and retail markets for electricity and capacity were launched. The legislative framework was updated and new entities were established to regulate relationships in the industry. The electric ties with neighboring countries are maintained and international trade is intensified.

At the same time, however, the industry faces new challenges affecting the price level for domestic consumers, the effectiveness of market operation and successful expansion of generating and network capacities. The obvious problems are related to the need to improve the effectiveness of the state control, revise the rules and regulations of the electricity and capacity market operation, and stimulate the investment inflow in the generation and network sectors of the industry.

Russia's experience in power industry restructuring and measures planned to resolve current problems can be useful for the countries where transformations in the electric power industry are in the early or in more mature stages.

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