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Russian electricity sector – reform and prospects
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Abstract

Electricity market reform is currently an ongoing process in Russia, promoting competitive wholesale and retail sectors. The overall goal of the reform is to attract investments and to improve the efficiency of the Russian electricity industry. The growing economy is consuming more and more electricity and the old capacity is deteriorating. There have been electricity shortages already and more severe ones are forecasted to occur this winter. Russia needs to speed up the reform and continue the stable development of its economy in order to attract investments to the sector. This could improve the situation in the medium term, but in the short term significant progress can be achieved by improving the efficiency of the electricity sector.

Keywords: Russia, electricity, liberalisation
Introduction

Energy has become an important topic in global political debates due to rising energy prices and the question of energy security. Russia plays a significant role in this debate, especially in Europe, because of its huge energy resources. Russia is the largest single provider of oil and gas to the European Union. Almost one fifth of the natural gas consumed in the European Union originates from Russia, while Russian oil corresponds to one sixth of the EU consumption. In addition to its substantial oil and gas exports, Russia is also a net exporter of electricity. Russia has offered to export more electricity to Finland and to the Nordic market through an electric cable to be built in the Gulf of Finland from the Sosnovy Bor nuclear power plant. At the same time, several parties have predicted upcoming electricity shortages within Russia.

Russia is currently reforming its electricity industry, which is one of the few still progressing major liberalisation processes in Russia. The goal is to improve the overall performance of the industry by introducing competition to electricity generation and retail sales. Russia is drawing on the international experience of liberalising the electricity industry, but it is nonetheless a long and complicated process. In addition, no well-defined system exists for creating an optimal electricity sector, as the results of liberalisation in other countries are controversial.

Electricity reform presents special challenges because of the nature of electricity. First of all, electricity requires a network to connect generation and consumption. Second, electricity cannot be stored, so demand and supply have to be equal at all times. This results in great variations in consumption depending on the time of the day or the time of the year. The third important characteristic is that generation capacity is very strict and demand quite inelastic to price. This can lead to very rapidly increasing prices during peak demand, if capacity is in full use. Generation capacity requires huge investments and cannot be increased in the short term.

Russian electricity sector

Traditionally the electricity sector has been vertically integrated monopoly owned, or at least controlled by the government. The United Kingdom was the first country to liberalise its government-owned monopoly, starting in 1989, and its example has been followed by several other countries. Until 2003, the Russian electricity sector was also a vertically integrated monopoly, owned almost entirely by the government. The government had a 100% ownership of the country's nuclear plants, large thermal generators and hydro generators as well as of the high voltage grid. In addition, the government had a majority ownership (52%) of the electricity monopoly Unified Energy System. RAO UES in turn controlled most of the Regional Energy Systems (Energos), the low voltage grid and retail sales. Most of the unbundling and regulatory reform started in 2003 and the market structure at the moment is in transition.

In 2003, 69% of the total generation capacity of 214 GW in Russia was thermal and co-generation plants. Hydroelectric plants represented 21% and nuclear plants 10% of the
installed capacity. The most important fuel was gas (see Figure 1). Russia is divided into seven regional electricity systems, with the Central, Siberia, Volga and Ural being the largest ones. The three smaller ones are the Northwest, the South and the isolated Far East. Nuclear plants are located in the western parts of Russia whereas Siberia is very dependent on hydroelectricity.

Figure 1  Electricity generation by fuel in Russia 2003

Russia is situated in 11 different time zones. This means that daily consumption peaks take place at different times in different areas (see Figure 2). Efficiently used, this can help to manage the variation in hourly consumption. Obviously that does require a well functioning network. In the Central area the daily demand peak is 30% higher than the lowest consumption early in the morning. In the whole of Russia, the peak is only 20% above the lowest level.

Source: IEA 2005

\[3 \text{ IEA 2005}\]
Since the late 1980s the Russian electricity sector has suffered from a lack of investments. At the end of the Soviet period, all-around investments fell and after the collapse of the Soviet Union, new capacity was not needed because of declining GDP and electricity demand. In July 2001 the Russian government announced a plan to create a competitive electricity sector within a decade. The main goals of the reform included improving the efficiency, transparency and reliability of the sector and promoting badly needed investment. International Energy Agency has estimated the need for investment into generation capacity to be $157 billion in the next 25 years with another $200 billion needed for investment into the network. According to IEA calculations, this corresponds to 1.9% of the Russian GDP during that period. Investment needs are expected to be moderate until the year 2010 (according to IEA about $6.5 billion a year), but after that they are expected to grow rapidly as the country’s generation capacity deteriorates.4

One of the major problems in the Russian electricity sector is pricing. Until the year 2005 residential users obtained electricity at a lower price than industrial users (Figure 3). In terms of market prices, the electricity should be 20-30% cheaper for industry to reflect the difference in costs5. This strong cross-subsidization distorts markets and leads to excess consumption by residential users.

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4 IEA 2005
5 IEA 2005
Figure 3  Electricity prices for residential and industrial users in Russia 2000-2005

Source: RAO UES 2006a

Electricity reform

Russian electricity reform is a part of the country's overall energy strategy, which was first created in 2000 and further developed in 2003. It covers the period up until 2020. The main goals of the strategy are to improve the investment environment, to implement energy price reform, to strengthen the role and independence of regulatory bodies and to improve energy efficiency. Anatoly Chubais, the head of UES, started to plan the restructuring of the company already in 1999. The company has been very active in reforming the industry and the government formulated its electricity reform plan based on the draft created by the UES.

The electricity industry consists of four parts: generation, transmission, distribution and supply. Traditionally all of these functions have been operated by a single monopoly. Such vertical integration can be separated, and competition can be introduced to generation and supply. Transmission, operated in the high voltage grid, and distribution using the low voltage grid, are natural monopolies. That means, that competition in those parts of the sector does not improve efficiency and monopoly is the most efficient market situation. If monopolies are not regulated, they provide less for higher price than competitive companies so some regulation has to remain in those parts of the sector to assure sufficient amount of service for a reasonable price. Usually electricity liberalisation has been carried out by unbundling the vertical integration, but another option is to allow new companies entry to the market.

Figure 4 describes the planned market structure for the Russian electricity sector. Nuclear plants will remain 100% government-owned. This is not usually considered a problem because of the security issues involved in nuclear energy. The government will
also keep its majority ownership of the hydro generation company. A total of 6 thermal plants (or wholesale generation companies, WGCs) and 14 territorial generation companies (TGCs) will be privatised.

Electricity is traded in the electricity spot-market managed by the Administrator of the Trading System (ATS). It is owned by market participants and covers all the trading in Russia excluding a few isolated electricity systems mostly in northern Siberia and the Far East. Trading began already in 2003. As in most countries, trading is done by a day-ahead closed auction, in which generators announce the amount and price of their supply and buyers announce the amount they are willing to buy. The system marginal price (SMP) is set to the level of the last accepted offer and all the electricity is sold at that price. The Federal Tariff Service (FTS) controls the prices for regulated users. Currently the forecasted amount of electricity consumption is traded according to regulated contracts and the consumption exceeding that amount is traded in market prices. From the beginning of 2007, 5% of the consumption will be traded in unregulated prices and the share will be increased in stages.

**Figure 4 Planned market structure**

Sources: IEA 2005 and RAO UES 2006b
75% plus one share of the Federal Grid Company (FGC) managing the high voltage transmission will remain government-owned. It was separated from RAO UES according to a decision made already in 2001. To secure competition, it is important to assure equal access to the transmission system for all the generators. This will be controlled by the Federal Antimonopoly Service (FAS). The system operator (SO-CDA) will be responsible for connecting the demand and supply at each moment. The company was registered in Moscow and has been operating since September 2002. Distribution of electricity will be provided by privately owned companies operating in the low voltage network. Their network covers the entire country excluding the Far East and a few isolated regional energy systems.

Retail companies will be separated from RAO UES and privatised. By June 2006, already 81 of those companies were admitted for trading on Russian stock exchanges. The exact number of the companies in liberalised markets is not clear yet. The government will keep control over so-called guaranteeing suppliers, which are designed to ensure the reliability of the electricity supply to households during the transition period. According to the plans, there will be around 70 of these suppliers of last resort. Consumers can choose their retail company freely. Prices will be competitive, excluding the guaranteeing suppliers. Their prices will be regulated and should not exceed the wholesale price by more than the companies' mark-up.

There have been several delays in the implementation process. According to the original reform plan, the first stage, including most of the unbundling and regulatory framework, should have been completed by the beginning of 2005. The process slowed down in the summer 2004 when the prime minister announced that all the decisions were postponed until 2005. Although delays were expected because of the ambitious timetable, this announcement caused some concern whether sufficient political will existed to reform the electricity sector. When the progress of this type of reform seems uncertain, it's impossible to attract investment to the sector. The reform started to proceed again in 2006 and even president Vladimir Putin expressed his personal concern over the slow reform process. According to Putin, Russia's overall economic growth was suffering from an undeveloped electricity sector. The reform was supposed to be completed by the year 2009, but at the moment that goal seems to be unrealistic. Moreover, there are still many unsolved questions and uncertainties about the reform.

The planned wholesale market structure in Russia is relatively diversified. This is also confirmed by the Herfindahl-Hirschman index (HHI), which measures the concentration of ownership and market power. It's calculated by:

$$HHI = \sum_{i=1}^{N} s_i^2,$$

where $N$ is the number of companies in the market and $s$ the market share for each company. Thus, the maximum value of the index is 10,000, indicating a monopoly, and values under 1,800 indicate relatively diversified ownership. The index for the Russian electricity sector is 860 (see Appendix 1), which might give a too positive image of the market. Network congestion can cause the appearance of regional markets from time to time. Fewer generators will be involved in competition and it might give the opportunity for market manipulation especially in areas where nuclear electricity plays a significant role. According to Russian electricity law, nuclear plants have to sell their production at the SMP and they cannot offer the price themselves. In addition, the nuclear plants have
only a little flexibility to in reacting to increases in demand during periods of high demand. The same is often true for hydro generators due to seasonal water flows. At the regional level, the Northeast, Volga and Siberia regions seem to suffer from a concentration of ownership and market manipulation can occur in those markets.

Using HHI may be the easiest way to study diversification of the markets, but it is not sufficient, especially in the case of electricity, where residual demand plays a significant role. When capacity is in close to full use, even a relatively small producer can manipulate the price. Residual demand means the amount of demand that remains to be met when all but one producer generates at full capacity. Usually residual demand is more elastic with respect to price than total demand, but if it's still inelastic enough, the last producer can set a high price and all the producers then receive excess profits.

Prospects of the Russian electricity industry

Electricity consumption in Russia is increasing rapidly. According to preliminary statistics of the Ministry of Industry and Energy, electricity consumption growth in January-September 2006 was 4.1% year-on-year. Danchenko, Coburn, and Milov (2006) have estimated that even moderate growth in electricity consumption in Russia will lead to inadequacy of the current generation capacity by the year 2008. The head of UES, Anatoly Chubais, has given similar estimations and believes there will be serious shortages already this winter.

Figure 5  Daily electricity consumption in Russia 5/2005-10/2006

Source: SO-CDU 2006
Total electricity consumption in Russia was 811,000 GWh in the year 2004, making it the fifth-largest consumer in the world. The same year its production reached 932,000 GWh and it was a net exporter of electricity by 7600 GWh. The difference between production and consumption is explained by substantial distribution losses. Russia consumes only a third of the amount of electricity per capita consumed by Canada or Finland, both being sparsely inhabited northern countries. This could imply a significant increase in consumption in the future because of the rising living standards of the population. Then again, electricity consumption per GDP in Russia is more than twice the amount of Canada or Finland, which might suggest a lack of efficiency in consumption. This is apparent, for example, in the aluminium industry, where Canadian producers use 13.7 kWh of electricity to produce 1 kg of aluminium, whereas Russian producers use 16 kWh. According to Milov (2006), the electricity intensity of Russian industry has declined during the past few years, but mostly because of structural change towards less energy-intensive industries and not because of actual improvements in efficiency.

The structure of electricity consumption in Russia is nevertheless very different from Canada or other OECD countries (see Table 1). Russian industry consumes a larger part of the electricity in Russia than on average in OECD countries. The share was even bigger in 1990, over 58%. The high percentage in Finland (55%) is explained by the significance of heavy industry. The share consumed by the agricultural sector also declined from 8% in 1990 to 4% in 2002. Overall the structure of electricity consumption in Russia has been approaching the OECD average. The same has happened to Poland in recent years.

Table 1  Structure of electricity consumption, percentage of total consumption 2002

<table>
<thead>
<tr>
<th></th>
<th>Russia</th>
<th>Canada</th>
<th>Finland</th>
<th>Poland</th>
<th>OECD</th>
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<tr>
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<td>52</td>
<td>42</td>
<td>55</td>
<td>40</td>
<td>38</td>
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<tr>
<td>Residential</td>
<td>23</td>
<td>29</td>
<td>25</td>
<td>23</td>
<td>31</td>
</tr>
<tr>
<td>Services</td>
<td>11</td>
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<td>18</td>
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<td>Transport</td>
<td>11</td>
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<td>1</td>
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<td>2</td>
<td>1</td>
<td>5</td>
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</tr>
</tbody>
</table>

Source: OECD 2004

According to the main provisions of the energy strategy planned by Russian officials in 2000, the country’s electricity consumption will increase by over 20% from 1995 to 2010. By the year 2005, the consumption had increased by 12%, 9 percentage points of which occurred in 2000–2005. If the consumption growth relative to GDP growth continues to follow the current trend, consumption in 2010 could in fact be 35% above the 1995 level. However, the correlation between GDP and electricity consumption has been weaker in the past couple of years at least partly due to the changing structure of the economy. Already last winter there were limitations on electricity supply for industrial users because of local electricity shortages, for example in Moscow.

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6 Milov 2006
7 Kurronen 2006
On the production side, there are some worries about the high dependence on gas as a fuel (see Figure 1). According to development plans of the sector, either coal or nuclear power will partly replace natural gas as a source of electricity. At the moment, Russia seems to be increasing the share of nuclear power in the production. The Russian government approved in October 2006 a draft program for developing the nuclear energy sector, which includes building 9.8 GW of new capacity. Currently the nuclear generation capacity is 22.6 GW, but it is deteriorating quickly. By the end of the year 2006, over a fifth of the plants comprising the existing capacity will reach the end of their original life span. The 15-year extensions to the life spans of the plants do not remove the low efficiency problem of nuclear plants. Old machinery needs repairing and maintenance, and the utilization factor in Russia is already low, 73% in 2004, while the most efficient countries reach 90%.

Figure 6  Household electricity consumption per capita vs. GDP per capita in various countries 2004

Yet, nuclear generation is not the only part of the electricity sector suffering from low efficiency. The majority of thermal power generation in Russia uses old steam turbines with a gas utilization rate below 30%. Modern steam-gas and gas-turbine generators with 50-60% efficiency are needed to replace the old equipment, but require substantial investments. Also Russian power plants need about 330 grams of oil to generate 1 kWh of electricity. Modern combined-cycle power plants can reach as low as 180 g/kWh. In

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8 IEA 2002  
9 According to the Finnish nuclear power company TVO, a modern nuclear reactor with the power of 1GW can reach the generation of around 8000 GWh a year.  
10 Milov 2006
addition, distribution losses in the Russian network system are notable. In 2004 distribution losses in Russia corresponded to 12% of the total domestic supply. The OECD average is around 6%.\textsuperscript{11}

Cheap prices have led to inefficient consumption of electricity. Even though electricity consumption per capita in Russia is low by Western standards, the Russian residential sector consumes much more electricity than the residential sectors of other countries with the same GDP level (Figure 6). Low prices are only a part of the problem. Other important factors of the wasteful electricity consumption are improper insulation of residential buildings and the high energy intensity of Russian household electrical appliances.

Energy sufficiency is already a problem in Russia. The gas monopoly Gazprom has announced that it will not deliver the amount of gas demanded by UES this year. Gazprom will concentrate on its international obligations and UES has to use more expensive fuel oil and coal in electricity generation. This creates pressures on the still-regulated price of electricity.

Although attracting investments to the Russian electricity sector is a key issue in moving the reforms and modernisation ahead, not much has been done. There are several initial public offerings planned to finance additional capacity, but the progress is too slow to meet the growing demand for electricity. The first offering, where OGC-5 is selling about a 15% stake, might take place in November 2006, followed by several others next year. Finnish Fortum, with its minority stake in TGC-1, is so far the only strategic foreign investor in the sector. Gazprom's growing interest in the electricity sector could have more negative effects in the long term, because of its position as a monopoly supplier of the most important fuel in electricity generation.

Conclusions

The Russian electricity sector faces huge challenges, not only in the next few years, but also in the next decade. The rapidly developing economy demands more and more electricity and the old generation capacity is deteriorating. Most power plants, installed in Soviet times, will come to the end of their lifespan around 2010. This means that investments in new capacity have to be made already now.

Russia is liberalising its electricity industry, and the reform seems to be headed in the right direction. By implementing the reform plan, Russia can achieve a competitive and efficient electricity sector. However, significant investments are needed to reach the goals of the reform. The political will for the reform, the consistency of the regulation and an adequate return on capital are necessary conditions for attracting private investments. At the moment, the reform seems to have support from politicians as the electricity shortages affect Russia's overall economic growth.

In the short term, the best way to insure the sufficiency of electricity in Russia appears to be improving efficiency in both the residential and industrial sectors. For the most part it is a question of modernisation, but the incentives for more efficient use of electricity should come from real price signals. Efficiency improvements are essential also as a long-term solution.

\textsuperscript{11} IEA 2006
References


## Appendix  Planned wholesale market structure

<table>
<thead>
<tr>
<th>Company</th>
<th>Planned ownership</th>
<th>Capacity MW</th>
<th>Share of total capacity (%)</th>
<th>HHI-index</th>
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