ISSN 1075-7007, Studies on Russian Economic Development, 2006, Vol. 17, No. 2, pp. 169–181. © Pleiades Publishing, Inc., 2006.

INDUSTRIES AND INTERINDUSTRY COMPLEXES

The Energy Crisis and Energy Reform in Russia: Competition Instead of Reliability

A. I. Kuzovkin

Abstract—Energy supply reliability problems are looked at in view of a mega breakdown in the energy grid of Central Russia, which occurred on May 25, 2005, and the energy reform underway in Russia. The splitting of RAO Unified Energy Systems of Russia (UES) into multiple independent companies, as stipulated by the current energy reform, lowers the reliability of energy supply and increases the risk of systemic energy breakdowns, as we noted in [1]. The roles of monopoly, oligopoly, monopolistic competition, and government regulation in the electric power industry are analyzed. The American economist and 2001 Nobel Prizewinner Joseph E. Stiglitz demonstrated the need for government intervention for market regulation, because there is no perfect competition in a real-life market economy, and the market under asymmetric information conditions does bring the economy to an equilibrium state, maximizing public wellbeing. The implications of establishing six wholesale generating companies from thermoelectric power stations for the growth of electricity tariffs and possible bankruptcy of some companies are also estimated.

DOI: 10.1134/S1075700706020055

On May 25, 2005, a mega breakdown occurred in Central Russia's energy grid, resulting in the blackout of most of Moscow city and Moscow, Tula, Kaluga, and Ryazan oblasts.[1] This man-made breakdown (more specifically, energy crisis), which, according to a UES estimate, hit approximately five million people, began at the Chagino power substation, built back in 1964, which is located in the Kuz'minki forest park in the eastern outskirts of Moscow. Its operating life had ended in 1997; however, it underwent scheduled repairs in 2003. The Chagino substation's last transformer collapsed on May 25 at 5:30 a.m. At 10:10 (rush hours), another four of the seven substations of the Moscow energy ring broke down, and five Moscow power stations came to a halt. A special commission was formed to ascertain the causes of this man-made breakdown and assess the damage caused to the population and the economy of Moscow and several other oblasts of Central Russia. The aggrieved regions brought compensation claims against UES for damages to the population and the economy.

According to standards, the breakdown should have been eliminated within 24 hours; however, it took about 30 hours to liquidate this mega breakdown.

The fact-finding commission's report of July 1, 2005, on the circumstances and causes of this systemic accident stated that its origin and development were caused by the failure of the operating and dispatching personnel at all levels (OAO System Operator–Central Dispatcher's Office UES, the Unified Dispatcher's Office Tsentr, and the Moscow Region Dispatcher's Office) to take necessary measures to prevent the current overloading of the equipment (high-voltage transmission lines, generators, etc.) and an inadmissible voltage drop in 110/220 kV networks.

The commission also noted:

—the unsatisfactory organization of the operation and maintenance of the electric equipment of the electric networks and stations and the wrong actions of the operating and dispatching personnel during at the start of the accident and during its development;

—that personnel development at UES holding enterprises was inconsistent with the Operating Personnel Rules adopted for electric power organizations of the Russian Federation;

—the absence of automatic load shedding equipment in the Moscow energy system, which led to an inadmissible drop in voltage in power networks; and

—the lack of technical reequipment, systems automation, and relay protection plans and conditions for the optimal use of the remaining life of aging equipment and the existing throughput reserves of the power networks under the increasing power deficiency in the Moscow region.

To prevent such abnormalities in the Moscow Energy System and in the country's power grid, the commission proposed measures eliminating these drawbacks: the replacement of obsolete equipment, the reconstruction of substations and the 110–220-kV aerial and cable circuits, the introduction of reliable communication channels and digital system control complexes to ensure the controllability of the Moscow Energy System in emergencies, and the accelerated

[1] The General Prosecutor's Office of the Russian Federation opened a criminal case on charges of negligence and abuse of authority and interrogated UES CEO A. Chubais on the same day.

development of technical regulations aimed at the safety and reliability of energy supply.

According to Federal Network Company data (2003), the general wear and tear of electric mains is 41%, and that of substation equipment, 65%. By 2006, the wear and tear of substation equipment will have been in excess of 70%. Radical measures must be adopted to stop the aging of basic equipment.

Of high concern is the high proportion (60% in 2006) of exceeded life of relay protection and emergence controls and circuit breakers[2] (27% in 2003 and 50% in 2006).

MosEnergo's First Deputy Director General D. Vasil'ev admitted, "Certain Moscow districts have backup power systems, and some districts have dead-end mains …. Thousands of overage or overloaded substations continue to operate in Russia. They may break down any time, and every day, the staff of all AO-Energos take the risk of putting them in operation" [2, p. 5].

Perhaps the main reason for a man-made disaster is the wear and tear of energy equipment. It is noteworthy, however, that this mega breakdown occurred during a UES reform. In particular, since March 2005, MosEnergo has been in the process of division into 13 independent power generation, transmission, sales, and servicing utilities. Under such a giant redistribution of personnel and control functions, the responsibility for specific control areas obviously declines.

Then, who is to be held liable for this "energy threat"?

The August 14, 2003, energy accident in the United States and the energy reform. Lessons for Russia. Technically, it all began with the breakdown of three power transmission lines in the state of Ohio. However, a local emergency turned into a national energy disaster, the causes of which will be investigated for a long time.

One of its main causes is the decentralization of the US electric power industry, i.e., the liquidation of vertically integrated power systems and the establishment of multiple generation, transmission, and distribution utilities.

Technologically unified facilities with decentralized control demand increased coordination of the responsibilities of all the independent members for reliable operation. A vertically integrated energy utility (VIU-Energo) operates as a single agent in the wholesale market. After its splitting, the coordination of the numerous new market participants becomes extremely complicated.

[2] One of them broke down at the Chagino substation on May 23–25, 2005, which finally led to the mega emergency in Central Russia.

The United States government has traditionally supported the Federal Energy Commission in its desire to split the remaining VIU-Energos. However, after August 14, 2003, the US Secretary of Energy S. Abrahams said that this process would be suspended for three years. To solve the problem of power outages, they have to introduce mandatory reliability standards and increase the capacity of transmission networks. To this end, they are prepared to slow down the deregulation process [2]. Thus, the Secretary showed that deregulation of the electric power industry is one of the reasons for this energy disaster.

Russia chose the same way of restructuring its electric power industry. Yet, will Russia's electric power industry retain the level of reliability inherent in Russia's UES, operating under government control? In the United States, peak loads are typical of the summer, and not winter, season; therefore, emergencies are not as dangerous as in the winter. In Russia, peak loads occur in winter; therefore, emergency power cutoffs cause serious problems for consumers; in particular, boilers break down, which results in people's sufferings from the lack of heat. The only guarantee of reliability of the electric power industry is the preservation of the vertically integrated structure of the energy systems and strict government control over the industry. Otherwise, Russia may face a situation when it finds itself without either light or heat during the winter as a result of an energy accident.

In relation to the energy disaster in the United States and Canada, UES CEO Chubais said on August 15, 2003, "There have not been and cannot be such large-scale power drops in Russia …. The basic principle of the reform underway in the Russian electric power industry is precisely securing the reliable and fail-safe operation of the industry" [2, p. 5]. MosEnergo's Director General A. Evstaf'ev confirmed his statement: "Large-scale power shutdowns in the Moscow region are out of the question …. MosEnergo has generating facilities that can switch electricity and heat consumers to other sources in case of emergency" [2, p. 5]. These statements are all the more strange at a time when "thousands of overage or overloaded substations continue to operate in Russia. They may break down any time" [2, p. 5].

Russian Deputy Minister of Energy V. Kudryavyi, said back in 2003, "When reforms started in the electric power industry, we were afraid that the principles of reliability would be lost. And they were. Reliability did not become a priority…. Market relations ousted power professionals from UES management and from regional companies. What kind of analysis (of accidents) can be made by market-oriented managers when it is a job for energy people?

Just look what large-scale accidents we have had. Three years ago (in 2000), there was a breakdown the like of which we had not witnessed in 50 years: the Ural, Chelyabinsk, and Kurgan energy systems were shut down. Their personnel did all this with their own hands: the maintenance diagram did not take into account all allowable deviations of parameters. This winter (2002/2003—*A.K.*), there was a load pickup, a natural situation for the winter, and suddenly, the was an emergency shutdown of one of the most demanding and crucial regions, Yakutia with its capital and cities, where there are approximately 800 boiler plants, at a temperature of 50°C below zero. Another unprecedented breakdown occurred in Kashira. The incidence of accidents is growing, but nonprofessional managers are unable to assess them properly.

Now, instead of being localized, a routine breakdown expands to the limits of a whole power utility. It is simply amateurish to say that what happened in America cannot happen here.

Now, Moscow this year (2003—*A.K.*) reached its peak load, as in the prereform year 1990. And it turned out that the network has no backups, and all defects began coming to light.

… The RAO chief is leading the electric power industry to a repetition of the American accident" [3].

Breakdowns and outages in the energy systems of Krasnodar krai (Sochi) and Chelyabinsk oblast (Zlatoust), which happened after the May 25, 2005, crisis in Central Russia, signalize serious reliability problems in the country's power supply, which are caused by two factors:

—the Russian energy reform, conducted by the UES management, which has caused disorganization in the energy systems' control as a result of the subdivision of AO-Energos, and

—the wear and tear of energy equipment.

However, driving the deterioration of energy equipment to the limit is also a result of the nonprofessionalism of the UES management. The main criterion in the electric power industry is the reliability of power supply to the customers and not the maximization of corporate profits; therefore, power professionals and not financers and lawyers must head UES and AO-Energos.

The May energy crisis in Moscow significantly changed UES CEO Chubais' ideas about the goals of this energy holding company. He admitted (on August 29, 2005) that the company management had mistakenly regarded the reform of the electric power industry and the optimization of AO-Energos' finances its main goals. As a result, UES has revised its priorities and intends to focus on the power network reliability. The administrative board of this energy holding company approved an action program to achieve the new goal, the most important objective being a comprehensive plan of development of the Russian power network until 2030 [4]. However, this raises the question, who will be responsible for the reliable power supply of Russia and for the implementation of the energy system's development plan until 2030 after UES's self-liquidation by 2007? It is doubtful that the UES management was unaware of the reliability situation in the electric power industry; perhaps, it simply ignored it, fearing the abolition or suspension of the destruction of VIU-Energos according to the package of electric industry reform laws, which it had lobbied. After all, the US Secretary of Energy had announced a three-year suspension of reforms. Thus, it would be in order to consider in brief the origins of the Russian power reform. It turns out that scientists and specialists have developed an alternative program of electric power industry reform, which fundamentally differs from the UES program.

The origins and progress of the electric power reform in Russia. The necessity of keeping vertically integrated systems (AO-Energos) was justified in a report of the Russian Federation State Council working group on electric power industry reform, formed by V. Putin's order of January 7, 2001. The report was submitted to the Russian president and government in May 2001. M. Kas'yanov's government was charged with decision making on the program of electric power industry reform. However, the government rejected the concept of the electric power industry reform contained in the report and approved the concept of UES and the Russian Ministry of Economic Development and Trade envisaging the division of VIU-Energos into generation, transmission, and distribution companies. This approach, the splitting of VIU-Energos, was chosen in order to promote competition in generation, but the growing shortage of power capacities does not allow them to be implemented.

Competition vs. reliability? The subject of the 2000 conference of the International Council on Large Electric Systems (CIGRÉ) in Paris was "Competition vs. Reliability?" The reason behind it was that the electric power industry restructuring efforts underway in several countries, namely, the division of VIU-Energos into independent generation, transmission, and distribution companies, allegedly to promote competition among producers in the electricity market, had resulted (or would result in the near future) in a loss of power systems' reliability. Negative results of energy industry restructuring were observed in New Zealand, where, after liquidating VIU-Energos, the country's capital Wellington was plunged into darkness. Another example is the 2002 energy crisis in Brazil: after restructuring the electric power industry and a dry summer, power generation decreased by 20%, and the government had to restrict power supply across the country. After the restructuring of the electric power industry in Kazakhstan in the late 1990s, one could also observe the "darkening" of the whole country. A recent energy disaster in Georgia was the result of the electric power industry's restructuring, which had taken place a few years before: the majority of generating facilities and networks were sold to private investors, mainly to AES. At the end of 2002, Norway, which had restructured eight years ago, faced a power shortage, and free market electricity prices multiplied up many times.

The opening of a competitive electricity market in California in 1999–2001 led to negative results, and the authorities ordered to close the market. Then, independent power producers increased electricity prices three-four times in the wholesale competitive market by creating an artificial capacity shortage. The largest energy untilities, including Enron, participated in it. This was found out after Enron's went bankrupt in December 2001. The judicial inquiry found out that Enron had implemented several illegal price manipulation schemes during the Californian energy crisis of 1999–2001.

In late February 2005, an energy conference in San Diego, Cal., announced that the destruction of VIU-Energos and the introduction of competitive electricity markets yielded negative results. Now energy specialists are thinking hard how to return to the former energy system.

On March 31, 2005, a joint meeting of the UES Science and Technology Council and the RAS Research Council on the Reliability and Safety of Large Energy Systems and Other Organizations adopted a resolution on the proceedings of the 40th session of CIGRÉ, which was held in August 2004 in Paris, and the 19th Congress of the World Energy Council (WEC), which took place in September 2004 in Sidney, stating that a competitive market stimulates the maximal use of existing facilities; creates tensions in covering peak load schedules; contributes to the establishment and maintenance of high prices for peak power and electricity, which ensure returns on capital invested in generating capacities; but does not stimulate the creation of energy reserves. It is *impossible to ensure stable reliability and safety of energy supply* under these conditions [5, p. 24].

Independent American systems experts from the Institute of Electrical and Electronics Engineers reported at the 40th CIGRÉ session that the restructuring of the US electric power industry, conducted by the Department of Energy and the Federal Energy Regulatory Commission (FERC), *was the main reason for the systems breakdown* in the United States and Canada in August 2003 [5, p. 38].

To answer the question, which is more important for the electric power industry, competition or reliability, we adduce the following argument. American energy specialists point out that the restructuring and introduction of competitive electricity markets in a number of US states helped reduce the electricity cost by 10–15%. However, it increased the likelihood of large breakdowns because of increased complexity of energy systems' control. During the California energy crisis, the electricity price at peak hours increased 10 times owing to its shortage. A sudden energy disaster increases losses hundreds of times. Therefore, damage resulting from reliability loss and electricity shortage during the movement of energy systems to the market is not offset by savings to consumers even if suppliers' competition does occur.

Regional energy systems in Russia are natural monopolies within administrative territories, fully responsible for energy supply, because they function as "supply authorities." The division of energy systems into business types leads to the loss of the full notion and functions of supply authorities, which are very important for both consumers and regional administrations under normal, as well as emergency, conditions. This is crucial for the Russian climate, in which control integrity largely determines reliability and the speed of remedial actions.

Russia belongs to the few countries where equipment maintenance is the responsibility of operators rather than manufacturers. Energy systems' main maintenance operations are performed by their maintenance divisions, which have their own repair facilities, spare parts, warehouses for the emergency stock of equipment and materials, vehicles, and implements. Energy maintenance divisions perform troubleshooting and develop complex maintenance projects. The service crews of these divisions service equipment at power stations and power and heat networks, taking full advantage of centralization. Energy systems' fragmentation will necessitate the establishment of separate service crews at power generation, transmission, and distribution units, which will increase maintenance costs. Additional service vehicles, warehouses, and maintenance dispatching for high- and low-voltage networks and power generation plants will lead to significant growth of transaction costs. The existing maintenance pattern is successful primarily thanks to multiple economic relations with energy systems. Taking into account the remoteness of the majority of energy systems from producers and the absence of competition in the works and services market, the current energy equipment maintenance pattern is not easy to replace [3].

The weakening of regional energy systems because of business splitting will inevitably lead to the slackening of dispatch control in the crucial section. It is regions that the dispatcher's instructions reaching the consumer take final shape. Regions have the bulk of the most conservative generation capacities like district heating plants, which largely contribute to the success of peak operations in the winter. We should reckon with the fact that the authority of weakened regional energy systems, in case of business splitting, will largely be eroded, complicating decision making on the matters of current and long-term energy supply.

The division of regional AO-Energos into numerous independent utilities in 2005 was a painful and tense process, because the companies that branched off from AO-Energos had to handle the tariffs that had been approved for AO-Energos for that year. Each utility is striving to get its share of revenues, often at the expense of other companies, since it needs funds for its new management and staff, which are not envisaged by the tariffs. As a result, administrative costs will be increased at the expense of equipment maintenance and modernization costs, leading to reduced reliability of energy supply. We should protect these reliability expenses against cuts. Every region should change from maintenance based on troubleshooting results to planned preventive repairs, which ensure the standard reliability of energy supply, and the regulated tariff must include these expense items.

Establishing a single network company under the UES umbrella, which brings together intersystem relations of all voltages, is unrealistic in itself, because it cannot be implemented for technological and proprietary reasons. Excessive infrastructural centralization without a technological justification creates an uncontrolled monopolist not interested in cost reduction. It is impossible to optimize such a monopolistic infrastructure from the center: given Russian distances, there is no economic justification for it.

Presently, UES ensures the reliability of energy supply across the country. At the regional level, regional energy systems (AO-Energos) ensure reliable energy supply to their respective regions, power generation, the purchase of electricity at the federal wholesale energy market (FOREM), its transmission, and distribution, as well as operating and dispatching control, and investment activities. They alone bear full responsibility for reliable energy supply to all customers in their region, working in close cooperation with the regional administrations. The division of AO-Energos into separate independent generation, transmission, and distribution organizations (joint-stock companies) will also lead to the redistribution of responsibility for reliable energy supply in the region among numerous legal entities: the generating company (which is usually located outside the region), the regional network company, and the regional marketing company.

The operational and dispatching vertical—the UES Central Dispatcher's Office–the Unified Dispatcher's Office–the Dispatcher's Office of an energy system—plays an important role in the UES control and the prevention of systems breakdowns. Energy systems are the direct executors of instructions, issued by the higher level dispatcher, concerning changes in the loads of power stations, disconnections of consumers, and the prevention and liquidation of emergency conditions. Energy specialists have noted that a sharp deterioration of executive discipline is traceable today to facilities that do not belong to energy systems or UES. There are numerous facts when substations owned by consumers have refused to limit the load in emergencies and remove automatic emergency circuit breakers from the feeders. These negative facts will get even worse if UES's plans to split AO-Energos into several parts by production activity are put into effect.

The fragmentation process will lead to the appearance of new legal entities independent from UES, which will own certain networks and power stations. In addition, the administrative responsibility along the operating–dispatching vertical will naturally decline, and the existing control hierarchy will be effectively destroyed. The topology of UES power networks, characterized by numerous sections with throughput limitations, mode complexity, and strict requirements for duty personnel, will only aggravate the general situation. This is proved by the experience of Ukraine and Kazakhstan after the division of their AO-Energos into separate utilities in 1996–1997. The current frequency in the energy system of Ukraine did not exceed 49–49.2 Hz, which is critical for the operation of nuclear power plants. The current frequency in Kazakhstan was also lower than standard, and system-level breakdowns occurred because of the disobedience of privatized thermal power plants to Central Dispatcher's Office instructions.

As they transferred to specific energy-industry models, countries met with difficulties and problems. It turned out that the technological control in the electric power industry under a wholesale electricity market is much more complicated than in the industrial (monopolistic) model of the electric power industry. The initial euphoria concerning the unlimited opportunities of the market was replaced by the sober awareness of the crucial role of control coordination principles. It also turned out that the introduction of the competition mechanism increases the energy system's efficiency but affects the reliability of fuel and power supply. This decreases the motivation for commissioning additional standby capacities and building transformer communications to ensure reliability; energy systems' operating conditions become more complicated because of energy exchange over longer distances, permitted transit traffic across other energy utilities' mains ("free access"), the aggravation of contradictions between independent energy companies, and numerous contractual relations, which are not easy to coordinate.

Wear and tear of fixed assets and investment shortage in the Russian electric power industry. According to the Russian Ministry of Industry and Energy, the wear and tear of fixed assets in the electric power industry is the highest in Russian industry (57.5%); approximately 20% of all power-generating capacities have used their design service life, and this index may reach 50% by 2010, while energy demand will continue to grow. However, the volume of investments in the electric power industry is 25% lower than the estimated necessary level as envisaged in Russia's Energy Strategy until 2020 [6].

The prevailing adverse investment situation in the electric power industry requires government measures to support the formation and targeted use of corresponding financial resources in these industries (Table 1). It is noteworthy that UES's huge financial investments into noncore activities and the purchase of foreign energy assets would have amply covered the invest-

Table 1. Fixed-capital and financial investments into industry, the electric power industry, and the fuel industry, billion rubles

Index	2000	2001	2002	2003
Fixed capital investments				
Industry	448.2	581.6	655.5	752.1
Power industry	43.3	54.2	73.5	92.7
Fuel industry	215.2	288.2	295.5	363
Financial investments				
short-term				
Industry	608.8	1398	1012	1565
Power industry	35.2	46.9	128.2	152
Fuel industry	141.7	201.3	310.7	230.4
long-term				
Industry	142.3	189.6	211.8	548.6
Power industry	15.2	20.6	81.8	169.6
Fuel industry	60.6	51.7	49.8	210.4

ments needed for reconstruction and renovation of the fixed assts of the electric power industry and would have ensured the energy security of Russia. Therefore, the statements of UES and MosEnergo leaders to the effect that they are short of investments for the reconstruction of power stations, network capacities, and substations because they are not included in the electricity tariff will remain unjustified as long as the energy holding company spends considerable funds, including from its income, on noncore activities.

MosEnergo has always been a surplus-capacity energy system; however, since 2002, it has been a power-shortage one, and in the winter of 2005, its shortage was 1700 MW; MosEnergo has no standby capacities, and new capacities are not being commissioned.

According to Table 1, long-term financial investments in the electric power industry grew faster than fixed-capital investments, considerably exceeding them in 2002–2003 in absolute values [7]. This means that the inappropriate use of financial funds in the electric power industry is much higher than in the fuel industry and industry at large. These funds are potential reserves for financing investments into the electric power industry.

Long-term and short-term financial investments are not made into fixed capital but into other assets, which are not related to the core activities; i.e., they are not targeted. Financial investments must be used as permanent investments if fixed assets are worn out and in need of replacement. In 2003, for every ruble of permanent investments in the electric power industry there were 3.45 rubles of financial investments, 2.8 rubles in industry, and 1.2 rubles in the fuel industry.

UES's global expansion. UES's foreign assets are constantly growing. It has bought power stations in Georgia and assets of energy utilities in Armenia, Moldova, and several other countries. Out of the proceeds of its license fee (400 million rubles in 2005 alone), which is included into the tariff, UES is building the Sangtudinskaya hydroelectric power station GES-1 in Tajikistan. However, the fate of its foreign assets (both under construction and purchased) is unknown after the self-liquidation of UES.

In May 2005, UES won an international tender to purchase two large thermal power plants in Bulgaria, offering double the price of Western energy companies [8]. The cost of the two thermal power plants was about 765 million euros ($960 million); that is, the cost of specific power of each power station was 460 euros/kW ($580/kW). At the same time, the Russian Ministry of Economic Development and Trade and UES are planning to sell six Russian wholesale generating companies of thermal power plants (WGCs TPPs) at an admittedly low initial price of about $100/kW (Table 2) to private investors (including foreign ones).

Thus, UES finds huge funds to purchase energy assets abroad but not to renovate its worn out fixed assets. The stand of the UES board appears to be strange: the majority of its directors represent the government and should, first of all, ensure the country's energy security and supply reliability. Meanwhile, both its management and board of directors have displayed incompetence and irresponsibility.

At its meeting of April 26, 2005, the board of directors considered it inadvisable to continue to include into the UES investment program new construction projects with scheduled completion dates beyond the time of UES's planned division. Yet, without any clear mechanism of legal succession, the board agreed to buy two thermal power plants in Bulgaria.

Monopoly, oligopoly, monopolistic competition, and deregulation in the electric power industry. The deregulation of the electric power industry and corporate scams, in which energy and gas companies were involved (Enron and others), have brought to light facts that show how these companies manipulated prices to create an artificial shortage of energy resources in their respective markets, for example, by excessive requests to reserve power transmission capacities. In this respect, basic questions arise about the role of the market and competition in the economy in general and in the electric power industry in particular.

Joseph E. Stiglitz, a 2001 Nobel Prizewinner in economics and the first vice president of the World Bank in 1997–2001, came to an important conclusion

Table 2. The book value of the assets of the six WGC TPP

Index	Year of WGC commissioning					
	WGC-1 1977	WGC-2 1976	WGC-3 1974	WGC-4 1983	WGC-5 1970	WGC-6 1974
Installed power, MW	9041	8695	8657	8530	8689	9172
Power depreciation ratio, %	17	43	23	56.3	30.6	31.4
Book value of assets at end of 2000, thousand rubles	13493313	10503565	15754578	11671789	8977973	13737139
Book value of January 1,2002						
thousand rubles	29685288	23107843	34660071	25677935	19751540	30221705
million dollars	948.4	738.1	1107.3	820.35	631	965.5
Unit value of assets on January 1, 2002						
rubles/kW	3283.4	2657.6	3986.2	3010.2	2273.2	3294.8
$/kW	104.9	84.9	127.35	96.17	72.62	105.26
Electricity production cost in 2000, kopecks/(kW h)	20.5	18.3	26.1	15.84	21.12	29.15

Note: the 2002 exchange rate was 31.3 rubles/$.
The analysis of the WGC asset structure and the evaluation of the assets were based on the accounting statements of January 1, 2001.
The evaluation of the book value of the assets of January 1, 2002 increased approximately by 2.2 times after the assets revaluation in 2002.
A consortium of evaluators, consisting of the Ernst and Young, ZAO MTsOTs, and ZAO ENPIKonsalt companies assessed the book value of the WGC assets in 2002.

that competition is never perfect in a market economy and that sellers and buyers of goods and services always interact under asymmetric information conditions (in particular, electricity suppliers do not disclose all information about their costs and profits to electricity buyers).

Stiglitz has proved that an economy under asymmetric information conditions does not reach an equilibrium state, which maximizes public wellbeing; it follows that government intervention is needed o regulate market prices. Otherwise, certain market agents—producers—by manipulating prices, would have unjustified superprofits at the expense of others—consumers—and to the detriment of public wellbeing [9].

Stiglitz notes that, over the last three decades, the world was on the verge of a crisis hundreds of times, and this was more than once provoked by some form of hasty deregulation…. The deregulation of the telecommunications sector paved the way for a surplus investments "bubble," which so resonantly burst in 2001. The deregulation of the electricity market led to market manipulations, which seriously harmed the economy of California—the center of origin of the majority of new American technologies [10, p. 133].

The following main structures operate in an economy: the monopoly, oligopoly, and monopolistic competition.

The sale of six WGC TPPs to private investors and the subsequent appearance of an oligopoly in the wholesale electricity market at free competitive electricity prices (this is defined by the Power Industry Law) poses a real danger of tacit (extrajudicial) collusion of these companies and their dictate of electricity prices. This would harm the economy and the population much more than oil companies' abuses related to the advance of gasoline prices, since the whole economy and every family consumes electricity.

Head of the Federal Antimonopoly Service (FAS) I. Artem'ev said in the Council of Federation on January 26, 2005, "The growth of energy costs, particularly, gasoline costs, is, first of all, related not to the price growth in the foreign markets but to the collusion of oil companies in the domestic market." A draft law on competition protection, submitted by the FAS to the Russian government, introduces the notion of *collective domination*: a situation when two or three economic agents jointly occupy the larger part of the market (for example, more than 50%) and pursue a coordinated policy. This is a case when a collusion cannot be established in a court of law (and the new law does not require this), and objective business conditions prompt businessmen to adopt a coordinated behavior and forego competition. Companies will have to pay a fine of 2% of their annual revenues for abuse of their dominant market position, and 4%, for a cartel collusion [11, p. 14].

In line with the legislative package on the electric power industry reform, the Russian government issued its Regulation No. 861, of December 27, 2004, On the Approval of the Rules of Nondiscriminatory Access to Electricity Transmission Services and of Provision of These Services, as well as access to the services of dispatcher's offices (the Central Dispatcher's Office–the Unified Dispatcher's Office), the Trading System Administrator (TSA) of the wholesale electricity market, and the technological hookup of receiving devices (power plants) to power networks.

The regulation contains only general rules. For example, the section "The Procedure of Access to Power Networks under Limited Capacity Conditions" does not describe the distribution of the limited network throughput among multiple requests from power consumers, generators, and receivers. In reality, this is a complex problem of providing nondiscriminatory access to the system operator's network and services. This problem does not arise in AO-Energos under the government regulation of electricity prices, because AO-Energos are supposed to meet the requests of all electricity consumers on the basis of the optimized development of UES.

The complexity and controversy of the relations of independent utilities—the agents of the electricity market (generators, power networks, the system operator, and consumers)—are revealed in the articles of the power economists B. Willems [12] and C. Hogerdorn [13].

Willems considers the Cournot model of competition of two generators who share one power transmission line with throughput limitations to supply electricity to solvent consumers (see Appendix). In this game-theoretic model, a power network operator sets the rule of network throughput distribution. Three rules are considered: all or nothing, proportionate rationing, and efficient rationing. Two results are possible:

—if the network operator collects payments (rent) only for network overload, the generators strategically change electricity output so that the network operator does not receive any payment (rent). This weakly stimulates the attraction of investments into improving the network capacity (throughput); and

—the network operator can create competition among the generators, which will help improve public wellbeing. The limiting nodal price for network overload, which is optimal under perfect competition, is not optimal when the generators can freely set power generation outputs. This does not yield income to the network operator and does not heighten the generators' competition.

The network operator has a larger market power than the buyers, who react only to the electricity price. The network operator can organize competition for the network throughput by distributing it proportionately to the generators' posted price if the transmission line is overloaded. The generators post throughput requests more aggressively because it decreases the available throughput capacity for the competitor. This bonus for posting a higher (more aggressive) price is not present in the standard pricing for line overload, according to which the total overload is paid for, and the prize does not go to the players.

Willems's model can be applied to a centralized market, where the generators post their requests to the network operator who sets sales (and production) volumes and prices for the players. The model is also applicable to a decentralized market (where the market itself determines the prices for electricity generation and transmission), but the generators are not allowed to buy transmission rights without using them. The oligopoly model with a decentralized market without this limitation has not yet been investigated theoretically. Yet, practice has yielded the following result.

The Enron judicial inquiry has shown that this company used several illegal schemes to manipulate prices during the energy crisis in California in 2000–2001. In particular, Enron deliberately ordered power supplies that exceeded the potential of the transmitting capacities of the federal power grid. Then, the federal authorities compensated the company for removing a part of the order.

In the Cournot model without transmission limitations, described by Willems, each generator maximizes its profit, assuming the volume generated by the other generator as the preset value. It turns out that, under a certain ratio of electricity generation costs and a preset linear function of electricity demand, both generators, maximizing their profits, will produce electricity, although, according to the public wellbeing criterion, only the generator with the lowest production cost should produce electricity, because its capacity covers the demand. This result shows the *inefficiency of the competitive market for society*, because each generator, being a free player, maximizes its profit.

When generators' transmission limitations are recognized, the decisive role of the network operator is revealed. If he has full information about the generators' production cost (value), then the optimum solution for the network operator is the generation of electricity only by the generator with low costs, which maximizes public wellbeing.

Under centralized control by the network operator, the generators may be interested in the true, not overstated information about their production costs, because otherwise their competitors would be loaded. If a generator understates its costs in the request, it will face penal sanctions.

Consequently, the network operator determines a generators' production levels and the network throughput, leaving no room for decision making by generators.

However, Willems notes that, in practice, a network operator may have incomplete information about generators' costs, and he is not necessarily interested in public wellbeing. Therefore, the *government regulator of the electricity market* imposes certain limitations on contracts concluded by the network operator. The author considers different rules, when generators can freely set their production levels, which, however, do not yield the public optimum.

Hogendorn studies the problems of long-term interaction between electricity generating and transmitting companies, based on mathematical models. In the short term, limitations on the electricity transmission system give the market power to generators. Article [13] considers whether transmission limitations may result in a long-term equilibrium in a competitive environment. The author has proved the theorem that independent transmission and generation companies may *enter into a tacit collusion in order to raise consumers' electricity prices and share the profits* and that the regulation of the price cap does not hinder this process but may even foster it. The tacit collusion mechanism lies in the fact that generating companies locate their power stations so that limited-throughput transmission lines connect them with consumers. The author shows that this collusion can be described by a static game without any penalty strategies.

It follows that the electric power industry is a specific example that proves Stiglitz's theory about the necessity of government control of market forces in order to maximize public wellbeing. In Russia, the initiators of the laws on electric power industry reform—UES and the Russian Ministry of Economic Development and Trade—have proposed to introduce a competitive electricity market with free prices starting in 2007 simultaneously with UES's self-liquidation. However, addressing the Third Russian Energy Forum in March 2005, Chubais said that UES had given up the idea of a 100% competitive wholesale electricity market and had decided to switch to a new wholesale-market model: bilateral long-term contracts between suppliers and consumers at regulated tariffs. But bilateral long-term contracts should be concluded after optimizing the UES development by the total cost minimization criterion using a mathematical programming model. It is used to determine the optimum long-term electricity tariffs and capacities for each sector of the wholesale market. Instead of this scientific approach, UES is developing some consumer–producer matrices. Their interaction philosophy is unclear, which will cause damage to third parties—other producers and consumers.

Wholesale generating companies. At present, the Russian government is considering the procedure of selling six WGC TPPs, which are being established under a Russian government order of September 1, 2003. In June 2004, the government resolved to establish only one instead of four WGCs, consisting of hydroelectric power stations, to be under government control. The six WGC TPPs, which are being established, with a total capacity of approximately 52 million kW (24% of the total installed capacity of Russia's power stations and 35% of all thermal power plants) will decisively affect the reliability of power supply in this country (see Table 2).

Note that back in 2004, the Russian Ministry of Economic Development and Trade and UES announced a public sale of six WGCs. However, early in June 2004, Prime Minister M. Fradkov postponed the decision on this issue until December 2004. As of August 2005, the government did not decide on the precise timing of the WGC sale (see Table 2).

In this connection it is necessary to take into account possible negative consequences of selling the above-mentioned six WGC TPPs to private investors.

The WGCs to be created will have *unequal starting conditions* on the competitive electricity market, because their electricity production cost will vary by 50–90% and their annual capacity utilization hours will vary by 50–60%. Only power stations of the same type (peak, half-peak, and basic), having similar operating characteristics and electricity cost, can compete. Otherwise, there would be opportunities for price manipulation on the electricity market, and this is harmful to consumers.

Studies made in different countries have led to the conclusion that not only the market share and the number of generating companies in the market are important but also the position on the supply curve of the power stations comprising a generating company. These provisions are not observed in the planned WGCs, because they consist of power stations of different types.

A tacit collusion of several generating companies is possible on the basis of their common interest in superprofits. Under the competition law, antimonopoly laws and compulsory government price regulation are inapplicable to an oligopoly, which includes at least three independent companies.

Since each WGC consists of power stations located in different regions of European Russia and Siberia, *operating and administrative costs will rise considerably* because of increased transportation and communication costs. This will lead to unjustified growth of electricity tariffs. The increased complexity of control over dispersed WGC power stations will result in the loss of energy supply reliability.

WGC-3 and WGC-6 will have the *worst initial conditions*, because their electricity production cost is 50–90% higher than that of the other four WGCs (according to 2000 data [14]). In case of UES having surplus generating capacities these WGCs would be ousted from the wholesale market and go bankrupt. However, according to the Corporate Balance of UES Holding Company for 2004–2008, approximately 4 million kW of standby capacity in the European power pool will remain uncovered; i.e., in fact, there will be a capacity shortage if the standard of reliability reserve is observed. Therefore, the third and sixth WGCs will operate, and their marginal costs will affect the free "equilibrium" price of electricity and thereby increase it in the competitive wholesale market. The cost of electricity production at WGC-6 (29.15 kopecks/kW h) is 38.1% higher than the average production cost of all the six WGCs (21.1 kopecks/kW h). The remaining WGCs will make superprofits at the expense of consumers. This will escalate inflation, lead to the bankruptcy of many power-intensive enterprises, and slow down the national GDP growth. Consequently, either certain WGCs or consumer enterprises will become insolvent. If a competitive wholesale electricity market is introduced, the electricity price in the European sector of the market will be determined by the costs of the most expensive thermal power plants—the Cherepets and Ryazan state district electric power stations—which are twice above average.

British experience shows that, when the equilibrium electricity price in the spot market is based on the marginal costs of power stations, a tacit collusion of an oligopoly—several generating companies—is possible, leading to overstated costs and hidden profits. The government regulator's ten-year-long unsuccessful struggle against this evil resulted in the abolition of this model of the electricity spot-market in 2001. At present, the UK system operator has standby capacities at a fixed electricity price. These capacities are put into operation as soon as the competitive market price exceeds this fixed level.

This approach is similar to government grain reserves, which many developed countries use to regulate market grain prices.

With the establishment of WGCs in Russia the system operator will have inadequate standby capacities to regulate the price in the competitive electricity market. This is a road to the total bankruptcy of erstwhile best thermal power plants in this country. A solution to the problem of Russia's reliable and efficient power supply is to be found not in creating then selling WGCs but in the multiple-choice financial, economic, and energy analysis of the ways of reforming UES [15].

Russian and foreign energy specialists have demonstrated that the growth of electricity tariffs brings down GDP growth rates, because the share of value added in the products of the electric power industry is below the economy average [16].

In conclusion, it is worth mentioning that only a few countries—Great Britain, Sweden, and Finland—have split their AO-Energos into generation, transmission, and distribution companies. Vertically integrated companies are operating in Germany, France, Japan, and the majority of US states. A European Union energy directive, which came into force in February 1997, requires the obligatory separate accounting of generation, transmission, and marketing but does not require the obligatory liquidation of vertically integrated companies.

An AO-Energo is fully responsible for power supply in its region. It is interested in energy-saving measures and introducing energy-saving technologies at their consumers, since it is more efficient than building new generating sources and high-voltage lines.

Independent power generation, transmission, and distribution companies in a region have weak incentives for customers' energy saving, and nobody is fully responsible for the reliable power supply in a region. In case of emergencies, it would be difficult to find the guilty person in the energy system, because the single process of electricity generation, transmission, and marketing cannot be broken.

The Russian Accounting Chamber's "Analytical Memo on the Fulfillment of the Power Industry Reform Program," sent by the Chamber's Chair S.V. Stepashin to Premier M.M. Kas'yanov on January 5, 2004, says:

—approximately 90% of the total energy system malfunctions occur in the power networks owing primarily to the aging of network equipment. The condition of 100–220-kV inputs (approximately 70% wear) causes concern, as well as the overage network protection and automatic devices;

—because of the withdrawal of the state from the elaboration of the reform's legal framework and the absence of detailed legal implementation mechanisms, AO-Energos are being split into generation, transmission, and distribution companies without a specific and *statutory* description of how financial flows should be allocated between these companies, where profits will be concentrated, and how they will be spent to meet the needs of the newly established power complex entities;

—the inadequately high level of contractual relations, based on a controversial legal framework, implies *unjustifiably high risks* of violating the technological and operational unity of Russia's energy system;

—there is no one at the generating companies being privatized to bear responsibility for critical situations, since their owners may be nonresidents and live outside the Russian Federation; and

—legislating the establishment of commercial generating companies in which the government does not hold the control stock leads to the *loss of state control over federal energy systems* and, thereby, the violation of Article 71 of the Russian Constitution, which stipulates that these systems are managed by the Russian Federation.

In reality, competition is successfully developing in Russia and elsewhere with vertically integrated Energos in place. In recent decades, technological progress facilitated the creation of small- and medium-capacity power stations, and consumer enterprises and municipalities install them to economize on the network component of the electricity and heat tariffs. The state must only provide for nondiscriminatory access to these networks.

Formerly, the Russian Ministry of Economic Development and Trade also insisted on the splitting of Gazprom into several companies on the UES pattern. However, the state chose a strategy of developing Gazprom as the largest vertically integrated company while ensuring free access to the gas pipe for independent gas producers. This option is also advisable for UES.

The effect of the joint optimization of the development of the UES generation and power networks, which is 5–10% of the total investments in the electric power industry, will be lost in case of the company's self-liquidation.

Upon completion of the transition period of the electric industry reform, Russia will face a dilemma:

—either not to build new power stations, given the low prices of the existing ones (2–3 cents/kW h), which will lead to a power shortage, or

—to raise prices by 2–3 cents/kW h to make it profitable for private investors to build new power stations. This will lead to unjustified profits for existing power stations and negative consequences for the economy, the escalation of inflation, and a decline in GDP growth [17].

The July 6, 2005, report of the Russian State Duma working group that investigated the circumstances of the crisis situation in the Russian electric power industry and the consequences of the accident at MosEnergo's Chagino substation on May 23 and 25, 2005, noted:

The working group deems it extremely important to analyze once again the legislative, normative, and methodological framework of the reform implemented in the electric power industry [18, p. 6].

The working group recommends reconsidering the appropriateness of merging the System Operator–Central Dispatcher's Office UES and Federal Network Company–UES with a view to reliability.

The working group believes that one of the main causes of the extensive system-level breakdown is the shortage of reactive-power sources in and around Moscow; the lack of these sources is fraught with repetitions of system-level breakdowns and, consequently, endangers the energy security of the Moscow region.

The working group recommends the State Duma of the Federal Assembly of the Russian Federation to charge the Russian Accounting Chamber with conducting an exceptional review of the accuracy of spending at UES, first of all, the spending of depreciation charges, the investment component, and profits [18, pp. 7, 8].

REFERENCES

1. A. I. Kuzovkin, "The Aim of the Power Industry Reform: Competition vs. Reliability?" Probl. Prognozir. **15** (2)(2004) [Stud. Russ. Econ. Dev. **15** (2) (2004)].
2. Kommersant, May 26 (2005).
3. V. V. Kudryavyi, "Primary Attention Must Be Paid to Reliable Energy Supply," Vestn. FEK Ross., No. 4 (2003).
4. "GOELRO Chubais Style," RBC Daily: Companies, Aug. 30 (2005).
5. Vesti v Elektroenergetike, No. 3 (2005).
6. A. B. Yanovskii, "Monitoring and Legislative Support of the Implementation of the Energy Strategy of Russia," TEK, No. 4 (2004).
7. *Russian Statistical Yearbook* (Rosstat, Moscow, 2004) [in Russian].
8. Profil', No. 18 (432) May 16 (2005).
9. Joseph E. Stiglitz, *Globalization and Its Discontents* (Norton, New York, 2002).
10. Joseph E. Stiglitz, *The Roaring Nineties. Seeds of Destruction* (Norton, New York, 2003).
11. Kommersant, Jan. 27 (2005).
12. Bert Willems, "Modelling Cournot Competition in an Electricity Market with Transmission Constraints," Energy J. **23** (3) (2002).
13. Christian Hogendorn, "Collusive Long-Run Investment Under Transmission Price-Caps," J. Regulat. Econ., 24–32, (2003).
14. V. V. Khlebnikov, "The Resources of Bulk Power Generating Companies as Main Participants of a Competitive Wholesale Energy Market: An Assessment," Probl. Prognozir., No. 3 (2003).
15. A. S. Nekrasov, "Commentary on V.V. Khlebnikov's Paper," Probl. Prognozir., No. 3 (2003).
16. A. S. Nekrasov, Yu. V. Sinyak, and M. N. Uzyakov, "Russia's Power Industry: Economics and Reform," Probl. Prognozir. **12** (5) (2001) [Stud. Russ. Econ. Dev. **12** (5) (2001)].
17. L. S. Belyaev and S. V. Podkoval'nikov, *The Power Industry Market: Generating Capacity Development Problems* (Nauka: Sibirsk. izd. firma RAN, Novosibirsk, 2004) [in Russian].
18. Vesti v Elektroenergetike, No. 4 (2005).

APPENDIX

Description of the Willems Model

We are modeling the simplest network: a single power transmission line connects two generators in a city in the north (N) with electricity consumers in a city in the south (S).

Generator $i \in \{1, 2\}$ in N produces the q_i amount of electricity with a single income of c_i, which does not depend on q_i. The generator's production cost i equals $c_i q_i$. The output q_i of each generator is not limited to its technical bounds ($q_i \in R^+$). At the electricity price for end user p, the profit π_i of generator i equals

$$\pi_i = (p - c_i)q_i. \tag{1}$$

The electricity consumption is q. The consumers are price takers with a linear function of electricity demand:

$$p(q) = a - q.$$

The two nodes are connected by one power transmission line with limited capacity k. Let us assume without loss of generality

$$k = 1. \tag{2}$$

We assume that transmission losses are disregarded, and all electricity generated is consumed:

$$q_1 + q_2 = q. \tag{3}$$

We also assume that all transmission costs equal zero. Since the transmission capacity is limited, it may be insufficient, and the transmission cost is introduced. The unit price of electricity transmission from node N to node S is τ and τ, its value not necessarily being zero. Then, taking into consideration the transmission price, the generators receive only ($p - \tau$) for one unit of electricity produced.

The profit of generator i is

$$\pi_i = (p - \tau - c_i)q_i. \tag{4}$$

Defining $\theta_i = a - c_i$ for a generator of the ith type, the profit π_i will be rewritten as

$$\pi_i = (\theta_i - q - \tau)q_i. \tag{5}$$

We assume that the marginal cost of electricity generation is significantly lower than the marginal desire of the consumers to pay for the first unit of electricity:

$$\theta_i = a - c_i > 0. \tag{6}$$

Let us first consider the basics of the Cournot game without power transmission limitations. Each generator in the Cournot game has one parameter for decision making: the quantity q_i of electricity production. Each generator maximizes its profit π_i; assuming the output q_j of the other player to be preassigned:

$$\max_{q_i \geq 0} \pi_i(q_i, q_j). \tag{7}$$

Generating companies have the following function of the Cournot response:

$$q_i^c(q_i) = \max\{(\theta_i - q_i)/2, 0\}. \tag{8}$$

The Nash equilibrium is the intersection of two response functions. Equilibrium depends on the ratio θ_i/θ_j of the two companies and is inside three different solutions:

$$q_{i,\mathrm{eq}}^c = \begin{cases} 0, \text{ if } \theta_i/\theta_j < 1/2 \\ (2\theta_i - \theta_j)/3, \text{ if } 1/2 \leq \theta_i/\theta_j \leq 2 \\ \theta_i/2, \text{ if } 2 < \theta_i/\theta_j. \end{cases} \tag{9}$$

When $\theta_i/\theta_j < 1/2$, company i has such a high cost that it decides not to generate. Company j generates the whole product and is a monopolist.

When $1/2 \leq \theta_i/\theta_j \leq 2$, the companies' marginal costs are comparable, and we get a pure productive duopoly.

When $2 < \theta_i/\theta_j$, company i is so competitive that it produces monopolistic output $\theta_i/2$; its price is lower than the marginal costs of company j. Company i is a monopolist.

If there are no transmission limitations, the equilibrium consumption volume is

$$q_{\mathrm{eq}}^c = q_{1,\mathrm{eq}}^c + q_{2,\mathrm{eq}}^c$$

$$= \begin{cases} \theta_2/2, \text{ if } \theta_1/\theta_2 < 1/2 \\ (\theta_1 + \theta_2)/3, \text{ if } 1/2 \leq \theta_1/\theta_2 \leq 2 \\ \theta_1/2, \text{ if } 2 < \theta_1/\theta_2. \end{cases} \tag{10}$$

This value is the generators' increasing function θ_i. When the generators have low cost c_i and the demand is high, the transmission demand is high, too.

We have already made the first classification of the Cournot game by distinguishing between a duopoly and an actual monopoly (see (9)). We can develop a second classification:

Whether equilibrium is physically possible according to the Cournot game taking into account throughput limitation k (i.e., $q_{\mathrm{eq}}^c \leq 0$).

By combining the two classifications, we obtain six different results. When the generators' costs are high (θ_i are small), the Cournot equilibrium value is small and, therefore, possible. For small cost values (θ_i are large), the Cournot equilibrium value is impossible.

Henceforth, we limit ourselves to the most interesting parametric multitude of pure duopoly ($1/2 \le \theta_1/\theta_2 \le 2$), and, without loss of generality, we assume that generator 1 is a generator with a high production cost, and generator 2, with a low cost ($c_1 \ge c_2$). Let us introduce the following technical assumption of relative difference in the generators' costs:

$$1/2 \le \theta_1/\theta_2 \le 1. \tag{11}$$

Each point $\bar{\theta} \equiv (\theta_1, \theta_2)$ is a different game with different cost parameters. To explain these graphs, one should remember that, for points close to a 45° slanting line, the generators have the same costs, while points located farther have increasingly asymmetric costs. For points located near the origin of coordinates, the generators have high production costs and would sell small amounts of power.

Transmission limitations, probably, have little effect on these points. If production costs decrease, the generators would produce larger volumes in the Cournot game.