General Characteristics of the Power Industry and Its Components

Russia boasts a strong power industry, which evolved principally in the Soviet era. As of January 1, 1991, the installed capacity of domestic power plants was 348,000 MW, and electricity production in 1990 was 1728 bln kWh.

Structural change in the electric energy sector in the post-Soviet period led to the establishment in 1992 of a Russian joint-stock electricity and electrification company, RAO EES [Unified Energy Systems] of Russia. Added to its authorized capital were large thermal power plants with capacities of 1000 MW or higher, hydroelectric power plants with capacities of 500 MW or higher, high-voltage trunk lines that form the single power grid of the Russian Federation, central and regional dispatching offices, R&D institutions, and part of the shares of regional joint-stock energy and electrification companies (AO-Energos), which grew out or regional energy systems. Two regional energy systems did not form part of Unified Energy Systems, OAO Irkutskenergo being incorporated as an independent player, and POEE Tatenergo remaining state-owned with the status of a state unitary enterprise. Apart from regional joint-stock electricity and electrification companies (AO-Energos), thirty power stations were incorporated as independent joint-stock power stations, or AO-Electrostations.

There are 74 energy systems (AO-Energos) in the Russian Federation, which include 72 AO-Energos that form part of the holding Unified Energy Systems, plus OAO Irkutskenergo and POEE Tatenergo.

All AO-Energos are part of seven integrated power systems (IPSs), of which six work in parallel (the Center, Middle Volga, Urals, Northwest, North Caucasus, and Siberia IPSs) and the East IPS, operating separately from the Siberia IPS.

Russian nuclear power plants are under the jurisdiction of the Ministry of Atomic Energy of the Russian Federation. Of the ten nuclear power plants of Russia (including the Rostov NPP, which was put in operation in April 2001), nine are supervised by an umbrella enterprise, the Russian State Concern for Electricity and Heat Production at Nuclear Plants, or Rosenergoatom, which was formed in 1992. The Leningrad NPP, an independent operator, reports directly to the Russian Ministry of Atomic Energy.

Major Electric and Thermal Power Facilities

Large Thermal Power Plants (TPPs)

The dominant position of heat power engineering is an objective, historically evolved pattern of the development of the Russian power industry.

The following typology of heat power plants (HPP) has evolved in the Russian power industry:

- by source of energy transformed by thermal power plants: organic fuel, geothermal energy, or solar energy;
- by kind of output energy: condensing or cogeneration;
- by the use of installed electric capacity and the contribution to load curve coverage: basic (no less than 5000 h of use of installed electric capacity a year), semi-peak or flexing generating (3000-4000 h a year), or peak (less than 1500-2000 h a year);
- by purpose and form of use: public, industrial, utility, transport, mobile, rural, or floating.

There are other, highly specialized thermal power plants, which are not very common: underground, experimental, etc.

Thermal power plants running on organic fuel are differentiated by the technological criterion:

- steam power (with steam-power units running on all kinds of organic fuel such as coal, fuel oil, gas, peat, slate, firewood and waste wood, fuel processing products, etc.);

- diesel-driven;
- gas-turbine; and
- steam-and-gas.

Each power plant, classified by technological characteristics, is, in turn, either condensing or cogeneration.

Public thermal power stations running on organic fuel, mainly steam power ones, are the most common type.

Diesel engine power plants (DPP), although numerous, are largely limited to the agricultural and transport sectors. Geothermal power plants and CES are still used only locally.

The world's biggest HPP is the Surgut SDPP-2 (4800 MW), which runs on natural gas. (SDPP stands for State District Power Plant, an abbreviation surviving since the Soviet era.) Among the power plants burning coal, the Reftinskaya SDPP has the highest installed capacity – 3800 MW. Also belonging to the biggest Russian TPPs are the Surgut SDPP-1 and the Kostroma SDPP, each with a capacity in excess of 3000 MW.

The Russian power industry has 36 thermal condensing power plants, each with an installed capacity of 1MW or higher, of which 13 power plants have an electric power of 2MW or more. The latter have a total power of 36 400 MW, which is 24.7% of the overall capacity of the Russian power plants.

Biggest Combined Heat and Electricity Plants (CHEPs)

Russian heat power engineering is the unqualified world leader in the production of thermal energy by thermal power plants. Thermal energy is generated by waste steam from the steam turbines of thermal plants. Heat power generation includes both the production and transmission, as well as the centralized distribution of thermal energy, among the users. When electric power is generated by the heat generation cycle, thermal power is put to beneficial use, which is lost when electric power is generated by thermal power plants working by the condensation cycle.

The power industry operates unique cogeneration facilities, which generates both electricity and heat. In 2000, the installed electric power of the cogeneration turbines at combined heat and electricity plants was 50.8% and the thermal power, 84.8% of the respective kinds of power at all the thermal power plants of holding United Energy Systems.

CHEPs generated 53.6% of electric power and supplied 97.4% of heat of the total heat generated and supplied by the thermal power plants of Russia.

Eight CHEPs have an installed electric power of over 1000 MW each, their total power being 10,172 MW, or 15.3% of the capacity of all the combined heat and electricity plants of Unified Energy Systems.

Short Description of Major Thermal Power Plants (TPPs) of Russia

Russia has a great hydroelectric potential, which offers great opportunities for the development of hydropower engineering. Some 9% of the world's water resources is concentrated in its territory. Russia ranks second, after the Chinese People's Republic, in the water-power resources endowment, ahead of the United States, Brazil, and Canada.

The total gross (theoretical) hydropower potential of Russia is estimated at 2900 bln kWh of power output, or 170,000 kWh per sq. km of its territory.

The technically feasible degree of utilization of its water resources is around 70% of its gross (theoretical) hydropower potential, that is to say, the total technical hydropower potential of Russia is 1670 bln kWh of annual output. The bulk of it is located in eastern Russia with its tremendous water resources of the rivers Angara, Yenisei, Ob, Irtysh, Lena, Vitim, and some others, whose natural conditions lend themselves to the building of high-capacity hydroelectric power plants.

The economic potential of Russia, as the utilizable part of its water resources, is estimated at 850 bln kWh.

The nation's economic hydropower potential has been developed most of all in the European part of Russia – 46.8%. The rate of development of the Siberian hydropower potential is markedly lower – 21.7%. In eastern Russia, the rate of development of hydropower potential is a mere 3.8%.

Thirteen of Russia's hydroelectric power plants have an installed capacity of 1000 MW or higher, and their total installed capacity is 34,108 MW. Among the larger HPPs, six plants have an electric power of 2000 MW or higher, the total capacity of these HPPs being 25,581 MW.

At present, construction is under way, with Unified Energy Systems participation, of seven hydroelectric power plants in the East, Siberia, and in the south of the European part of Russia. The rated installed capacity of these HPPs is 7102 MW, and the rated average annual power output is 30 bln 421 mln kWh.

Table 1.1.5

Russian hydroelectric power plants with capacities of over 1000 MW

Name	Installed capacity, MW
Sayano-Shushenskaya HPP	6400
Krasnoyarsk HPP	6000
Bratsk HPP	4500
Ust'-Ilim HPP	3840
Volgograd PHH	2541
V.I. Lenin Volga HPP	2300
Cheboksary HPP	1370
Saratov HPP	1360
Zeya HPP	1330
Nizhnekamsk HPP	1205
Zagorsk HPP	1200
Votkinsk HPP	1020
Chirkei HPP	1000

Nuclear Power Plants

Nuclear-power engineering started in Russia on June 27, 1954, with the start-up of the Obninsk Nuclear Power Plant, which had a 5 MW carbon—uranium reactor.

In 1958, construction work began on the Beloyarsk NPP, featuring a channel-type water-carbon reactor with active section reheating.

The early period of nuclear-power engineering was characterized by the wide coverage of alternative and reserve avenues. In 1954, a massive effort was concentrated on two designs for dual-purpose reactors that could combine power generation and the development of weapon-grade plutonium: a graphite—water reactor with zirconium and steel pipes (a prototype of the RBMK, a large-capacity channel reactor) and a water-moderated tank reactor (a prototype of the VVER, a water-moderated power tank reactor).

The VVER project was launched in 1954-1955. The first power unit of this type of reactor at the Novovoronezhskaya NPP was placed in the circuit in 1964 and taken out of service in 1984. The second ran from 1969 to 1990.

Also implemented were power units with graphite water-cooled reactors featuring essentially new design solutions for the fuel core and the fuel element channel, which were used at the Obninsk HPP. They included the 1st and 2nd power units of the Beloyarsk NPP and the four power units of the Bilibinsk NPP. The Beloyarsk NPP featured nuclear reheating of turbine steam, and the Bilibinsk NPP featured natural circulation of primary coolant through reactor channels. The Beloyarsk NPP power unit 1 was in operation from 1964 to 1983 and power unit 2, from 1967 to 1990. The Bilibinsk NPP power units have serviced electric mains since 1974.

In 1962, the nuclear-power engineering program was expanded to cover gas-graphite and heavy-water reactors in addition to AMB and VVER reactors. Subsequently, heavy-water reactors were replaced by the water-moderated reactors, and gas-graphite reactors, by fast reactors (FR).

The RBMK reactor program was launched in 1963. The first version of the reactor was an elaboration of the dual-purpose concept using uranium metal and zirconium channel piping. In 1967, the reactor took final shape as a purely power reactor using dioxide fuel. The first power unit with this type of reactor was started up at the Leningrad NPP in 1973; a total of six such units were placed in operation at the Leningrad and Kursk NPPs between 1973 and 1978.

A breakdown at the fourth unit of the Chernobyl NPP on April 26, 1986, led to a review of the physical characteristics of RBMK reactors and necessitated a tightening of the technological regulations with a view to upgrading the safety of these reactors. Today, pressurized water-moderated and channel-type uranium-graphite reactors dominate Russia's nuclear-power engineering. The country's 10 nuclear power plants, including a ninth, Rostov NPP, which is under construction, operate 29 power units with an installed capacity of 21,242 MW.

The Russian Power Grid and Cross-system Electric Links

Description of the Russian Power Grid

The Russian Power Grid is the world's largest highly automated complex to generate, transmit, and distribute electric power and also to control these processes on a day-to-day basis. The power industry in Russia developed stepwise, by incorporating regional power systems, working in parallel, and forming interregional electric power pools, which merged to form a single Power Grid. The nation's Power Grid started to evolve as soon as the GOELRO plan was launched.

Early power systems, MOGES in Moscow and Elektrotok in Petrograd, were created in 1921. The first 100 kV high-voltage line between Kashira and Moscow was put in operation in 1921.

The nation's earliest dispatching services were established in the Moscow and Leningrad power systems in 1926, and in the Donbass power system, in 1930.

The early 1930s saw the development of isolated power systems in the center of European Russia, in the Northwest, in Ukraine, and the Urals. Joint power systems followed, as precursors of integrated power systems. In the post-WWII period, the Power Grid continued to evolve through the integration of power systems in the South, Northwest, North Caucasus, Transcaucasia, Siberia, Kazakhstan, and Central Asia. Crucial to the development of the Russian Power Grid was the construction of supervoltage tie lines which brought together all the regional systems to form a single power system.

A major step toward the completion of the Power Grid was made in 1978, when the Siberian Unified Power System was put in parallel operation with the European part of the Power Grid. The same year saw the completion of the Western Ukraine – Albertirsa (Hungary) 750 kV electric main, and 1979 saw the parallel operation of the USSR Power Grid and the Unified Power System of CMEA member countries. As the Power Grid was joined by CMEA countries' power systems in the west and the Siberian Unified Power System and Mongolia's power system in the east, the boundaries of synchronous operation stretched from Berlin to Ulan-Bator.

The parallel operation of the USSR Power Grid and the power systems of Eastern and Central European countries issued some challenges associated with international deliveries of electricity and power.

In the 1980s, the Power Grid together with separate Integrated Power Systems of Central Asia and the East embraced the entire settled territory of the USSR.

The development of an integrated single system -- despite the lingering problem of weak network links between the European part of Russia and Siberia and between Siberia and the Russian Far East -- is an unqualified major achievement of the Soviet power industry. This creates appreciable cost savings thanks to the effective control of electricity (power) flows and serves as a solid base for improving the reliability of the national energy supply system. The integration of the Power Grid constituent mains, which can be controlled from a single center, is a key factor in the integration of the nation's production complex and the integrity of the state at large.

Russia's Power Grid, the main component of the national power industry, is a complex network of power plants and mains, which have the same operating mode and centralized dispatching control. The transition to this form of organization of the power industry made it possible to make the most of power resources and to raise the economy and reliability of energy supply to both economy and population.

The control of this immense, synchronously operating system, which reaches 7 000 km west to east and over 3000 km north to south, is a very complex engineering task, which has no analogs anywhere in the world. Also, in its more than 40 years in operation, the Russian Power Grid has accumulated a wealth of experience in the reliable and efficient supply of quality energy to users. It is attested by the fact that, in 2000, the Russian Power Grid operated steadily 99.9% of calendar time at a standard frequency of 50 kHz.

Of the total 74 power networks, the Power Grid of Russia comprises 69 power networks. Of the seven Integrated Power Systems (IPSs) six work in parallel as part of the Power Grid: the Center, Middle Volga, Urals, Northwest, North Caucasus, and Siberia IPSs. The East IPS operates separately from the Siberia IPS.

The annual peak load, registered in the Power Grid in 2000, was 128 700 MW.

Power Grid plants's output in 2000 was 820.8 bln kWh, with TPPs generating 542.3 bln kWh, HPPs generating 149.8 bln kWh, and NPPs generating 128.7 bln kWh.

Working in parallel with the Russian Power Grid are the power systems of Kazakhstan, Ukraine, Moldavia, Belarus, Estonia, Latvia, Lithuania, Azerbaijan, and Georgia, and, through the insertion of direct current, the power system of Finland.

Interconnection Power Lines

An advanced 500-700 kV network evolved in the European part of the Russian Power Grid, while the 1150 kV voltage was introduced alongside a 500 kV network in its Asian part. High-tension transmission lines with voltages of 200 kV or higher form the core system-forming network of the Power Grid; they are operated by Unified Energy Systems zonal enterprises, which are intersystem electric networks. Their length is 153 400 km. The overall length of electric mains of all voltage classes in the Russian Federation is 2,647,800 km.

Production Facilities

The Russian power industry is one of the world's largest. It uses practically 100% home manufactured equipment, its own fuel resources, covers the nation's electricity and heating needs, and exports electricity. At the end of 2000, the total installed capacity of the Russian power plants was 213,300 MW, including 147 300 MW (69.0%) from thermal plants, 44,300 MW (20.8%) from hydroelectric plants, and 21,700 MW (10.2%) from nuclear plants. Of the total capacity of thermal power plants, combined heat and electricity plants (CHEP) accounted for 56.8%, and condensing plants (CPs), for 42.3%.

The engineering base of the Russian power industry is formed by 432 public power plants with an installed capacity of 196,200 MW, including 334 TPPs with a capacity of 131,000 MW, 98 HPPs with a capacity of 44 000 MW, and 10 NPPs with a capacity of 21,200 MW.

As of the end of 2000, the total installed capacity of power plants supplying energy to Unified Energy Systems networks was 192,200 MW, of which TPPs accounted for 68%, HPPs accounted for 21%, and

NPPs accounted for 11%.

In recent decades, with a downturn in industrial production and a corresponding 20% decline in electricity consumption and production, the utilization of installed capacity by all types of AO-Energo plants was very low indeed: in 2000, the total rate of utilization of installed capacity was 47.92%, specifically, 46.32% for TPPs, 42.50% for HPPs, and 69.07% for NPPs. With federal level plants this indicator was 38.15% for TPPs and 54.85% for HPPs.

Technical Condition of Production Facilities

Low electricity and heat tariffs established by regulatory bodies, which were not economically justified, and hence the crediting of consumers with cheap energy, led to underinvestment in the power industry with respect to replacement of production facilities. As a result of the wear and tear of production equipment, the installed capacity of public power plants today does not exceed 163,500 MW, and the utilized capacity, 140,000 MW.

The amount of equipment that has used up its fleet life is rapidly rising, fleet life meaning minimum fail-safe useful life. By 2001, 30% of the TPP steam turbines with a total capacity of 39,600 MW had exhausted their fleet life. By the end of 2005, 45% of the TPP steam turbines with a total capacity of 59,300 MW will have used up their fleet life, by 2010, 62% of the TPP steam turbines (80,500 MW), and by 2015, 72% of steam turbines (94,600 MW).

A technical re-equipment concept has been developed for HPPs at which turbines with a total capacity of 21,600 MW (50% of their installed capacity) have used up their standard operation time, which envisages their renewal or complete reconstruction. By a tentative assessment, renewal will prolong the service life of an HPP by 15 years at 15-20% the cost of complete reconstruction.

Power Industry Production and Performance Characteristics

According to the 2000 energy balance of electricity production and consumption of the Russian Federation, power output was 534.6 bln kWh, with HPPs producing 164.5 bln kWh, NPPs producing 128.9 bln kWh, and isolated generating plants producing 34.9 bln kWh. In the first six months of 2001, TPPs produced 269.9 bln kWh of electric power, HPPs produced 88.3 bln kWh, NPPs produced 66.6 kWh, and isolated generating plants produced 18.6 bln kWh.

Among energy producers the share of the Unified Energy Systems holding in 2000 was 72.17%, that of outside AO-Energos (Irkutskenergo and Tatenergo), 8.84%, that of NPPs, 14.94%, and that of isolated generating plants, 4.04%. In the first six months of 2001, the share of Unified Energy Systems was 72.08%, that of outside AO-Energos, 8.71%, that of NPPs, 15.02%, and that of isolated generating plants, 4.19%.

In 2000, Unified Energy Systems' enterprises accounted for 32.7% of heat supply in the Russian Federation, and in the first six months of 2001, against the background of continuing growth in heat consumption, the holding company's share in the nation-wide heat supply grew to 33.4%.

Since 1999, the dynamics of electricity production in the Russian Federation has been positive; power output grew to 831.1 bln kWh in 1999 and 862.8 bln kWh in 2000 from 812.1 bln kWh in 1998. In the first six months of 2001, power output was 443.4 bln kWh, which suggests that the 2000 performance will be surpassed.

However, in 1999, the output of chief energy producers, thermal plants, was 517.53 bln kWh, down from 518.16 bln kWh in 1998. Growth in total power output was due to a build-up in the output of HPPs (from 158.49 to 160.51 bln kWh) and NPPs (from 103.52 to 120.01 bln kWh).

In 2000, all types of power plant stepped up production: TPPs, from 517.5 to 534.6 bln kWh, HPPs, from 160.5 to 164 bln kWh, and NPPs, from 120.0 to 128.9 bln kWh. In the first six months of 2001, power output by TPPs was 269.9 bln kWh, by HPPs, 88.3 bln kWh, and by NPPs, 66.6 kWh.

With respect to energy zones, in 2000, 26.6% of electric power was produced by plants in the Center, 23% in the South, and 21.5% in the Urals. Power plants in the Northwest, the Volga region, Siberia, and the East accounted for 29% of the total energy output. In the first six months of 2001, the pattern of power production zone-wise did not undergo any significant change; there was a slight rise in the shares of Sevzapenergo, from 9.02 to 9.52%, and Vostokenergo, from 4.67 to 5.07%.

Energy supply to customers in Russia was 1444.0 mln Gcal in 2000, a rise of 0.7 mln Gcal from 1439.3 mln Gcal in 1999. The supply of heat to thermal power plants (CHEPs, district boiler houses, and electric boilers) was 37.2% that to individual customers in 2000. This indicator had a positive dynamics in the year 1997 alone, when it grew from 557.5 to 578.1 Gcal. In 1998 to 2000, the supply of heat to CHTP and district boiler house customers declined; it was down 1.3% in 2000 (from 543.98 to 536.89 mln Gcal). Heat supply by CHEPs, district boiler houses, and electric boilers was 298.4 mln Gcal.

In 2000, TPPs generated 61.95% of the total power, HPPs generated 19.06%, NPPs, 14.94%, and isolated generating plants, 4.05%. In the first half of 2001, the share of TPPs went down to 60.86%, that of HPPs rose to 19.93%, that of NPPs to 15.01%, and that of isolated generating plants, to 4.20%.

Decrease in the share of TPPs in the structure of power production and increase in the share of NPPs has been a general trend. The share of HPPs went down from 19.31% in 1999 to 19.06% in 2000, and grew, on the contrary, in 2001. Power output by HPPs depends in large measure on water resources available. A decrease in the share of HPPs in 2000 was due precisely to this reason.

Electricity and Heat Market

The period 1991 to 1996 saw wholesale and retail (consumer) energy (power) markets evolve in Russia.

Consumer energy (power) markets are created within the service areas of regional energy suppliers (AO-Energos). They emerge as a result of organizational and technological relations of groups of energy producers, transmitters, and distributors connected to consumer supply mains and distribution networks. These markets enable the purchase of the end product directly from the supplier.

The conceptual possibility of developing a wholesale energy (power) market appears as soon as generating capacities, or power plants, are removed from vertically integrated electric utilities (regional energy suppliers). The idea is to form independent energy producers who are free to leave energy transmission companies and are independent from energy producing and distributing companies. With this goal in mind, the Federal (All-Russia) Wholesale Market of Electric Energy (Power), or FOREM in Russian, was initiated.

Federal Wholesale Market of Electric Energy (Power)

The FOREM operates pursuant to the Federal Law of April 14, 1995, "On the State Regulation of Electricity and Heat Tariffs in the Russian Federation" and the Russian Federation Decree no. 793, of July 12, 1996, "On the Federal (All-Russia) Wholesale Market of Electric Energy (Power)". The FOREM is the domain of the service, purchase, and sale of electric energy and power carried out by its members within the Power Grid of Russia. It is a set of contractual relations between its members, who are connected by common processes of the production, transmission, distribution, and consumption of electric energy within the Power Grid.

Entities offering services in the FOREM are organizations of whatever organizational and legal form that have been duly authorized to take part in the process of purchase and sale of electric energy (power) in the FOREM.
RAO Unified Energy Systems is both FOREM organizer and participant.
Other FOREM participants are:

- Suppliers of electric energy (power), namely, federal level power plants or generating companies (power plant groups), joint-stock electric and electrification companies (AO-

Energos), and other energy producers;

- Buyers of electric energy (power), namely, AO-Energos and direct buyers, who are legal persons entitled to buy electricity from FOREM (wholesale buyers-resellers and end-users).

FOREM service providers are organizations of whatever organizational and legal form that have been duly authorized to provide to individual FOREM participants and the wholesale market generally services in support of the FOREM trading system.

FOREM service providers include:

- the FOREM systems operator, Unified Energy Systems Central Dispatch Administration, which performs all its functions conjointly with regional (integrated) dispatch administrations (IDA)
- the FOREM trading system operator, ZAO CDR FOREM; and
- the Rosenergoatom concern, whose services include arranging for nuclear power plants' participation in the FOREM and arranging for the development and safe operation of nuclear power plants.

The list of FOREM participants is established annually by the Government of the Russian Federation at the suggestion of the Federal Energy Commission of the Russian Federation.

The Federal Energy Commission sets the rates for the energy (power) bought/sold on the wholesale market.

The routing of financial flows between FOREM participants depends on the planned and actual payments scheme for the accounting period (month).

FOREM Participants 2000

(for a key to the boxes, see the end of the text**)**

FOREM Performance

In 2000, the FOREM had 132 participating entities, including 16 large federal-level consumers. The list of participants is constantly growing. At the end of the second half of 2001, the FOREM had as many as 143 participants, including eight new ones (seven large consumers and the Rostov NPP), which entered the market within half a year.

The FOREM energy supply increased to 293.3 bln kWh in 2000 from 282 bln kWh in 1999. Supply during the first six months of 2001 was 148.4 bln kWh.

The FOREM's share in the energy supply to the Unified Energy Systems network was 38% in 2000.

The supplier group dynamics for 1999, 2000, and the first half of 2001 shows a rise in the nuclear power plants' share of supplies to the FOREM and a decrease in the share of excess energy systems.

In the first half of 2001, closed energy auctions were initiated by ZAO CDR FOREM, at which 6.4 bln kWh of electric energy was sold to the amount of over one billion rubles.

Avenues to FOREM Improvement

Despite rate increases by government regulatory bodies and some improvement in the payment of electricity bills, every second AO-Energo does not recover its costs of production and transport of electric and heat energy, and the investment component of tariffs is insufficient even for the simple reproduction of basic productive assets. Incentives are still weak for raising the efficiency of electric energy production and delivery to the user; cost-based pricing mechanisms for energy (power) suppliers have not been discarded yet; existing contractual relations between suppliers and buyers need to be reworked; and the regulatory and methodological base of the market operation is imperfect. Given all these problems, we need to continue our efforts to refine the guiding principles and practices of the operation of the wholesale energy and power market.

As a federal wholesale energy and power market is developed, the following problems must be addressed:

- the establishment of competitive relations among market participants;
- the greatest possible involvement of energy producers in trading on a single wholesale market and providing nondiscriminatory access to the network;
- raising the effectiveness of wholesale trade through the introduction of a competitive pricing mechanism on the wholesale energy (power) market;
- optimal use of the operational equipment of power plants and reduction of fuel outlays; and
- optimizing the development of generating capacities and the network infrastructure.

The primary task in making the market competitive is to separate the functions of operational and technological control of the operating modes of market participants who are part of Unified Energy Systems from those of establishing commercial relations among them. To improve the efficiency and transparency of the wholesale energy (power) market we need to develop a system of wholesale trade management bodies, based on self-organization and self-regulation principles.

ZAO CDR FOREM was established jointly by Unified Energy Systems and the Rosenergoatom concern to perform the functions of a Trading System Operator. At present, ZAO TsDR FOREM carries out the functions of the Trading System Operator in the FOREM actual operating environment. The TsDR FOREM functionality is as follows:

- to form energy (power) balances and to harmonize them with the System Operator;
- to manage and take stock of energy (power) supply agreements between market participants and schemes of formation of contracts by wholesale sectors;
- to maintain commercial records of energy supply and arranging for payments for energy (power);
- to analyze reasons for deviations of the actual mode of operation from planned mode according to System Operator reports; and
- to develop new forms of electric energy trade (exchange trade etc.).

As a competitive market model emerges in real-life conditions, ZAO TsDR FOREM is developing and introducing exchange technologies, including their technological infrastructure and the infrastructure of commercial control of the wholesale energy market.

Efforts are being made to structure and analyze all areas of commercial accounting for the implementation of effective business processes and the development of market models, in particular, a model of the business processes of construction of an energy exchange of the spot energy market, a model of the business processes of commercial accounting, a model of the business processes of information support, and the Trading System Administrator (TSA) and System Operator (SO) structures.

The course of reform of the wholesale energy market is harmonized with the sector restructuring and the development of the regulatory and legal framework of the wholesale market. The share of segments with a market-driven pricing mechanism will steadily increase as the share of market sectors with regulated pricing is decreased until they are eliminated.

Perfecting the FOREM System of Contractual Relations

Principal avenues to continuing improvement of the FOREM contractual relations are connected with the movement toward a competitive energy market.

One avenue to improvement is for energy (power) suppliers to sign consignment agreements with the FOREM Operator, with the latter signing bilateral contracts with large consumers. Another avenue is to sign energy (power) supply agreements on the strength of a tender or exchange type financial contracts.

The Board of Unified Energy Systems has approved, subject to Federal Energy Commission (FEC) of Russia agreement (FEC Decree no.28/5, of May 25, 2000), a temporary procedure for holding tenders for the sale of electric energy generated over and above the plan by subjects of the federal (national) wholesale market of electric energy (power).

Tariff Policy

Government Regulation of Tariffs

Government regulation of electricity and heat tariffs was introduced in Russia in 1991 in connection with the economy's movement to the market. At present, the economic, organizational, and legal framework of government regulation is laid down by Federal Law no. 41-FZ, of April 14, 1995, "On the State Regulation of Electric and Thermal Energy Tariffs in the Russian Federation." Government regulation of electricity and heat rates occurs on two levels, federal and regional.

Federal Level

The Federal Energy Commission of the Russian Federation develops and approves tariffs for Federal Wholesale Energy (Power) Market participants (AO-power plants, NPPs and excess AO-Energos), tariffs for electricity supplied from the FOREM to deficit AO-Energos and large consumers that have been brought into contact with the FOREM, and also approves the license fee for the service of management of Unified Energy Systems operation and development.

FOREM tariffs. Rate making for FOREM electricity suppliers and buyers is subject to "Tentative Guidelines for the Formation and Application of Double-Rate Tariffs on the Federal (All-Russia) Wholesale Electric Energy (Power) Market (FOREM)," which was approved by the FEC Board on May 6, 1997 (no.76).

Rate making for energy suppliers relies on the cost-based method, i.e., tariff size is reckoned as the sum of economical cost and profit.

Rate making for FOREM buyers relies on the FOREM cost balance, i.e., the total cost of the energy bought from the FOREM is equal to the commodity output of all the FOREM suppliers.

FEC Resolution no. 47/3, of October 22, 1999, introduced one-part tariffs differentiated by daily load curve zones. By using a two-part tariff (with separate rates for electricity and power) and a one-part tariff, consumers are enabled to choose the most flexible payment system and to optimize their electricity consumption schedule. Two-part tariffs apply to FOREM electricity buyers in the Center – Urals energy zones. Both one-part and two-part tariffs are in effect for the zones of Siberia and the East.

In 2000, actual average selling tariffs for all groups of FOREM energy (power) suppliers were up 31% from 1999, with TPPs tariffs up 30%, HPPs tariffs up 10%, NPPs and Rosenergoatom (REA) tariffs up 36%, and AO-Energo tariffs up 15%.

In the first half of 2001, tariff growth was 33% from 2000, including 32% for TPPs, 14% for HPPs, 36% for NPPs and REA, and 65% for AO-Energos.

In terms of integrated power systems, or IPSs, the greatest growth of average selling tariffs for FOREM buyers was in the Northwest IPS (45.27%) and the least, in the East IPS. The first six months of 2001 saw tariffs practically to double in the Volga energy zone (48.61%), with less rapid growth in the East IPS (12.98%).

The FEC license fee establishes the procedure of economic justification and sets the size of the license fee for Unified Energy Systems services.

All Unified Energy Systems energy suppliers, both FOREM sellers and buyers, as well as consumers duly brought into contact with the FOREM, use Unified Energy Systems services. Government regulation of Unified Energy Systems activities takes the form of a reasonable license fee for its services of the management of the operation and development of Unified Energy Systems. The Unified Energy Systems service costs are charged to the product costs of organizations using these services.

RAO Unified Energy Systems may apply to the FEC for the revision of the license free for the services of management of the Unified Energy Systems operation and development subject to the following:

- an average inflation across Russia in excess of 2% a month;
- a revision of provisions of the industry tariff agreement on wages;
- a revision of the list and size of taxes and obligatory deductions and payments established by statutory acts of the Russian Federation and those of Federation members;
- a more than 30% change in the interest rate of the Central Bank of the Russian Federation and commercial banks on long-term internal loans; and
- an unlikely occurrence (force-majeure), which has had a substantial influence of Unified Energy Systems.

From October 1997 to March 1999, license fee regulation by the FEC led to its 14.4% decrease. This had the effect of reducing investment, electric main reconstruction and re-equipment programs, and repair work programs.

On March 1, 1999, the FEC raised the license fee 14.7%, but this had hardly any effect on the industry's situation.

On April 11, 2000, the FEC raised the license fee by 75.9% owing to a change in the investment component and the incorporation of mission-oriented investment funds for the reconstruction of power facilities in the Chechen Republic. Mission-oriented investment funds grew by 74%, making it possible to increase the scale of capital construction on power facilities by 90%.

In 2001, license fees were increased twice: on January 1, 2001, by 15.5% without a change in the investment component, and on May 1, 2001, by 33.3% with an increase in the investment component.

Regional Level

Regional Energy Commissions (RECs) set tariffs on the electricity and heat delivered by power suppliers to various groups of consumers within the jurisdiction of respective Federation members based on AO-Energy computations ("Guidelines for the Rating of Electrical and Thermal Energy on the Consumer Market" approved by the FEC on April 16, 1997).

Throughout recent years, government regulation of the tariffs on power industry products and services, aimed at curbing them, was not only an instrument for smoothing inflationary processes in Russia but also an important factor in the stabilization and resumption of general economic growth. At the same time, electricity and heat rates, which lagged behind industry prices, precluded the normal operation of power facilities.

By way of illustration, industrial product prices grew by a factor of 39,700 between 1990 and 2000, fuel industry product prices grew in the same period by a factor of 76,600, and energy rates, by a factor of 20,800. After August 17, 1998, the situation of the first inflation wave of 1992 was repeated: a surge of industrial product prices and virtually unchanged electricity and heat tariffs. From August 1998 to December 2000, price advance in industry was 276.2%, while the rise of tariffs for electricity for industrial consumers with an installed capacity of 750 kW or more was 181.8%. During the same period, consumer prices rose 279.9% and household electricity tariffs rose 237.6%.

As a result of tariff regulation, starting in May 2000, the growth of electricity and heat prices began to outpace the growth of industrial product prices. From December 1999 to December 2000, industry prices grew 131.6% and electricity rates, 140.5%. This kind of tariff regulation changed the situation for the better: the number of loss-making AO-Energos was 17 in 2000, down from 19 in 1999, and the number of underperforming ones (with a profitability of not more than 5%) was 16, down from 20 in 1999. On the whole, power industry prices grew 1.9 times slower than industrial manufacturers' prices in 1991-2000. According to returns from the first half of 2001, 20 AO-Energos were loss-making, and 13 entities had low profitability (not more than 5%).

In 2001, there was a turning point in the downward trend in the profitability of the power industry. While in 1990-2000, the average profitability of power entities decreased from 37.2 to 11.7%, with that of the production, transmission, and distribution of electricity going down from 50 to 15.3%, in the first six months of 2001, average profitability was 14.2%, with electricity production showing a profitability of 16.4%.

A number of regional power industry enterprises sustain considerable financial losses because tariffs are not reviewed for over a year or, when reviewed, not raised enough to ensure stable power system operation. Primorskii krai is a good case in point. The krai administration's and REC's policy of establishing unprofitable, economically unsound tariffs resulted, in the period 1994 to 2000, in a shortage of funds of over three billion rubles, even if federal budget subsidies are taken into account. This fact, first and foremost, is behind the fuel shortages experienced by regional power plants and frequent outages.

An analysis of the state of tariff regulation by regional energy commissions in Federation members reveals that virtually no region, when establishing electricity tariffs by consumer group, complies with the "Guidelines for the Rating of Electrical and Thermal Energy on the Consumer Market" with respect to the rate making by voltage level. As a consequence, one of the problems in tariff regulation is imbalances in electricity tariffs by consumer group (cross-subsidizing), which is compounded by the subsidizing of households, public organizations, and agricultural consumers at the expense of other consumer groups, who pay higher tariffs.

Recently, the level of cross-subsidizing (the ratio of the household electricity tariff to the industrial consumer electricity tariff) has been coming down. In 2000, household electricity tariffs were up 44.2% and industry tariffs, 37.7% on 1999. Between 1995 and 2000, the cross-subsidizing coefficient doubled, from 0.29 to 0.59; it was 0.647 in the first half of 2001, an economically justified rate being 1.5-2.0. Although this coefficient is steadily growing, the subsidizing of households by industry remains a topical issue.

The Russian government repeatedly decreed to phase out cross-subsidizing in the power industry and to bring the household electricity tariff down to its actual cost. The applicable regulation is Decree of the Government of the Russian Federation no. 418, of May 30, 2000, "On the Rates of Tariffs on the Electric Energy Used by the Population", which says that these tariffs are to be set according to the "Methodology for the Calculation of Minimal Tariffs for Electric Energy Used by the Populations of Russian Federation Members," approved by FEC Decree no.36/4, of July 21, 2000.

At the same time, actual selling tariffs for households, agricultural commodity producers, individual industrial branches catering for agriculture, and public organizations prove to be much lower than REC ones on account of numerous concessions, which are introduced without considering a compensation source. The amount of energy concessions is estimated at about 14 bln rubles a year (VAT included).

In addition, for lack of an articulated government policy of implementation of federal laws and other statutory acts providing for energy tax concessions for certain consumer categories, AO-Energos suffer extra losses. As they regulate tariffs, RECs do not take into account AO-Energos' decreased revenues owing to household concessions, and federal, regional, and local authorities do not lay out necessary funds to make up for missing AO-Energo revenues, which occur because of household concessions granted by regulations in force.

Reduced tariffs for various consumer categories should be established subject to the compensation for energy suppliers' lost revenues, made out of a regional or local budget, or else to direct subsidizing of such consumers out of the same budgets; in practice, however, no compensation is paid.

Another serious impediment to establishing economically justified energy tariffs is the imperfection of the existing regulatory and legal framework of tariff regulation and rating approaches.

[Expert RA]