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DEVELOPMENT OF THE RUSSIAN POWER INDUSTRY AND IMPROVEMENTS IN ITS ENVIRONMENTAL EFFICIENCY*

(Transmitted by the Government of the Russian Federation)

* Prepared by Mr. L.M. Eremin, Deputy Director for Technical Policy, RAO "EES Russia", Moscow.

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Development of the Russian power industry and improvements in its environmental efficiency

1. General remarks

The power industry is one of the few industrial sectors which affect the prosperity of every sphere of economic and social life and exert a direct influence on general technological progress. At the same time the industry must concern itself with the negative impact of power stations on the environment, which is an issue that has to be faced squarely.

The environmental efficiency of power stations significantly influences national environmental safety and is an important element in environmental protection around the world. Thermal power stations account for 16% of the total volume of pollutants released into the atmosphere by industry and transport in the Russian Federation. For this reason, environmental control in the power industry has been entrusted to appropriate administrative and technical authorities for the past 20 years. Every power company has services responsible for taking environmental action. National standards on permissible emissions of atmospheric pollutants have been adopted, which are no less rigorous than those adopted in a number of industrially developed countries.

Quantitative monitoring of pollutant emissions at plants is carried out in accordance with the Regulations on control of atmospheric emissions at thermal power stations and boiler plants, drawn up in conjunction with the Ministry for the Protection of the Environment and Natural Resources. Rules covering environmental control at individual power stations are coordinated with the local environmental protection authority. These rules pinpoint the sources of the emissions (or discharges) and indicate the substances being monitored, the methodology and the periodicity of monitoring. The quantities measured are noted in a register of emissions and discharges into the environment. All substances for which appropriate and valid standards have been devised are subject to monitoring. The results are recorded in reports which are subsequently sent to the National Statistical Commission.

The safety of ash dumps and dams at hydroelectric power stations is being properly monitored. Seismological studies are being carried out in the vicinity of key hydroelectric power stations. The operation of existing power stations, the design of new plants, and highly important decisions concerning organization and technology are all coloured by an awareness of the need to systematically minimize the harmful impact of technology on the environment in line with the internationally endorsed philosophy of achieving sustainable economic development.

For two years now, power companies have been operating within the parameters of the Environmental Programme for the Development of the Electricity Generating Industry to the Year 2005, a seminal document adopted in 1996. The programme takes up the challenge of gradually cutting emissions (discharges) of pollutants into the environment, even after allowance has been made for a return by 2010 to 1990 levels of heat and electricity output. In devising this programme, account has also been taken of the country's

obligations under international conventions to reduce transboundary emissions of sulphur dioxide and stabilize emissions of carbon dioxide at 1990 levels by the year 2010.

2. Current state of the power industry and its environmental characteristics

For many decades the Russian power industry developed on the basis of domestic technology and know-how, and today it constitutes a key sector of the economy. Total output capacity is 215,000 MW. A total of 812 billion kWh of electricity and 656 billion kWh of heat was generated in 1998 (1,469 billion kWh overall).

Thermal power stations predominate in the industry, accounting for over 60% of output. From the environmental point of view, their impact on atmospheric air is long-term (measurable in decades) through the emission of products of combustion.

The positive trend of recent years, namely lower emissions of atmospheric pollutants from thermal power stations as a result of an environmentally favourable fuel balance, continued throughout 1998. The proportion of natural gas in the fuel balance increased from 61.5 to 62.9% at the expense of solid and liquid fuels, and thanks to modernization and technological improvements undertaken by thermal power stations to cut nitrogen oxides and boost the efficiency of ash trapping equipment.

The following table shows the overall trends in thermal power station environmental indicators during the period 1990-1998:

million tonnes

Emission	1990	1993	1995	1996	1997	1998	% decrease relative to 1990
Particulates	2.3	1.8	1.38	1.38	1.17	1.15	50
Nitrogen oxides	1.6	1.4	1.17	1.12	1.07	1.03	35.6
Sulphur dioxide	3.1	2.4	2.05	1.98	1.76	1.70	45.1
Total:	7.0	5.5	4.60	4.48	4.0	3.88	44.5

The table shows that during the 1990s there has been a steady decline in emissions of the principal atmospheric pollutants, and over a period of seven years the total volume of emissions has decreased by 44.5%. Of course, the main reason for this positive trend is the nationwide slump in industrial output (approximately 44%) as the country makes the transition to a market economy. However, the total decline in heat and electricity output has not

been so significant, amounting to 34.2% over the same period. Analysis of the data shows that an even bigger reduction in pollutant emissions has been achieved through qualitative improvements in the operation of thermal power stations at a time of decreasing demand. This is particularly striking when one compares the same emissions on a unit basis.

Indicator	Unit of measurement	1990	1993	1995	1997	1998	% decrease relative to 1990
Particulates [1]	kg/trf*	24.5	21.6	19.2	16.8	16.4	33.1
Nitrogen oxides [2]	-"-	4.7	4.5	4.5	4.3	4.3	8.5
Sulphur dioxide [3]	-"-	21.8	20.6	20.6	19.5	18.8	13.8

* trf = ton of reference fuel.

It is widely held in scientific circles that carbon dioxide (CO_2), as one of the products of fossil fuel combustion, is particularly harmful to the earth's climate. The threat to the climate is a global problem, and the topicality of the issue is inextricably bound up with the nature of energy production and consumption.

The adoption of the United Nations Framework Convention on Climate Change by a significant proportion of States reaffirms the international community's awareness of the problem and its unanimous desire to avert potential global disasters. The States parties to the Convention have committed themselves to stabilizing CO_2 emissions by the year 2000 at levels not exceeding those of 1990. Only a handful of States are currently honouring this commitment (the Russian Federation, Germany and the United Kingdom). During the 1990s the Russian Federation has witnessed a substantial decline in CO_2 emissions; by 1996 they totalled approximately 600 million tonnes, a 22.4% decrease compared to the 1990 figure, which is principally due to the

[1] Ash emissions classified with solid fuel only.

[2] NO_x emissions given for all organic fuel.

[3] Sulphur dioxide emissions classified with sulphur-containing fuel only.

overall slump in industrial output. The power industry, as a key economic sector that accounts for a significant volume (34%) of total CO_2 emissions in the Russian Federation, has also achieved considerable success.

Indicator	Unit of measurement	1990	1991	1995	1997	1998	% decrease relative to 1990
Total CO_2 emissions	millions of tonnes	708.5	698.5	516.9	493.0	485.3	31.5
Unit emission of CO_2 [4]	kg/kg trf	2.03	2.02	2.02	1.98	1.95	3.94
Ditto [5]	kg/kWh	0.478	0.476	0.464	0.460	0.414	13.3

The decline in gross emissions of carbon dioxide compared with 1990, the base year, is mainly due to the general economic decline in the country and the proportional fall in demand for heat and electricity. The improved indicators for unit emissions of carbon dioxide point to certain positive quality enhancements in the energy production structure and the quality of the organic fuel consumed.

On the subject of compliance with international commitments, mention should also be made of the decrease in transboundary air pollution and the 30% reduction by 1993 of sulphur emissions relative to the base year 1980 (the Oslo and Sofia Protocols to the respective 1979 Conventions). These emissions were actually cut by 48.3%. During this period there was a 69% decline in sulphur oxide emissions from power stations.

3. Prospects for the improvement of environmental indicators at thermal power stations

The fact that the Russian Federation is a party to the above-mentioned international agreements, coupled with its awareness of the importance of environmental protection, places an obligation on power industry workers to promote further progress. The environmental programme is a very important document which lays down some basic guidelines. It envisages that electricity output will increase to 1,018 billion kWh by 2005. A turning point in the

[4] The ratio of total CO_2 emissions at thermal power stations to the total quantity of organic fuel consumed at thermal power stations expressed in conventional units (1 kg of reference fuel = 7,000 kcal).

[5] The ratio of total CO_2 emissions at thermal power stations to total heat and electricity output.

level of output is anticipated in 1999. However, increased output must not translate into greater impact on the environment. The main environmental indicators of the programme are summarized in the following table:

Indicator	1990	1994	1997	2000	2005	% decrease in 2005 relative to 1990
Particulates	2.3	1.5	1.17	1.6	1.3	43.5
Nitrogen oxides	1.6	1.2	1.07	1.4	1.3	18.8
Sulphur dioxide	3.1	2.2	1.76	2.6	2.7	12.9
Total:	7.0	4.9	4.0	5.6	5.3	24.3

Despite the increase in energy output, total emissions of the principal pollutants will be substantially reduced owing to the implementation during the period 1998-2005 of a package of measures designed to boost environmental indicators. This forecast is in line with the planned increase in these indicators on a unit basis, as shown by the following data.

Pollutant	Unit of measurement	1990	1994	1997	2000	2005	% decrease in 2005 relative to 1990
Particulates [6]	kg/trf	24.5	20.4	16.8	17.2	16.3	31.4
Nitrogen oxides [7]	-"-	4.7	4.6	4.3	4.2	4.1	12.8
Sulphur dioxide [8]	-"-	21.8	20.9	19.5	20.2	19.4	11.0

[6] Ash emissions classified with solid fuel only.

[7] NO_x emissions given for all organic fuel.

[8] Sulphur dioxide emissions classified with sulphur-containing fuel only.

The lessening of the negative impact of thermal power stations on the environment over the period 1997-2005 will depend on a number of factors, namely:

- A change in the fuel balance resulting from a further increase in the proportion of natural gas at the expense of high-sulphur liquid fuel;

- An increase in the proportion of solid fuel with improved environmental characteristics (lower sulphur and ash content), primarily run-of-the-mine and washed Kuznetsk and Berezovka coals;

- The elimination from the balance of obsolete, uneconomic and environmentally “dirty” plant;

- The retrofitting of existing boiler units with up-to-date gas scrubbing equipment;

- The introduction of new, environmentally clean plant that satisfies modern requirements (emissions standards for atmospheric pollutants from new boiler units are regulated by the new national standard 50831-95);

- The development of new, highly efficient power-generating plant with an efficiency gain of 10-15% (combined-cycle plant, generating sets using an ultra-supercritical steam cycle).

Most of these factors, together with the introduction of new generating capacity at hydroelectric power stations, the construction of wind-power and geothermal power stations, and the expansion of combined heat and power technology, will help to cut carbon dioxide emissions. The forecast trends in respect of total and per unit indicators of CO_2 emissions in the power industry are shown in the following table:

Indicator	Unit of measurement	1990	1991	1995	1997	2000	2005	% decrease relative to 1990
Total CO_2 emissions	million tonnes	708.5	698.5	516.9	493.0	517.6	557.8	21.3
Unit emission of CO_2 [9]	kg/kg trf	2.03	2.02	2.02	1.98	1.96	1.94	4.4
Ditto [10]	kg/kWh	0.478	0.476	0.464	0.460	0.455	0.448	6.3

[9]The ratio of total CO_2 emissions at thermal power stations to the total quantity of organic fuel consumed at thermal power stations expressed in conventional units (1 kg of reference fuel = 7,000 kcal).

[10]The ratio of total CO_2 emissions at thermal power stations to total heat and electricity output.

The final indicator requires some comment. In contrast to the preceding indicator, which principally illustrates the pattern of organic fuel use at thermal power stations, it measures a station's operating efficiency. When questioned about unit emissions from thermal power stations, spokesmen for the majority of electricity companies are often at a loss. Yet this is a very important indicator which should be applied all over the world. Its value depends on the type of fuel in use and the efficiency of the technological cycle at the power station.

In the case of thermal power stations in the Russian Federation, this indicator was 0.476 kg/kWh in 1991. For comparative purposes, the equivalent figure for Ontario Hydro, one of Canada's largest power networks with an installed capacity of 35 million kW, was 0.971 kg/kWh in 1992. [11] This significant difference is due to the fact that the Russian power industry traditionally generates heat and power combined, with more than 30% of the output being consumed as heat - a highly advantageous solution from the environmental point of view. In recent decades certain countries in northern Europe have had considerable success using similar technology. Unit emissions of CO_2 at Elkraft, one of Denmark's two electricity companies (output capacity: 4 million kW), totalled 0.535 kg/kWh in 1996. [12] Approximately half of Denmark's energy generation takes the form of heat, but the environmentally adverse fuel structure (the principal fuel being coal) prevents the country from becoming a world leader in this field.

4. International cooperation on global climate issues

The outcome of the Third Conference of the States parties to the Framework Convention on Climate Change, held in Kyoto in December 1997, has given new impetus to the work of ecologists employed in various international environmental organizations. Intensified efforts are being made to hammer out draft instruments on a regime for record-keeping, monitoring and trading of CO_2 emissions. Some countries have expressed misgivings as to their ability to implement economically acceptable measures in fulfilment of their commitments to stabilize or reduce existing levels of carbon dioxide emissions. These countries have an interest in purchasing the requisite quantity of CO_2 emissions permits. The details of an international trading system are expected to be worked out soon; the topic will be considered at the Fourth Conference of the States parties to the Framework Convention on Climate Change, due to be held in Buenos Aires (Argentina) in November 1998. So there will shortly be an opportunity to purchase “surplus” CO_2 emissions from countries which have a surplus to sell. China and the Russian Federation are considered to be the principal suppliers.

In the Russian Federation, the deep cuts in CO_2 emissions that have occurred during the 1990s are mainly associated with the sharp decline in industrial output that has characterized the transitional economic phase. The carbon dioxide “surplus” is a temporary phenomenon which will disappear when

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[11] Source: Ontario Hydro 1992 Environmental Performance (annual report).

[12] Source: SK Power company, Denmark, annual report 1996.

the economy recovers. If we dispose of this surplus lightly (if the Government decides to sell it), its absence could prove to be a new form of bondage. Certainly, it will be more expensive to buy it back at a later date.

There is, however, another way to trade CO_2 emissions permits. It consists in the implementation of joint projects in the seller country financed by the purchasing country. This course is less risky for the seller country, since its natural economic development is not impeded. It must, however, be stipulated that the acquired CO_2 emissions permit is valid only for the estimated duration of the project in question, because the environmental benefit which the project was designed to bring about ceases when the equipment and plant reach the end of their working lives.

This is the approach recently adopted by the Japanese Government, which has instructed major Japanese corporations to contact their Russian counterparts, including power companies, asking for proposals that would substantially reduce emissions of greenhouse gases. To date, in the power industry alone, a package of proposals embracing approximately 50 projects has been drawn up. The Japanese Government has submitted this package to Japanese corporations for further study. The list of projects is known to include 18 power stations where the Japanese are conducting feasibility studies.

The package mainly consists of projects associated with the widespread introduction of steam and gas technologies at large power stations. There are also projects to renovate thermal power stations, build new hydroelectric power stations and develop non-traditional energy sources.

5. Conclusion

In discussing efficiency projects in the Russian power industry, it should be noted that the country's largest reserves are in the energy sector. Potential is estimated at 200 million tonnes of reference fuel. We mentioned earlier that average indicators in the Russian power industry are not strikingly different from those in industrially developed countries, but consumption of electrical and thermal energy is under-efficient. This is where investment should be targeted, and where it would yield the optimum ratio of cost per tonne of carbon dioxide emitted.
