

Nuclear Power and Energy Security in Russia

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The crisis through which Russia's entire economy, including its fuel and energy industry, is currently passing will be a real threat to the country's energy security in the immediate future. The most worrying tendencies are:

- The acute investment shortage, leading to capacity losses in the fuel and power industry which cannot easily be compensated for.
- The deterioration of the raw materials base, particularly in the oil industry. The decline in oil production in Russia from 1990 to 1996 was 45%, that in coal 36% and even for gas the figure was 6% (Figure 1).
- The power intensive nature of the Russian economy. In 1994 the power consumption per unit of GDP was actually 1.5 times greater than in 1990 (although in 1995 a downward trend in power intensity began to appear).

The energy policy adopted by the present government, despite its declarations about ensuring a good balance and diversifying electric power sources, essentially establishes dependence on gas as the guiding principle of development for the coming decades.

The share of natural gas in the country's fuel consumption was 62% in 1996, and is expected to reach 70% by 2010. It has already reached 80% in the European part of Russia. It is characteristic that in 1996, 96% of all Russia's gas extraction (as well as about 70% of oil) originated from the North Tyumen area (3% of the country's territory), which is distant from the main consuming regions and has poor living conditions. This fact leads some economists to describe Russia as a "gas drug addict with a 4000 km-long needle".

The present difficulties of the country's fuel and energy industries, as well as the de facto mono-fuel policy in favour of gas, considerably decrease the energy supply reliability because of a reduction in the diversity of power sources.

The "gas pause" which now exists in Russia is driving those involved in energy policy to make intensive analysis of the short and long term possibilities for nuclear power and its place in the country's economy. The highest decision-making circles already understand the importance of this task, which is confirmed by the recent decision by President Yeltsin to establish a commission, reporting to the government, to prepare in the short term a programme for nuclear power development.

Practically no-one doubts that nuclear power has the capability to be one of the principal energy technologies of the future. It has all the necessary preconditions for that: fuel resources, the ability to satisfy all the expected requirements of safety, ecological acceptability, and economic efficiency. Its present modest role in electricity production is explained not by defects in nuclear power itself, but by the current situation in the market for electrical power.

At the present time we can see the results and consequences of too rapid nuclear power development in the 1970s and 1980s. We can now select from all the multitude of projects initiated during the period when unlimited resources were invested in nuclear power, choosing those which will allow the creation, at minimum expense, of the nuclear power structure which will most effectively overcome the existing difficulties of

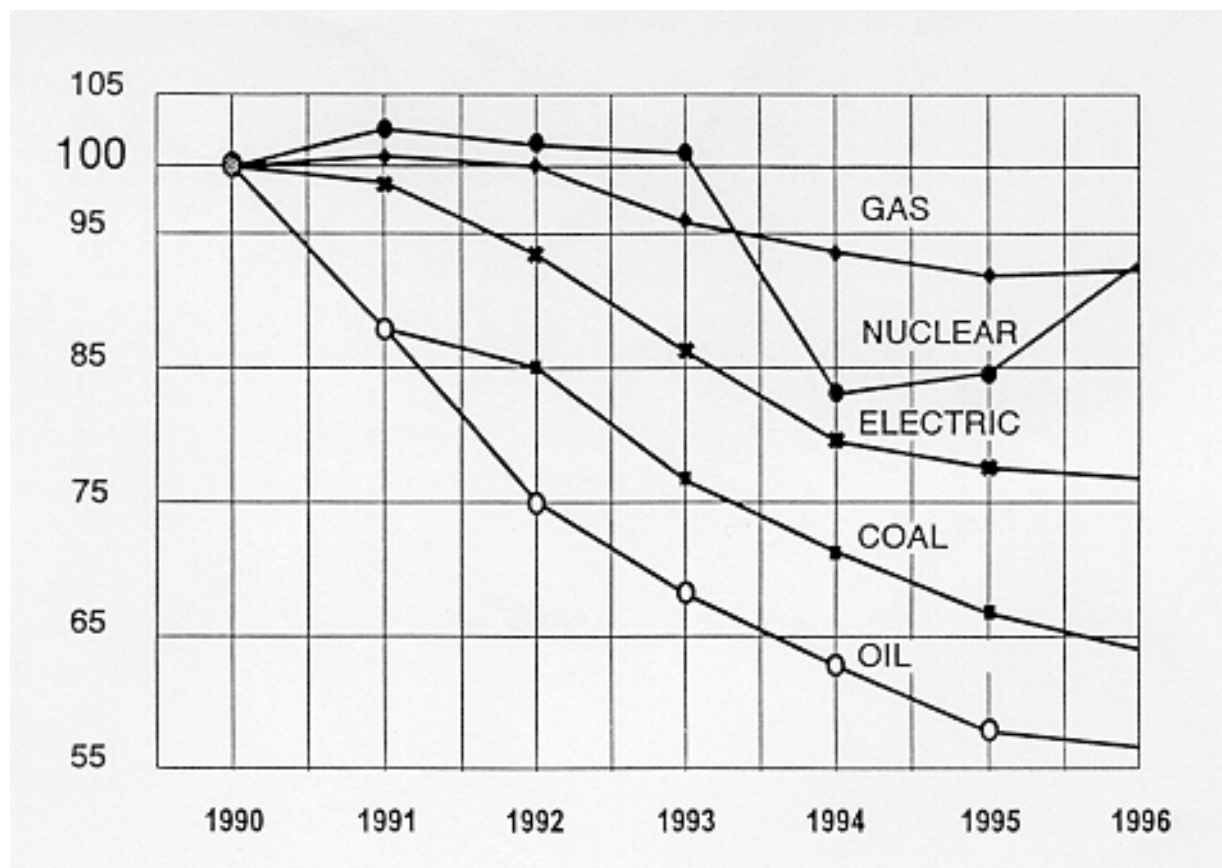


Figure 1. Changes in Russian energy production 1990–96 (1990 = 100).

ensuring its competitiveness with other power technologies.

Under Russian conditions nuclear power remains very attractive, because in addition to fuel resources, world-class fuel cycle enterprises and highly qualified personnel, there is also a complete portfolio of established technologies and projects for creating a multi-component nuclear power structure with a closed fuel cycle. This includes the military nuclear complex, which could be efficiently converted to the civil nuclear industry.

However, in order to preserve the technical potential and scientific base to ensure the possibility of a new start for nuclear power, which most experts agree will begin in the second decade of the next century, the nuclear power industry must survive through the “gas pause”, in which it will experience conditions of economic crisis, an unfavourable investment climate for capital-intensive technologies, and a hostile public attitude, which is quite natural after the Chernobyl accident of 1986.

The dynamics of the main parameters of electricity production in Russian NPPs is given in Table 1. These data illustrate that nuclear power has survived through the technogenic crisis of

1986 following the Chernobyl accident. Although this crisis did not eliminate nuclear power, it ended the programme for its enhanced development, which had provided for 190 GWe of installed nuclear capacity by 2000 (ie. five times the present level in the countries of the former USSR). It should be noted that, despite the crisis, no operating nuclear units in the former USSR territory have been decommissioned in direct connection with the Chernobyl accident (with the exception of the Armenian plant, which has already started operation again, and the recent decommissioning of one of the Chernobyl units).

The political crisis following the collapse of the USSR led to difficulties with the operation of nuclear power plants, notably in Ukraine, because of the breaking of economic ties. However, the crisis has not eliminated nuclear programmes in any of former USSR countries, and has even promoted the reactivation of nuclear development in Belarus and Kazakstan.

After surviving with great losses the technogenic crisis of 1986 and, with less damage, the political crisis of the collapse of the USSR, nuclear power has made some clear technical achievements despite the long economic crisis:

Table 1. Status of nuclear power in Russia, 1991–96.

	1991	1992	1993	1994	1995	1996
Number of units in operation	28	28	29	29	29	29
Installed capacity (GWe)	20.242	20.242	21.242	21.242	21.242	21.242
Electricity produced (billion kWh)	120.0	119.6	119.2	97.8	99.3	108.8
Share of electricity produced (%)	11.4	11.8	12.7	11.3	11.6	12.8
Average load factor (%)	67.2	67.3	64.9	52.6	53.4	58.3

- measures to improve safety have been implemented at all nuclear power units in the former USSR countries;
- decommissioning of several old units has been carried out;
- several first-generation RBMK units have been backfitted;
- advanced reactor projects for a new generation of plants have been developed up to the level of licensing and site selection.

The most important parameters characterising the reliability and safety of the operation of nuclear power units, such as the number of incidents at various levels of the INES scale, and the frequency of automatic actuations of emergency protection systems, demonstrate a declining trend (Figure 2). These parameters for Russian NPPs place Russia among the leading nuclear countries of the world, a fact which is at odds with persisting Western pressure in connection with “unsatisfactory safety levels” at Russian NPPs.

However, the unfavourable economic conditions for nuclear power operation in Russia are clearly shown by the level of load factors (Figure 3), which (excluding the only fast neutron unit BN600) are considerably lower than world averages. The main reasons for such low load factors are well known:

- Extended shutdowns (because of financial difficulties) of several units at Leningrad and Kursk NPPs for reconstruction.
- The limitation of first-generation RBMK units to 70% of capacity until the completion of backfitting.
- A decrease in electricity consumption, with less favourable conditions for NPPs compared with fossil fuel plants.
- Non-payment for electricity supplied, which

has led to units having to reduce capacity. In 1996 the debt of the monopoly electricity consumer — the joint stock company RAO EES — to nuclear power plants and to Rosenergoatom reached 7.9 trillion roubles (US\$1.4 billion).

Nevertheless, even with the continuation of the RAO EES monopoly, nuclear power has demonstrated its economic efficiency. The cost of nuclear electricity in 1996 was an average of 70 roubles (1.2 US cents) per kWh, which is 30% cheaper than the best RAO EES plants. The fuel component was 13 roubles (0.2 US cents) per kWh, or five times cheaper than the best district heating plants.

In the coming period, nuclear competitiveness will increase due to the increasingly rapid growth of prices for fossil fuels, compared to the more conservative increase in nuclear fuel prices. This effect is magnified by the high fuel component in the costs of fossil fuel plants of 60–70% for coal and 80–90% for oil, compared to 30% for NPPs (even taking into account the cost of spent nuclear fuel management).

The official power strategy of Russia provides for the necessary level of nuclear power development to supply by 2010 at least 125 billion kWh (or 22 GWe of installed capacity), with a maximum level of 160 billion kWh (or 28 GWe of installed capacity).

In spite of such governmental programmes and the economically proven efficiency of NPPs in the areas of Russia which are distant from cheap coal and oil deposits (these regions include the centre, northwest, Caucasus, far east, etc.), it has to be recognised that in recent years there has been no nuclear power growth in Russia.

Completion of the construction of the fifth unit at Kursk NPP and the third unit at Kalinin NPP (VVER-1000s) may take an indefinitely long period,

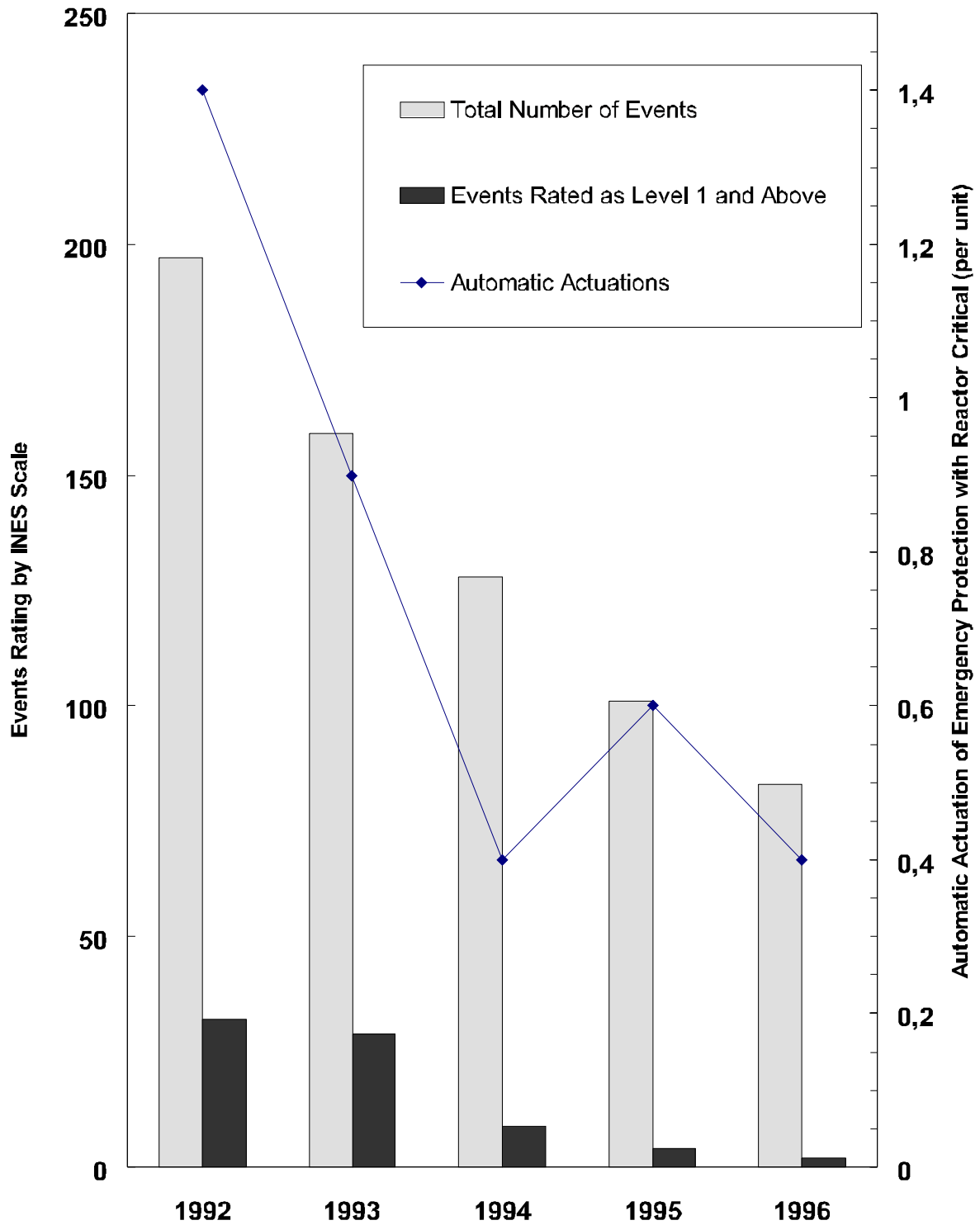


Figure 2. Trends in operational events at Russian nuclear power plants.

if investment levels stay at the 1996 level of US\$30 million. For the Rostov unit (also VVER-1000), which is far closer to completion, political barriers still persist. After many expert ecological investigations, the regional Duma (parliament) must soon make a decision on the fate of this station. About US\$700 million needs to be invested in order to complete these three units.

Even more indefinite are the construction perspectives for new generation units with advanced VVERs of high and medium capacity. However, construction of a VVER-640 unit has formally begun at Sosnovy Bor, the extension of the Kola NPP has received the necessary licensing, and the Novovoronezh NPP (with an advanced VVER-1000) is also close to achieving this. Prep-

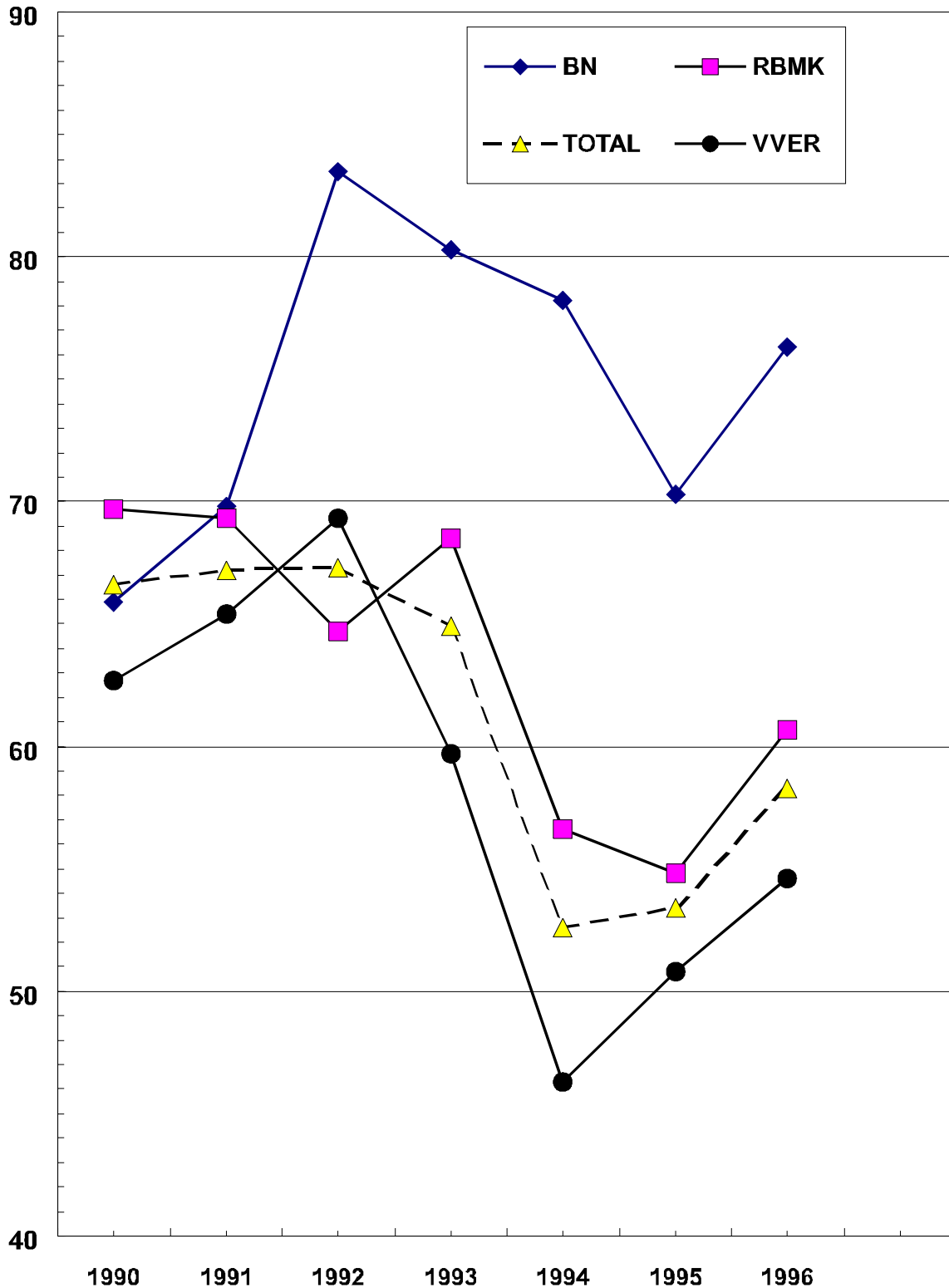


Figure 3. Trends in load factors at Russian nuclear power plants (%).

aratory work on these sites has already begun.

There are also real chances of restarting construction of the new fast neutron units with BN800 reactors at Beloyarsk, and (more problematically) on the South Ural site. The cost of each of these units is estimated as US\$500–600 million. The

existing industry infrastructure is able to provide an annual budget for works of US\$120–150 million per unit.

The main reason for uncertainty in the nuclear programme, as was already noted, lies not in rejection by the public, as it did at the beginning of

the 1990s, but in the lack of investment. With capital investment having disappeared from the federal budget in 1992, and in conditions unfavourable for long term credit, the only real (and obviously insufficient) financial source for nuclear power is the money received by Rosenergoatom from the sale of electricity, which it receives, moreover, with long delays and only in part. It has not yet been possible to attract funds from regional budgets, though in all probability this is a real prospect for the Kola and Ural regions.

Additional financial resources could be provided by Minatom exports, including those under the HEU Agreement with the USA and from the construction of nuclear plants in Iran, China and India. In 1996 the volume of Minatom's export was US\$2 billion, and there are reasons to expect this to increase to US\$3.5 billion per year by 2000. However, it should be noted that these resources, both received and expected, are far from exclusively devoted to the needs of the nuclear power industry.

In this perspective, Russia's high technologies for spent nuclear fuel management and long term storage (subject to the completion and commissioning of the Krasnoyarsk RT-2 reprocessing plant) could be used for the benefit of the world community and become a major financial source for the country. But the attitude of some Russian politicians and the effect of some anti-nuclear acts adopted by the Duma still hinder progress in this direction. It should be noted that the Russian government is making all efforts to overcome these barriers.

On the other hand, there are examples where favourable decisions on nuclear power have come from the political arena in Russia. For instance, the request to stop plutonium production at Tomsk-7 and Krasnoyarsk-26, and the necessity to provide substitute energy supplies, could lead to a reactivation of the programme to develop nuclear district heating plants, particularly construction of the Tomsk NDHP (AST-500 design). The problem of military plutonium disposition has already given a great impulse to the programme for MOX fuel

use in Russia and is also having a positive influence on the programme to construct several BN800 units.

With the present indefinite delays in commissioning new capacity, the task of extending the operating lifetimes of existing NPP units has become especially important. If Russian units were to be decommissioned after a standard 30-year operating lifetime (allowing for the four units which are already shut down at Russian NPPs), by 2010 about 7 GWe (ie. first-generation RBMK and VVER-440 reactors) would be decommissioned. In the following five years about an additional 7 GWe (including units with VVER-1000s) would be shut. This would lead to large capacity losses in the most populated areas (northwest and central Russia), where the nuclear electricity share is large (30–40%).

It is therefore quite natural that the programme to extend the operating lifetimes of existing reactors is now the focus of attention for leading Russian nuclear specialists. The key problems — VVER reactor vessel strength and the state of RBMK graphite stacks — are well known. However, it can be recognised that the possibility of VVER operational lifetime extension looks more definite than that for RBMKs.

Returning to prospects for nuclear power development beyond the next 10–15 years, it can be stated with confidence that this method of energy production in Russia is a guarantee of the country's energy security in conditions where the exhaustion and increase in price of other energy resources is inevitable. Nuclear specialists are of the opinion that after 2010 the nuclear share in the country's electricity supply could increase up to 30–35% for Russia as a whole and to 40–50% for its European part.

The fate of nuclear power shows an obvious analogy with the fate of Russia itself: a worthy future can be predicted, but first it is necessary to pass through a hazardous transient period.