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## PRESIDIUM OF ACADEMY OF SCIENCES STUDIES LONG-TERM FUEL PROBLEM

Summary: A session of the Presidium of the Academy of Sciences has studied the long-term fuel problem of the USSR. The rapporteur was noticeably cautious about the large-scale expansion of nuclear power stations, and seemed to imply that there are many unsolved questions concerning it, especially with regard to the engineering of breeder reactors. If neither nuclear power nor natural gas build up as fast as is hoped, he foresees considerable reliance on brown coal, even at the turn of the century.

The mounting concern in the West with the long-term outlook for fuel supplies seems to be matched in some respects in the USSR, to judge by a recent session of the Presidium of the Soviet Academy of Sciences. This session was convened to discuss the basic scientific and technical questions of energy supplies, and a brief survey of the proceedings is given in the latest issue of Vestnik Akademii Nauk SSSR (1) to reach Munich.

The main report was delivered by Academician M.A. Styrikovich, in his capacity as Secretary of the Department of the Academy that deals with the Physical and Technical Problems of Energy. He began on a relatively optimistic note, by saying that a substantial fuels deficit is unlikely to emerge for 80-100 years, and that if the problem of extracting uranium from sea water can be solved, it will

come considerably later. Therefore, at least until the middle of the 21st century, nuclear power stations will be widely used only if they provide cheaper electricity than other stations. During this time, they will mainly be breeder reactors.

Styrikovich pointed out that the problem of transmitting large quantities of electricity over distances of 3,000-4,000 kilometers is especially important in the USSR, because the cost of electricity in the European part of the country is 3 or 4 times higher than in Central Siberia, and he expects this ratio to remain constant for the next 10-15 years. Consequently, much work is being done on superhigh tension direct current ( $\pm 750$  kilowatts) and on alternating current of 1150 kilowatts.

However, Styrikovich said, granted the swift development of atomic energy (where the cost of electricity is almost independent of the location of the station), the difference will decrease, and there will correspondingly be a reduction in the savings from the transmission of electricity over very long distances. In that case, the mass transmission of electricity from Western Siberia to the European areas of the USSR might not be expedient. It follows that transmission at still higher tension (direct current  $\pm 1100$  kilowatts), which could only be effected on a large scale in 15-20 years time, would only be necessary if there are delays in the development of atomic energy. But transmission at  $\pm 750$  kilowatts would be necessary with any of the variants for electric power development.

This part of Styrikovich's report is extremely unusual, in that normally Soviet media never admit that there may be delays in the atomic energy program. Western specialists are distinctly puzzled by the relatively modest plans for the expansion of the nuclear power network, which at present foresee a quadrupling of capacity, from 2,000 megawatts to 8,000 Mw in 1971-75 (2) with a further quadrupling, to 32,000 Mw, by 1985. (3)

In December last year, Academician A. Aleksandrov, Director of the I.V. Kurchatov Institute of Atomic Energy, predicted in Izvestia that Soviet fast-neutron stations might have a capacity of 200,000,000 - 300,000,000 kilowatts by the end of the century, (3) but Styrikovich's caution seems to imply some doubt about the feasibility of the program.

### Natural Gas Transmission

In his comments on natural gas, Styrikovich said that although the development of atomic energy would reduce the importance of research on gas problems, the question of transporting and storing liquefied natural gas (transport at  $-100^{\circ}\text{C}$ ) would retain its significance for a longer period. It can be effectively used for peak loads (which, for a long time to come, will not be covered by atomic power stations).

Styrikovich then repeated his cautionary phrase concerning nuclear power, this time including natural gas:

If there is a restricted growth of atomic energy and of the gas industry, there will be a need for the mass transport of brown coal from the Kansk-Achinsk field to the European areas, and the most effective method, it seems, will be specialized transport (by pipeline or long-distance rail) of enriched coal. But the solution to this problem would take a long time and at least until the middle of the nineties, the simpler variant of transporting enriched coal by normal rail would be the main solution.

So it appears that even in the year 2000, a substantial part of the industrial economy in the western USSR may still be using brown coal as its basic fuel. The ecological consequences are likely to be seriously worse than in the case of natural gas or atomic power, although there is little doubt that the Kansk-Achinsk coal is probably the cheapest source of power in the USSR.

A primary problem which needs urgent solution, according to Styrikovich, is the development of nuclear power stations with a capacity of 1.5 million kilowatts. They will have to be efficient plutonium producers, and optimized to provide the base load in areas where fuel is expensive. Secondly, semi-peak thermal stations using organic fuels must be developed, optimized for 12-16 hours a day and five days a week. An electric grid system with a capacity of 6 million kilowatts and 1750 kilowatts direct current will be needed for switching between the electric power systems of the European areas and Siberia, and in order to reduce the tension in the power balance of the European areas, until there is a significant growth of nuclear power.

For gas, Styrikovich sees a pressing need for super-capacity pipelines of 1,400-1,600 millimeters in diameter, taking pressures of 75-100 atmospheres. If there are to be large-scale exports of gas by tanker (which now seems virtually certain in view of the progress already made in the negotiations for a Tyumen-Murmansk line to ship n.g. to the East Coast of the U.S.), pipelines for liquified gas must also be developed.

Other essential projects include the large-scale installations for enriching the Kansk-Achinsk brown coal, equipment for transporting the product to the European areas of the USSR, and breeder reactors of large capacity in which the main emphasis will be on maximum reduction of the time taken to double the plutonium supply.

But Styrikovich sounds yet another cautionary note concerning their development, when he writes:

Here, as abroad, the water-cooled reactors on which the large scale construction of atomic power stations is based are distinguished by an extremely low utilization of natural uranium. The fast-neutron breeder reactors are free from this defect, but they are still little developed, and it is difficult to determine at all precisely the date for the beginning of mass construction of large power stations of this type. However, even after that date, the speed of construction of fast neutron stations will be held back by the shortage of the plutonium needed for the initial loading of the reactors.

The "self-breeding" of nuclear power stations using fast neutron reactors is a very slow process. With the reactors now being built the time for doubling the plutonium charge, i.e. the time in which an additional quantity sufficient to load a new reactor of the same capacity, is about 8-10 years. And in about the same time, the capacity of all the electric power stations in the USSR is doubled. It follows that the "self-breeding" of power stations using fast neutrons will only support the original share of such stations in the energy system of the USSR. Their role may increase if plutonium "from outside," i.e. plutonium produced in the present atomic power stations, is utilized. The expected long-term reduction to 6-8 years of the time needed to double the plutonium charge will improve the position, but even so until the end of the century both here and abroad more than half of all nuclear power stations will be using thermal-neutron reactors. In view of the large scale of construction, this will cause very high demand for natural uranium, which may lead to the use of more expensive uranium from less economic mines....

Later in the debate, N.A. Dollezhalya made a speech which hinted at one possible reason for the remarkable caution with which Styrikovich hedged his remarks on nuclear power. Dollezhalya said:

Atomic energy is not only the building of reactors and their power stations, but it is also concerned with the problems of reprocessing fuel, its use, etc. In the USSR there are a number of institutes with a physical profile, which ensure a high level of nuclear physics, but there is no institution which studies the scientific and engineering problems in this sphere, although the future development of atomic energy depends on the correct combination of engineering and scientific decisions....



To judge by this criticism, it seems possible that the physicists have got out of step with the engineering capacity of the nuclear power industry, and that they may have been designing plants which are ahead of the "state of the art" in terms of concrete application. If that is the case, the numerous hedges raised by Styrikovich in his main report would be understandable.

Pyotr Kapitsa, in his speech, asked the Academy to consider the energy problem not only on the scale of the USSR, but also globally, taking into account the demands of the whole world for the limited energy resources available.

In winding up the debate, the President of the Academy, M.V. Keldysh, spoke on the organization of research into durability.

Because at present the problems of durability are connected to a large extent with concrete designs and processing technology, the engineering ministries should have their own research organizations to study durability. Experience shows that basically it is the scientific research institutes of ministries and departments which study the durability problems of particular branches. Fundamental research into the general problems of durability is carried out at the various institutes of the Academy of Sciences USSR and of the Ukrainian Academy of Sciences.

This strong closing emphasis on reliability may also be an indication of the reasons behind the cautious approach to nuclear power. If the presently operating stations have been having engineering problems, as seems distinctly likely judging by Western experience, the new scepticism concerning the speed of the nuclear build-up in the eighties and nineties becomes readily comprehensible.

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- (1) No. 10, 1972, pp 3-8.
  - (2) Radio Moscow, 18 October 1972.
  - (3) 25 December 1971, p. 2.
  - (4) Radio Moscow, 16 August 1972; New York Times, 4 July 1972.