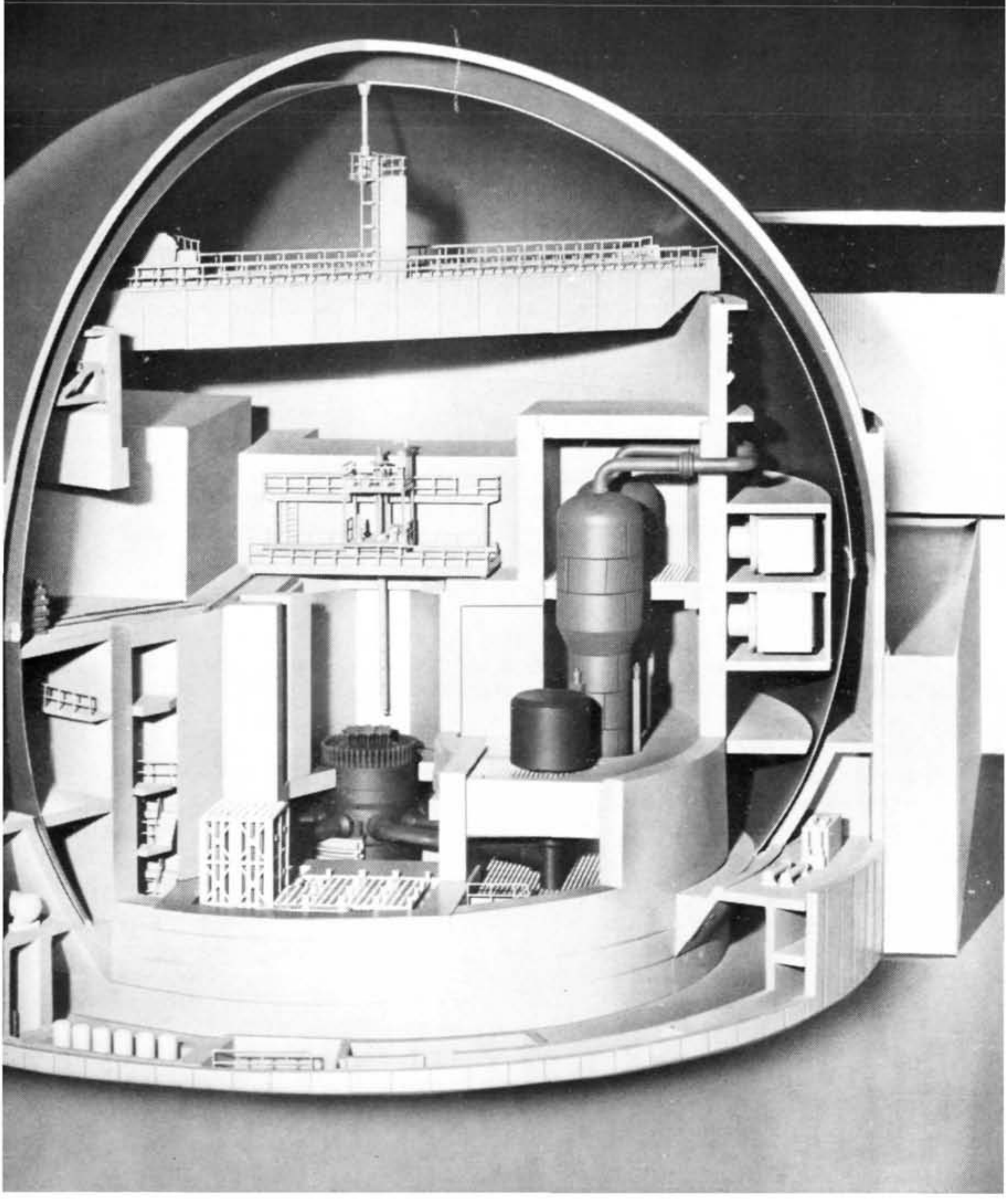
FEDERAL REPUBLIC OF GERMANY



PROSPECTS FOR NUCLEAR ENERGY FROM 1972-1992

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All nuclear development work in the Federal Republic of Germany has been and is devoted exclusively to peaceful purposes. Diagram 1 shows government expenditure on nuclear research and engineering.

The Current Situation

The number of nuclear power stations, both built and planned, in the Federal Republic of Germany, bears witness to what has been achieved so far. At present, nuclear power stations in operation generate a total of about 2000 MWe, while power stations with a total capacity for a further 10 000 MWe are under construction.

The first export orders demonstrate the competitiveness of the German nuclear power industry – power stations are now being built by West German firms at Atucha in Argentina, Borselle in the Netherlands, and Zwentendorf in Austria.

In the Federal Republic of Germany a total of almost 25 000 people are employed in nuclear research and engineering. Of these, about 11 000 work in government-financed nuclear research centres, and approximately 14 000 are employed by industrial firms.

In the future, there will be a sharp increase in power consumption, particularly in the consumption of electric power. As in other comparable industrialized countries, the consumption of primary energy in the Federal Republic would, according to present increase rates, double in 15 years' time, whereas the consumption of electric power would already double within the space of 10 years. (This development is shown in diagram 2).

We therefore expect a sharp rise in nuclear power station capacity during the next 20 years. As is shown in diagram 3, nuclear power stations with a total capacity of approx. 100 000 MWe will probably account for as much as half the installed power station capacity in the Federal Republic of Germany in 1990.

Promotion measures in the field of nuclear research and engineering in the Federal Republic of Germany cover reactor development, and the fuel cycle, safety and radiation protection, isotope and radiation technology – and also basic nuclear research.

The 4th German Nuclear Programme covering the years 1973 – 1976, the draft of which has recently been published, envisages government expenditure of a total amount of approx. DM 6.5 thousand million.

Thirty years ago it was proved that the energy released during nuclear fission can be won in a continuous and controllable process. Many more years of intensive research and development work were required however, before nuclear power stations could be operated commercially, and nuclear energy did not become truly competitive with other sources of power until recently.

The foundation stone was laid for the utilization of nuclear energy in Germany in 1938, when Otto Hahn discovered nuclear fission. A start on the development of nuclear engineering could not be made in the Federal Republic of Germany until 1955. The first task was to overcome the great lead held by other industrialized nations, where nuclear technology and engineering had developed rapidly, partly for military reasons. This aim was achieved by broad-based promotions, including fundamental research, and timely concentration on promising reactor lines.

The nuclear power plant at Biblis, seen through the reactor door.

Reactor Development

In the field of future reactor projects, research and development in the Federal Republic of Germany are chiefly concentrated on two advanced reactor systems, following the commercial breakthrough of the light water reactor: high temperature reactors and sodium-cooled fast breeder reactors. Both of these give rise to expectations of considerable advances compared to present reactor types.

The high temperature reactors will bring improvements in economy and a guaranteed supply, as they make better use of uranium and will be using thorium as a breeding material. In particular, however, the high temperature reactors will influence the environment to a considerably lesser degree than today's reactors. As a result of the higher temperature, it is also possible to carry out dry-cooling under economic conditions. Due to the possible transition to power stations equipped with a helium turbine in the primary coolant circuit, they have a particularly interesting technical potential. By improving efficiency they could considerably reduce the amount of heat released into the environment.

In the Federal Republic of Germany, the pebble-bed reactor constitutes the development of an all-out German reactor type. Experience gained with the 15 MWe AVR experimental reactor at Jülich has led to the decision to build a 300 MWe prototype reactor. At present, the THTR 300 is being constructed at Schmehausen in the Ruhr district, and should be completed in 1977. In order to accelerate the introduction of high temperature reactors on the market,

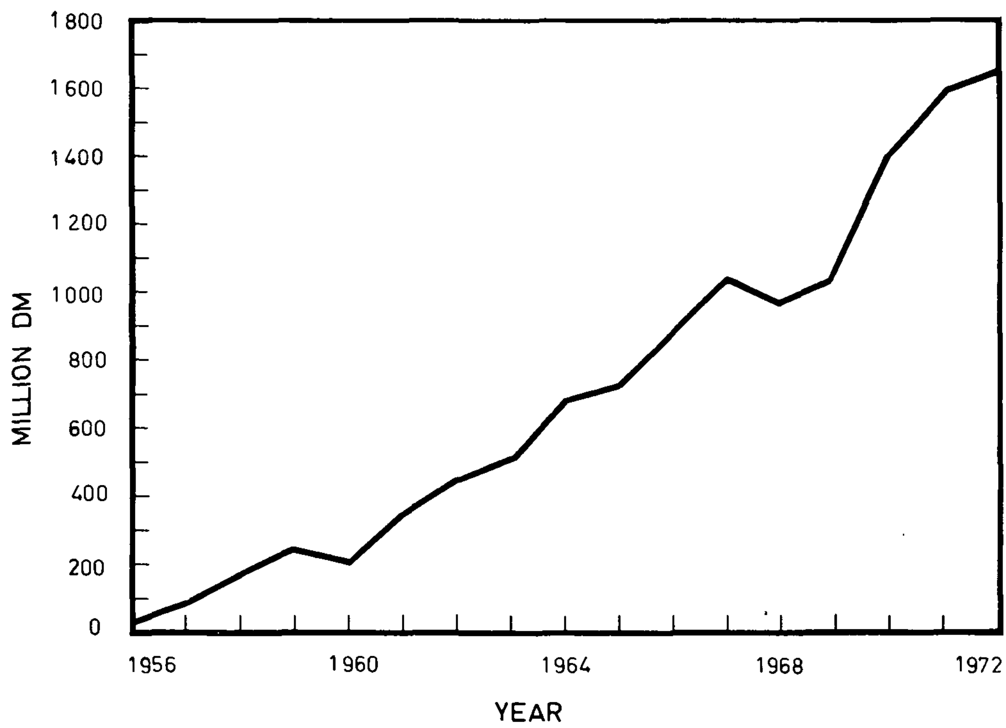

Diagram 1: Government expenditure on nuclear research and engineering in the Federal Republic of Germany.

consideration is being given to the construction of a large-scale 1000 MWe high temperature reactor power station with block-shaped fuel elements.

A start was made this year on the project of a high temperature reactor equipped with a helium turbine, to make full use of the advantages of the high temperature reactor line. This project should likewise result in the construction of a 300 MWe prototype power station.

Another promising field of application for high temperature reactors is the generation of industrial process heat, and in particular the conversion of fossil sources of primary energy into clean energy such as methane or hydrogen. This is particularly important where the direct consumption of energy is necessary, as e.g. for transportation and many industrial processes.

While high temperature reactors can be expected to provide a technical and commercial alternative to light water reactors in the near future, it is unlikely that the fast breeder reactor will add to the generation of electricity until after 1990. However, because of the possibility of utilizing the plutonium generated in light water reactors, fast breeder reactors could close a gap in supply which might appear in 20 years' time if light water reactors are used exclusively. For this reason, the fast breeder reactor is being intensively promoted in the Federal Republic of Germany, as it is in many other highly-industrialized countries.

The focal point of the fast breeder reactor promotion is the construction of a 300 MWe prototype nuclear power station with a sodium-cooled fast breeder reactor (SNR 300). Work on this power station, which is to be built at Kalkar on the Lower Rhine, is to commence in the spring of 1973. It is expected that the building will be completed in 1979.

The Federal Republic of Germany is carrying out the SNR 300 project jointly with Belgium and the Netherlands. This means that not only the preparatory research and development and the construction is being jointly executed by the three countries, but the contract is also awarded awarded by a firm in which three national power supply companies are linked, and the contractors are a team of Belgian, Netherlands and German manufacturers. This international co-operation at government, industry and research centre level is a particularly interesting aspect of this important project.
the advanced reactor lines, that the nuclear power station market over the next 20 years will continue to be influenced by light water reactor power stations. Therefore, particular industrial and commercial importance attaches to the further development of light water reactor technology. Heavy water reactors can also be of importance in the future, especially for countries possessing their own large deposits of uranium.

Nuclear Ships

Nuclear ship propulsion is regarded with special interest in the Federal Republic of Germany. The merchant vessel "Otto Hahn" has completed voyages covering 250 000 nautical miles since October 1968 and has demonstrated its excellent operational behaviour. At present the second, advanced reactor core is being installed. With this core, further experience is to be obtained in a second operational phase for big pressurized water ships' reactors.

As a further step along the path towards the commercial application of nuclear ship propulsion, a German-Japanese working group drew up a joint study in 1971 and 1972 for a nuclear container vessel with a capacity of 80 000 shaft horesepower. The study revealed that nuclear propulsion can be particularly economic for big and fast moving ships. During the next few years, plans will be drawn up for the construction of a large container vessel.

The fuel cycle

A perfectly functioning fuel cycle is essential if a major share of energy is to be supplied in the form of nuclear energy. This is why our development plans cover all phases of the fuel cycle.

Due to the lack of sufficient uranium deposits at home, prospecting schemes and sharing in deposits abroad are promoted.

Uranium enrichment projects are of particular importance here. Efforts are centred on the development of the gas ultra-centrifuge process. Experimental facilities are at present under construction at Almelo and Capenhurst, on the basis of a cooperation agreement with the Netherlands and the United Kingdom; construction of a joint prototype plant is scheduled to be started in 1973. The experience thus gained will provide a comparison with the competing diffusion and separation nozzle processes. Investigations of other techniques will also be continued.

Only after careful examination of all existing alternatives under exclusively economic aspects, will a decision be made as to which process will be the basis of a large European plant. This decision will have to be made no later than 1977. Considering the developments to date, we are convinced that the decision finally taken will be in favour of the gas centrifuge technique, particularly because of the smaller amount of energy consumed by it.

Other aspects of the fuel cycle, such as the reprocessing of irradiated fuel, also receive particular attention. The reprocessing plant at Karlsruhe is used for research and development in this field. The recycling of plutonium, as fuel in light water reactors, and the treatment of highly active waste are also studied.

Fissile material flow control is of particular importance in all fields of the fuel cycle, to safeguard the exclusively peaceful use of nuclear energy. In the Federal Republic of Germany, effective and practicable systems are being developed and tested in this respect. On the basis of the model agreement of IAEA on safeguards in accordance with the Non-Proliferation Treaty and the Verification Agreement with EURATOM, international organizations are of particular importance to the development and implementation of safeguards measures.

The Environment

The preservation of a healthy environment despite the continuing growth of energy consumption is a major challenge of the next twenty years.

Here, nuclear energy can make a significant contribution. The present-day light-water reactor nuclear power stations admittedly give off a larger amount of waste heat to the environment than fossil fuelled power stations do. On the other hand they do not, contribute significantly to the pollution of the air, by the release of carbon monoxides, sulphur oxides and nitric oxides into the atmosphere.

Also, advanced reactors, above all high-temperature reactors, promise a higher level of efficiency and thus a lower thermal strain on the environment. However, the fact that nuclear power stations are better suited to the needs of the environment will only be brought to bear if any possible hazards involved in the radioactive inventory of the facilities are taken into account.

Particular importance must therefore be attached to effective safety and protection measures, including their continued improvement. This is why in the Federal Republic of Germany the control function of the government is increasingly being strengthened, compared to its promotionel function in nuclear technology. By means of a safety research programme, control of possible incidents during reactor operation, and of conceivable external influences on nuclear power stations, must be further improved. Radiological protection are to be increasingly improved. Our aim is to reduce even further any additional radioactivity to which the population might be exposed as the uses of nuclear energy increase, though this amount is already regarded as harmless.

The final storage of radioactive wastes is being tested in a large-scale experiment being carried out in the disused salt-mine of Asse II.

This building site near Biblis on the Rhine bank looks like a huge ampitheatre.
It is part of Europe's largest nuclear power plant.

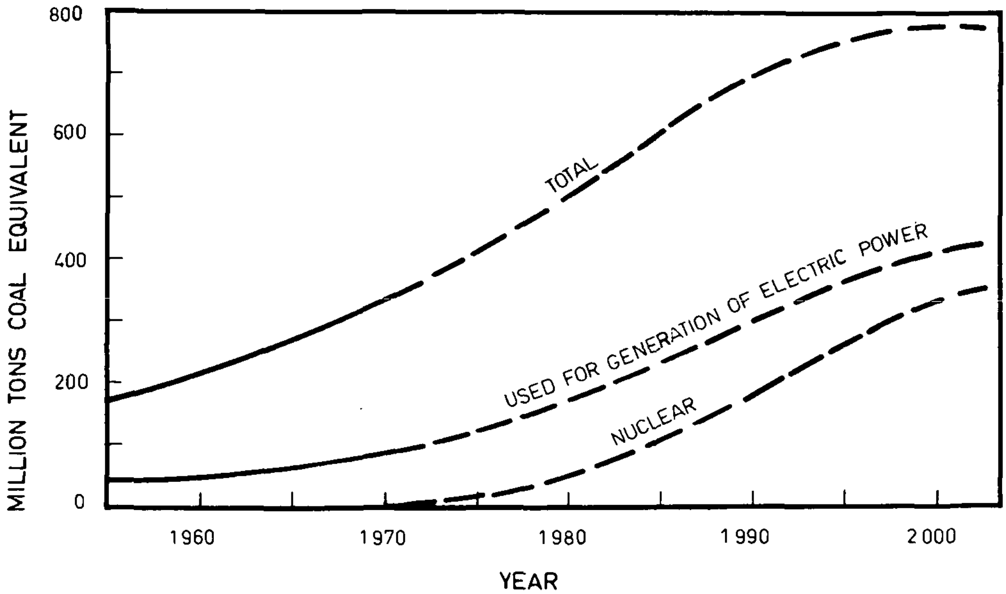

Diagram 2: Consumption of primary energy in the Federal Republic of Germany.

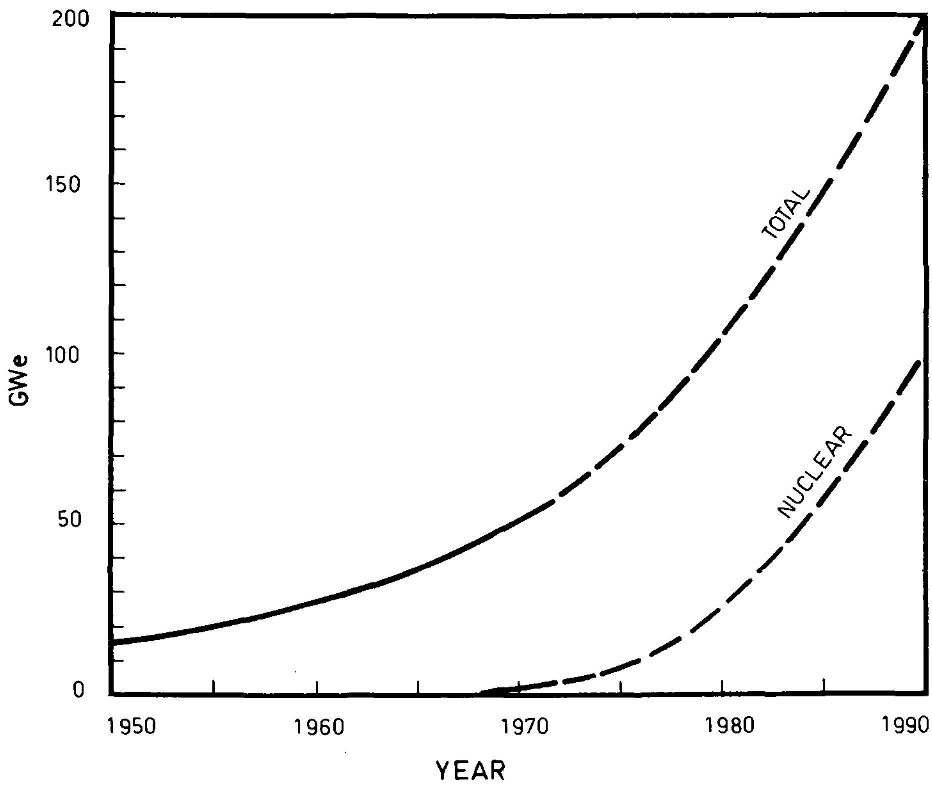

Diagram 3: Installed capacity of power stations in the Federal Republic of Germany.

International Co-operation

Because of parallel technological advances reached by the world's major industrialized nations, and the large funds necessary for further nuclear development, international co-operation is increasingly important. The federal Government therefore follows a policy of joint-development projects, particularly within a European framework. The SNR 300 fast breeder reactor, which is to be constructed with Belgium and the Netherlands, and the development of the gas centrifuge technique being carried out with the Netherlands and the United Kingdom, are excellent examples of this policy.

Technical assistance to developing countries is one of the most important fields for international co-operation. Here the IAEA has a particular task to fulfil.

In the next 20 years nuclear power will help to narrow the energy gap in many countries of the Third World. An IAEA study team to investigate their needs includes a number of German experts. In connection with this study which type of reactor developed in the Federal Republic of Germany and which site would be best suited to the demand and structure of developing countries is being examined. In particular, studies are to be carried out to investigate special uses of smaller reactors, for example for the generation of process heat or the heating of plants for the desalination of sea water.

In addition to the training of experts, special emphasis is attached to the continued development and application of nuclear technologies which are suitable for the solution of the problems confronting the Third World. Isotope and irradiation techniques readily lend themselves to application in developing countries. They can be used in food production, the exploitation of raw materials, pest control and medicine. These techniques have the great advantage of not making excessive demands on the infrastructure. Moreover, they allow developing countries to become equal partners of the industrialized countries by means of developments of their own in some of these fields.

The Federal Government is resolved to intensify both bilateral and multilateral cooperation with developing countries in the years to come – in particular within the IAEA. The importance attached to such tasks is emphasized by the fact that, in the draft of the Fourth Nuclear Programme for 1973 to 1976, a separate chapter is dedicated for the first time to co-operation with the developing countries.

The concrete objectives for technical assistance and safety measures, and also general participation in the provision of a long-term supply of energy by means of the world-wide peaceful utilization of nuclear energy, including protection against its hazards, will more and more increase the importance of the IAEA in the years ahead. The Federal Government will therefore continue to give priority to supporting the Agency.

The prospects for nuclear energy in the next twenty years are extremely varied. The tasks to be performed in order to meet the challenges of the future are likewise varied. Once these tasks have been recognized all over the world, we can look forward to the next twenty years with confidence.