Nuclear Power in Developing Countries

As of March 1977, only five developing countries (Argentina, Bulgaria, Czechoslovakia, India, Pakistan) had nuclear plants in operation with a combined net output of about 2000 MWe (2GWe).

These and eleven other developing countries, however, have nuclear power reactors under construction, ordered or planned for operation by 1985. If all of these plants are built on schedule, their combined capacity will bring the total to 30 GWe. This near term commitment to nuclear power is significant: it will provide electricity equivalent to 300 million barrels (43 million tons) of oil per year. Yet it will represent only 9% of the world nuclear capacity in 1985.

Because of the economic recession of 1974 and 1975, and of other factors which might inhibit the future demand for energy, electricity and nuclear power, present forecasts of the growth of nuclear power in the developing world are only about half of the potential market for nuclear plants estimated in 1974 [1].

Table 1 shows the IAEA's forecasts for nuclear power growth given in a paper at the conference [2]. Data for industrialized countries are also given in Table 1, based on OECD and other sources. It is seen that the developing countries' share of the nuclear market will increase from 5% in 1980 to 20% in the year 2000.

FACTORS INFLUENCING NUCLEAR POWER GROWTH

Although nuclear power is expected to represent an important benefit to the developing world as a whole, to achieve this benefit will require co-operation between the supplying and receiving nations in overcoming problems which might inhibit nuclear power growth. Such problem areas, which were identified in numerous papers presented at the conference, include: financing (in particular, foreign currency requirements), skilled manpower needs, adequate local industrial and engineering infrastructure, the need for a free and open nuclear market, access to advanced technology, the availability of nuclear plants in the required sizes, and an assured supply of nuclear fuel and fuel cycle services. Many papers pointed out the important role the IAEA should play in assisting developing Member States in overcoming these problems.

The listing of the many factors which might adversely influence the introduction of nuclear power tends to give the impression that it will be very difficult to expand the present role of nuclear power in the Third World. Papers presented at the conference by countries which have already passed through different stages of planning and implementing nuclear power projects are, however, quite encouraging in that the nuclear programmes of these countries now show a high degree of maturity and an increasing local involvement. Thus, it is evident that solutions to the problems do exist and the various constraints can in fact be overcome, although not without major efforts.

Table 1
IAEA Nuclear Growth Forecasts

REGION	MARCH 1977 actual	GWe 1980 min.	max.	1985 min.	max.	1990 min.	max.	1995 min.	max.	2000 min.	max.
LATIN AMERICA[1]	0.3	1	2	4	6	15	27	39	66	85	132
MIDDLE EAST, AFRICA[2]				0	2	3	9	10	18	20	34
ASIA, FAR EAST[3]	0.7	4	5	12	15	29	48	60	91	98	139
EASTERN EUROPE[4]	1.0	2	5	10	16	29	41	53	78	84	120
OTHER DEVELOPING COUNTRIES[5]				0	1	2	4	4	6	8	12
SUB TOTAL	2.0	7	13	26	40	78	129	166	259	293	437
INDUSTRIALIZED COUNTRIES[6]	84.0	155	194	279	420	480	780	770	1260	1110	1790
WORLD TOTAL[7]	86.0	162	207	305	460	558	909	936	1519	1403	2227
DEVELOPING COUNTRIES (as % of total)	3	5		9		14		18		20	

[1] Argentina, Brazil, Chile, Colombia, Cuba, Mexico, Peru, Uruguay, Venezuela
[2] Algeria, Egypt, Iraq, Israel, Kuwait, Nigeria, Saudi Arabia
[3] Bangladesh, Hong Kong, India, Indonesia, Iran, Korea, Malaysia, Pakistan, Philippines, Singapore, Taiwan, Thailand
[4] Bulgaria, Czechoslovakia, Hungary, Poland, Romania, Yugoslavia
[5] Greece, Turkey
[6] Includes USSR and German Democratic Republic
[7] Excluding mainland China

SPECIFIC NUCLEAR PROGRAMMES

The conference brought forth a wealth of data on the nuclear power plans of individual developing Member States. These plans are briefly summarized in the following paragraphs.

Brazil

Starting with the 626 MWe Angra dos Reis nuclear plant which will be in operation in 1979, Brazil plans to expand its nuclear programme to about 10 000 MW in 1990 and to 75 000 MW by the year 2000. If these plans materialize, the distribution of capacity in the year 2000 will be 90 GWe hydro, 75 GWe nuclear and 20 GWe thermal. Corresponding electricity generation would be 355 TWh, 460 TWh and 50 TWh respectively from these three types of plants.

In order to implement the nuclear programme, several joint Brazilian – Federal Republic of Germany companies have been established for reactor construction, uranium exploration and fuel manufacture. Brazil's target is complete independence in reactor manufacture and fuel cycle in about 15 years [3].

Egypt

Egypt represents a developing country with a rapidly growing population, ever increasing demand for energy and relatively few indigenous energy sources to meet this demand. Thus, nuclear power will play an important role in the country. At the present time, the installed electrical capacity of the interconnected system (4000 MWe) appears large in comparison to the 1976 peak demand (2050 MWe); however, during the minimum water period, the available capacity of the Aswan Dam drops by 1000 MW considerably reducing the reserve margin, and more thermal capacity will be needed even in 1977. Lacking other viable sources of energy, therefore, future electricity demands will be met from nuclear plants and oil or gas-fired plants.

During the period 1975–1977, electricity consumption is expected to increase at a rate of 25% per year primarily as a result of bringing a number of industrial complexes (fertilizer factory, oil refinery, steel and aluminium plants) on line. From 1977 to the year 2000, however, an electrical growth rate of the order of 9% per year is anticipated. To meet this demand, plans call for the addition of two 600 MW nuclear plants, plus 2000 MW of thermal plants, by 1985. From 1986 to 2000, 5400 MW nuclear and about 5000 MW thermal plants may be added to the system.

The first step toward implementation of the nuclear programme has already been taken to purchase a 600 MW pressurized-water reactor from Westinghouse. This plant is expected to be in operation by 1983 [4].

Hungary

At the present time, Hungary's electric power system is based on coal (52%), hydrocarbons (43%) and hydro (5%). The growth of electricity generation to the year 2000 is projected at 7% per year reaching 130–140 $\times$ 10^9 kWh in the year 2000. The capacity of the power generating system in that year is estimated at 25.5 to 27.5 GWe. It is desired to meet future electricity demands with reduced dependence on hydrocarbons and also to stabilize the contribution of coal at about 30% of electricity generation. Thus, nuclear power will play an important future in Hungary. The first 4 X 400 MWe station will come into operation during the 1980–84 period, followed by a second stage of 2 X 1000 MWe nuclear plants between 1986–90. By the year 2000, Hungary expects to have 12–14 GWe of nuclear capacity in operation. At that time, the composition of electricity generation might be coal (31.5%), hydrocarbons (13%), nuclear power (48%) and gas turbines/hydro (7.5%). Electricity would then represent 58% of total energy consumption [5].

India

India has one of the largest resources of thorium and a somewhat modest resource of uranium. The strategy of nuclear power development has, therefore, been based on natural uranium reactors in the first phase, followed by fast breeder reactors in the second using plutonium recovered from spent fuel. The fast breeders would have either U-238 or thorium in the blanket with the ultimate goal of building reactors based on the U-233 thorium cycle. Indian estimates indicate that between 5000 and 8000 MWe of phase-1 reactors can be sustained by available natural uranium resources. Present targets are 6000 MW of nuclear capacity by 1990 of which about 1000 MW may be in fast reactors, and 20 000 MW nuclear capacity by the year 2000, including 5000 to 7000 MW of fast breeders.

In constrast to practices in other countries, India is continuing to build units in the size range of 200 to 250 MWe for which the installed cost, including heavy water, is about $700/kW. Even for projects scheduled for completion in the 1984–5 period, estimated costs are below $1000/kW [6].

Indonesia

Indonesia is a developing country well endowed with natural resources. Estimated recoverable reserves amount to 15–17 X 10^9 barrels of oil, 0.8 X 10^{12} cubic metres of gas and 10 X 10^9 tons of coal. A recent nuclear power planning study indicated that the installation of coal-fired plants would be the economic choice for the period 1980–1985; however, hydroelectric power, oil-fired steam plants, gas turbines and diesel plants would continue to have a significant share of electricity generation up to 1985. Nuclear power would play a role only after 1985. A feasibility study will be carried out in the near future to define the exact timing of the first nuclear station [7].

Pakistan

Projected growth rates to the year 2000 for population, commercial energy consumption and electricity generation are expected to be 3%, 5.2% and 10% respectively. On this basis, the population in the year 2000 will be about 150 million, energy consumption will reach 107 X 10^6 TEC (3.15 X 10^{18}J) and electricity generation will be about 120 TWh. To meet this demand will require the exploitation of all of Pakistan's economically recoverable hydro resources, the use of indigeneous coal and natural gas and the use of nuclear power. Power system planning studies show that the most economic expansion schedule would have 4800 MW of nuclear power by 1990 and about 16 000 MW by the year 2000. This latter capacity would be in addition to 8000 MW based on gas. The first 600 MW nuclear plant at Chashma is scheduled for operation by the end of 1983. These plans, however, are contingent on overcoming such constraints as financing, the availability of trained manpower and the development of a suitable industrial and engineering infrastructure to handle the programme [8].

Philippines

Numerous nuclear power planning studies and feasibility studies were carried out during the period 1964 to 1972, which led to the decision to construct a 600 MWe pressurized-water reactor for operation in 1982. This was to be followed by a succession of similar plants; however, the sudden rise in oil prices in late 1973 adversely affected the national economy. As a result, energy conservation measures were adopted and more emphasis was placed on the development of hydropower and geothermal energy sources. The latest energy plan developed in September 1976 showed a much reduced nuclear power contribution of 3900 MWe in the year 2000. This represents roughly 25% of the total generating capacity of the Luzon Grid [9].

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[1] IAEA "Market Survey for Nuclear Power in Developing Countries — 1974 Edition".

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[3] A.R. Barbalho. "Planification de la Contribution de l'Energie Nucléaire au Programme de Puissance Brésilien". IAEA-CN-36/421.

[4] K.E.A. Effat, et al.,"Projected Role of Nuclear Power in Egypt and Problems Encountered in Implementing the First Nuclear Plant". IAEA-CN-36/574.

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[6] H.N. Sethna and M.R. Srinivasan, "India's Nuclear Power Programme and Constraints Encountered in its Implementation". IAEA-CN-36/385.

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[8] M. Shafique and M. Ahmad, "Development of a National Nuclear Power Project, Constraints Likely to Influence Timing and Introduction". IAEA-CN-36/546.

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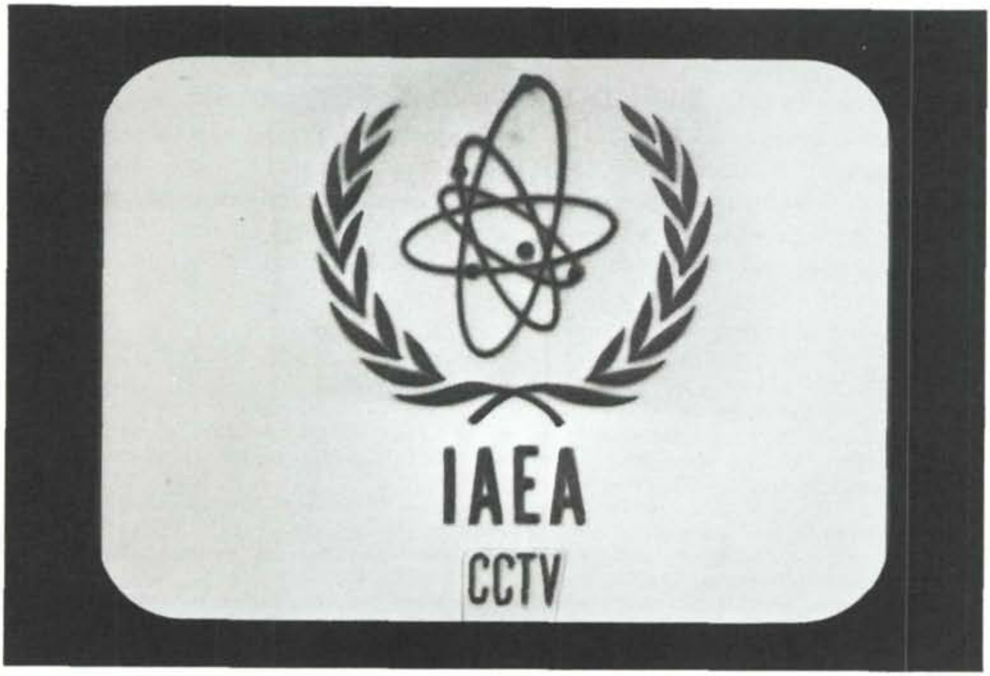
Selected papers:

1. W.J. Schmidt-Küster, "National Energy and Nuclear Power System Plans of the Federal Republic of Germany". IAEA-CN-36/092.
2. M. Boiteux, "The French Nuclear Power Program". IAEA-CN-36/217.
3. R.W. Fri, "National Energy Projections and Plans of the USA". IAEA-CN-36/397.
4. I. Spiewak et al., "Technical and Economic Studies of Small Reactors for Supply of Electricity and Steam". IAEA-CN-36/398.
5. J. Adar et al., "Near Term Feasibility of Nuclear Reactors for Sea Water Desalting". IAEA-CN-36/052.
6. W.D. Crawford, "PWR and BWR Light-Water Reactor Systems in the US and their Fuel Cycle". IAEA-CN-36/566.
7. A.P. Aleksandrov et al., "Uranium-Graphite Reactor Development in the USSR". IAEA-CN-36/586.
8. J.J. Went, "Status and Prospects of Thermal Breeders". IAEA-CN-36/302.
9. L.F.C. Reichle, "MSR (Pu converters) and MSBRs in Commercial Nuclear Power Stations". IAEA-CN-36/424.
10. P.H. Margen et al., "Reactor Waste Heat Utilization and District Heating Reactors". IAEA-CN-36/275.
11. B.B. Baturov, "Nuclear Steam Superheat — Results and Current Prospects". IAEA-CN-36/325.



A closed circuit television connection was installed between the Festspielhaus and the Kongresshaus in order to allow participants to watch sessions in the other building.

Conference staff provided supporting services during the sessions and kept a record of the speakers.

Prof. Ivan S. Zheludev, Deputy Director General of the IAEA Department of Technical Operations, was chief of the Conference's Scientific Secretariat.

Alvin M. Weinberg of the Institute for Energy Analysis, Oak Ridge Associated Universities (USA) gave an invited evening lecture during the conference. His topic was "Nuclear Energy at the Turning Point".

The second invited evening lecture was given by M.F. Troyanov of the Institute of Physics and Power Engineering, USSR State Committee on the Utilization of Atomic Energy. He described the BN-350 fast breeder reactor at Shevchenko which is used to generate electricity and to provide steam for a water desalination plant.