

# nuclear power to aid development

Before nuclear power can play its full role in contributing to the development of less advanced countries, full understanding of the capital investment, fuel costs and other economic factors as well as of the place it must take in existing power programmes is essential. Some insight into the problems and prospects was gained at the symposium arranged by the Agency, and held in Istanbul in October, on "Nuclear Energy Costs and Economic Development"

With experts from thirty-five countries present, an exceptional opportunity was presented to examine the varying influences in different parts of the world on costs valid in some areas but misleading in others, differing experiences in the performance of reactors in various countries, and forecasts of the effects of introducing advanced systems for nuclear power. Hope of the improved efficiency and economics which will follow the introduction of fast reactors was coupled with warnings that proof of their performance has yet to be given and that it might be over-optimistic to count on their general introduction during the 1980's.

At the opening of the symposium Rurik Krymm (IAEA) who was speaking on behalf of the Director General, emphasized the great disparity in the present and future distribution of nuclear power plants

between industrial and developing countries. Some of the main reasons for this situation were the concentration by manufacturers on the construction of large units of 500MW and more which could not always be fitted into relatively small grids; decrease of fuel oil prices throughout the world; increasing financing costs and rising capital costs of nuclear stations. In spite of these adverse factors, nuclear power continued to make progress and represented an important source of diversification of energy supply. He emphasized that it was important not to restrict economic comparisons to the first nuclear power plants considered against conventional stations of well established design and enjoying all the savings of repetitive production.

### Analysis and evaluation

In speaking of selection criteria for nuclear power plants Jacques Gaussens (France) expanded his analysis to considerations which, quite apart from the question of generating costs, may affect economic comparisons between conventional and nuclear power stations on a national level. Problems of security of supply, availability of foreign currency, domestic financing and industrial possibilities all combined to raise exceedingly complex questions which could only be solved by resorting to the analysis of different strategies and evaluations taking into account uncertain futures.

P.J. Searby (UK) considered the role of energy in a number of countries in widely different stages of development. Varying circumstances affected the urgency for nuclear power. Detailed studies should be performed by developing countries on demand and supply, and the prospects with regard to the various energy sources, before embarking on ambitious nuclear reactor programmes.

The connection between nuclear power and economic development was examined by A.M. Aikin (Canada) who stated that as more nuclear power stations are built experience indicates little difference in capital costs for various reactor concepts. The competitive positions of nuclear power stations depended on their low fuelling costs. These were lowest when natural uranium was burned directly, giving the advantages of diverse sources of supply and a simple fuel cycle.

One economic factor widely variant from country to country is the cost of fuel oil. An invited speaker, Soren Friis (Denmark) said that the share of oil in the energy market was still growing and that oil prices have had a downward trend in spite of transport difficulties. It was very likely, he added, that this trend might continue.

### Reactor systems

While the costs of pressurized water reactors (PWR's) are reported to have risen by as much as 50% during the past four years in the United States, J.H. Wright (U.S.A.) pointed out that this does not mean that the outlook for nuclear power is dismal. On the contrary, the costs of coal fired stations, the usual competitor to nuclear power in the United States, have also escalated sharply and the two alternatives

remain competitive. He predicted that in the future, PWR costs will be significantly reduced by shorter construction schedules and improved construction practices and he confidently expected that nuclear power costs will compare even more favorably with coal fired plants in the future.

H. Gutmann, (Germany), reviewed recent developments with high temperature reactors (HTR's). Small HTR's are now in operation in the U.K., U.S.A., and Germany, and the first HRT nuclear power plants in Europe are expected to go to full power between 1975-1977. Present studies indicate important economic advantages for HTR's especially when the thorium fuel cycles are sufficiently proven to be used instead of the semi-homogeneous cores, and gas turbines are used instead of the present steam turbines.

The various steps that led Argentina to chose a heavy water reactor (HWR) were discussed by B.J. Csik (Argentina). He stated that "turnkey" bids were accepted on a global basis, but many bids did not contain a detailed cost breakdown or have a complete definition of what the customer would be required to furnish. It was therefore necessary to conduct a critical evaluation of all offerings. The part of the cost of the HWR which was selected (about \$70 millions) was financed by the manufacturer. Heavy water and fuel were not included in the "turnkey" package, and when considering these and other additional items required, the cost of the plant was \$105 million or \$330/Whr. The 300 tons of heavy water which was required was from the U.S., and the fuel elements will be fabricated by the manufacturer with uranium furnished by the customer.

#### Future needs

Pakistan with the present population of 125 million derives 45-50% of its gross national product from agriculture. M. A. Quaiyum (Pakistan) said that as a result of industrialization, the share of agriculture is declining. The shift in the economy of Pakistan is also reflected in the high growth rate for electric power which has been 18% per year during the last five years. High prices of fuel oil and other energy sources in Pakistan have been a stumbling block to development. The speaker reviewed generation costs of conventional and nuclear power and found that in view of the scanty supply of fossil fuels, nuclear power is a very promising source of low-cost electricity for sustaining and accelerating the economic development of the country.

In a review of the present and forecasted power situation in Turkey N. Aybers (Turkey) found that even with the completion of the new hydraulic and thermal schemes presently in the planning stage, there will be a marked energy and power deficit beyond 1982. A large hydro station may be built later on the Firat, but in the meantime studies based upon a CANDU pressurized heavy water reactor (PHR) have shown that it may be appropriate to construct a 300-400 MW nuclear power plant by 1976-77 and 2 x 600 MW nuclear plants in the period 1982 - 1987.

The Japanese economy is growing rapidly, especially the heavy and chemical industries. In order to meet the accompanying growing demand for electric power it is necessary, said M. Takei, to develop vast new

power resources. Up to the 1950's major power resources in Japan had been hydro-power and coal. But by that time, hydro-power supply was found insufficient and coal to be uneconomical. Thus, thermal power based on petroleum has emerged as a new major power source. But petroleum has its own shortcomings; public hazards, huge oil imports and large outflow of currency. Moreover, the use of oil for thermal power stations may make Japan dangerously dependent on specific areas of the world for supply of oil. Therefore Japan has a long range electric power supply plan which includes constructing 16 nuclear power plants with a total capacity of 8,600 MW by 1975 and 22 more with 18,400 MW by 1978. By then, 70% of the electric power generation will be by thermal power, 20% by hydro-power and 10% by nuclear power. According to a longer range plan, nuclear power plant capacity will be 30,000 to 40,000 MW by 1985, which is 18 - 25% of the overall power plant capacity. It is expected that nuclear power will be economically competitive with oil fired plants shortly after 1975, especially if there is participation of domestic manufacturers in the nuclear programme.

W. Lepecki described a study of nuclear energy potential in Brazil. He reported that about 30,000 MW would be needed during the next 30 years. He also described the demand this would place on such industries as mining, fuel fabrication and plant equipment, and the impact of the nuclear programme on the general level of the economy.

J. Barth (France) discussed the manufacturers' problem of pricing reactors realistically. An important consideration in determining this policy is the elasticity of the costs of various components of a nuclear power plant as a function of the number of items one expects to build. He also considered the effect that collaboration with local industry will have on these decisions.

Two of the more important comments in the discussion of reactor design and nuclear programme planning were:

- 1) Some of the developing countries which are trying to engage in nuclear power plant projects are faced with the problem of an initial utilization factor as low as 50% for a nuclear power station of a commercially attractive size.

- 2) Developing countries often adopt very optimistic cost values in their studies and do not provide an adequate allowance for the impact of technological problems and delays which arise during construction on the economics of the plants.

### Fuel Cycle Costs

Mr. A.D. Wordsworth (U.K.) discussed in detail the fuel procurement purchase and fabrication and stressed that comparative studies of the economics of different reactors should be carried out with care. He pointed out, for example, that some analyses are based upon the assumption of too favourable load factors, interest rates and amortization periods, which lead one to the conclusion that the installation having the highest capital cost is the one which produces power at the lowest cost in mills/kWhr.

The paper of A.J. Hoffmeister (U.S.A.), presented by F. Maltini (Switzerland), gave a detailed breakdown of present fuel cycle costs and made predictions of their trends for the future.

Regional co-operation between nations for building and operating nuclear fuel-cycle facilities for nuclear power was suggested as offering considerable opportunities for industrial and economic development by Ashton J. O'Donnell (U.S.A.). Using the western rim of the Pacific basin as a case study, he considered that Australia, China, Japan, Korea, New Zealand and the Philippines could all benefit. Approximately 30,000 megawatts of electricity from nuclear sources would be generated in these countries by 1980. Such a regional approach could benefit the investment situation in diverse industries and strengthen economics and industry.

### Nuclear Desalination

During the previous year the 50 - 150 million gallon per day dual-purpose plant for Los Angeles was cancelled (as discussed at the Agency's Symposium on Nuclear Desalination of 1968 held in Madrid). The nuclear desalting plant at Shevchenko is nearing completion but is not yet in operation. Furthermore, the costs of nuclear power plants have escalated sharply (especially in the United States), and this together with higher interest rates has increased the estimated cost of desalted water. It was therefore timely to review the impact of recent technical and economic developments in desalting.

I. Spiewak (U.S.A.) pointed out that many of the factors which have increased nuclear power costs have increased the cost of other capital intensive facilities even more, such as the long-distance transport of water. He concluded that the cost of long-distance water transport is more sensitive to increases in interest rates and labor rates than is desalting, and this, together with advances in desalting technology is already making desalting increasingly competitive with long aqueducts.

In the technical area, engineers considering the design of nuclear desalting plants have been concerned with the extrapolation of design data from the largest desalting plant in operation today (7.5 Mgd), to the 50 - 150 or even 1,000 Mgd nuclear dual-purpose plants envisaged in the future. In this regard R. Douvry's paper (France) on Kuwait's recently purchased 25 Mgd plant was interesting. This plant which will be in operation next year, will consist of units of 5.5 Mgd and is therefore a reasonable prototype for the larger nuclear plants.

### Energy Centres and Agro-Industrial Complexes

Israel, Puerto Rico, and the UAR are working with the United States in preliminary studies of the feasibility of energy centres and agro-industrial complexes for their countries. J.W. Michel (U.S.A.) reported on some of the recent developments and indicated that aluminium and steel industries and certain fertilizer industries appear economically attractive when raw materials are available and the dry farming of rice improves the agricultural economics. W.C. Yee (U.S.A.) described an economically attractive chemical complex based on the use of sea salts (but it should be noted that the cost of water is not affected by this sea-salt use since only a small percentage of the available salt could be utilized).

The attractiveness of the agro-industrial complex is heavily influenced by the assumptions regarding the amount of water required for certain crops, the yields which can be consistently obtained and the market value of the crops. Recent work indicates that agro-industrial complexes may be economically attractive with certain crops. Agricultural experiments using high quality water are being conducted or planned by France, Kuwait, Israel, India, the UAR and the U.S.A. and A. Fourcy reported on the French work.

The discussions gave evidence not only of the interest of many of the major developing countries in latest nuclear progress, but also of the complexities connected with its introduction into energy systems. In this respect several of the national review papers describing the careful preparatory action being taken by joint groups with the participation of atomic energy commissions, of electricity utilities and of outside consultants demonstrated the thoroughness with which some countries prepare their first steps towards a nuclear future.

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A research reactor in Taiwan, to be obtained from Canada and to operate in 1973, will be subject to Agency safeguards. An agreement to this effect was signed by Ambassador Chi-Tseng Yang, Resident Representative of the Republic of China to the Agency, and Dr. Sigvard Eklund, Director General.

