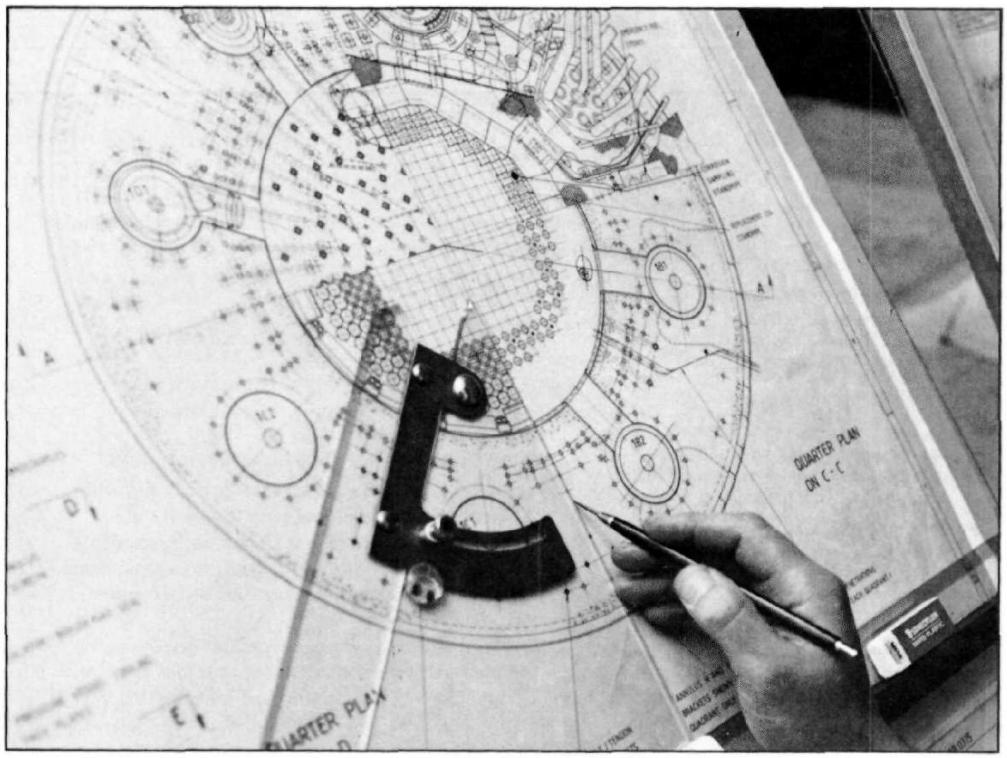

One cost factor: plant design. (Credit: UKAEA)

Nuclear power programmes in developing countries: Costs and financing

Seminar experts emphasize need for creative, realistic approaches

by J.P. Charpentier and L.L. Bennett

Nuclear power's technical feasibility and economic competitiveness have been demonstrated in industrialized countries, and although experience in the developing world is somewhat limited for the time being, the situation there is not so different. The examples of the Agency's 10 developing Member States which already have embarked on nuclear power programmes prove that, step-by-step, technical problems can be solved and the economic competitiveness of nuclear power can be demonstrated.

As the IAEA has seen, the success of nuclear power projects and programmes in developing countries is, to a large extent, dependent on five infrastructures:

- Grid size and stability
- Availability of qualified manpower at all levels, from managing staff to welders
- Organizational structures to plan, take decisions and stick to those decisions, execute and operate the project, and regulate its safety
- Industrial support, not only for construction but also for operations, maintenance, and repair
- Research, development, and demonstration, not only on the nuclear side but also in general industrial research of fundamental importance, e.g., for standards promulgation in the country.

Assistance in strengthening and developing these infrastructures is a matter to which the IAEA – especially during the last 10 years – has focused its attention for developing Member States considering nuclear power introduction.

It has become apparent, however, that it is also necessary to focus on financing: It clearly is a major constraint that must be solved if nuclear power is to find more widespread use in the Agency's developing Member States. To address the problems, the IAEA organized a Seminar on Costs and Financing of Nuclear Power Programmes in Developing Countries, in Vienna from 9–12 September 1985.

The seminar dealt with three main topics: (1) nuclear investment and fuel cycle costs; (2) financial risk assessment at project and country levels; and (3) loan conditions. Its main objective was to promote a dialogue

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among the various parties involved in the domain of nuclear power financing, i.e., buyers, suppliers, and financing organizations. The keen interest in the subject was demonstrated by the participation of some 80 delegates from 29 Member States (18 of them developing countries) and seven international organizations. Many financing organizations were represented in the seminar.

At the meeting, the Agency presented information based on its own studies, national experience, and the work of other international organizations showing that nuclear power plants are an economic means of generating electricity.*

Performance and economic records

The records of power plants in operation clearly indicate that availability factors have been increasing steadily over the last 10 years and now reach a level of around 70 to 80% in most countries, and even higher in some. Furthermore, analysis of operating experience data collected in the Agency's Power Reactor Information System (PRIS) clearly shows that availability factors are strongly influenced by the experience of nuclear power plant operators.

The economic competitiveness of nuclear power stations against oil-fired plants has been clearly established, especially with crude oil prices being above $25 per barrel.** With coal-fired plants the situation depends on local conditions, on plant size and, of course, on the coal price. Studies published by the International Union of Producers and Distributors of Electricity (UNIPEDE) and the OECD Nuclear Energy Agency (OECD/NEA) have shown that in Europe and Japan, nuclear power plants would have a 30 to 70% cost advantage over coal-fired power plants. In the USA and Canada, the competitiveness depends very much on the region considered. Nuclear power shows an economic advantage in Central and Atlantic Canada and a small advantage in the northeastern and southeastern parts of the United States.

Projected nuclear plant additions

Ten developing Member States of the IAEA already have active nuclear power programmes, as shown in the accompanying table. In terms of electrical power needs and considerations of grid sizes, it might at first glance appear that an additional 20 to 30 developing countries could be potential users of nuclear power plants during the next 15 years.

For various practical reasons, however, this is much too optimistic. The IAEA expects nuclear power additions in the developing world to be some 35 to 75 gigawatts-electric (GWe) during this period, leading in the year 2000 to some 45 to 85 GWe of nuclear power capacity in developing countries. The lower figure would apply if present programmes continue at a rate slower than expected and only two or three new countries introduce nuclear power. The higher figure assumes that present programmes continue as planned and that some five or six new countries place nuclear plant orders.

Seen from the developing countries' point of view, these figures would mean that only some 5–10% of their new capacity additions will be nuclear, which is certainly disappointing but probably a realistic assessment of present and future constraints.

Seen from the suppliers' point of view, this would still mean a market for some 50 to 100 nuclear power units, the great majority of which will be based on imported designs. This represents on the order of 15 to 20% of the total expected additions in the industrialized world and very likely more than 50% of the total export market.

For this projected market to develop, however, in particular at the higher figures, certain conditions favourable to nuclear power would have to be met. It would certainly require that financing be made available under acceptable terms, and that the new countries would plan for development of their infrastructures in an accelerated manner.

Financing constraints

In spite of their proven overall economic competitiveness, the high capital requirements for nuclear power plants pose difficult financing problems and financing remains a major constraint on nuclear power programmes in developing countries. The capital costs for a nuclear power plant in the size range of 600 to 900 megawatts-electric (MWe) are about $1.5 to 2 billion, including interest during construction.

It is interesting to compare this amount for a single plant with the approximately $2.5 billion that the

Status of Nuclear Power Programmes in Developing Member States (as of 1 January 1985)

Country	Plants in operation		Plants under construction	
	Units	MWe	Units	MWe
Argentina	2	935	1	692
Brazil	1	626	1	1245
China	–	–	1	300
Cuba	–	–	1	408
India	5	1020	5	1100
Korea, Rep. of	3	1790	6	5622
Mexico	–	–	2	1308
Pakistan	1	125	–	–
Philippines	–	–	1	620
Yugoslavia	1	632	–	–
Total*	18	9140	19	12 202

* Total figures include Taiwan, China, where there were five units with a total capacity of 4011 MWe in operation and one unit with a capacity of 907 MWe under construction.

* See also "Economic performance of nuclear plants: How competitive?", *IAEA Bulletin*, Vol.27, No.1 (Spring 1985).

** Costs and prices throughout this article are expressed in US currency.

World Bank will have available for electric power sector loans to the whole developing world during 1985, or to the $10 billion of foreign exchange that, on average, is made available for the power sectors of all developing countries each year.

Current debt problems

In fact, it is not only the large amount of money that hinders the financing of nuclear power plants, but also the creditworthiness of countries, as seen by various lending organizations. In a period where most of the developing countries are facing difficulties in fulfilling their debt services, commercial bankers as well as governmental organizations of exporting countries are reluctant to lend these countries additional funds.

Although the situation regarding the national debt of different countries is improving nowadays, the situation still remains serious. Some countries have rescheduled the reimbursement of their debts, and the interests due are generally paid step by step. Yet the net export of goods often is still too low to supply sufficient foreign exchange for repayment of the capital.

Of course, the situation is different from country to country. However, in general, as long as the debt service situation of a given country is not judged satisfactory (e.g., by comparing the level of debt and debt services against the gross national product and supply of foreign exchange through export of goods), lenders, exporters, and governments of industrialized countries will remain hesitant to finance nuclear power plants. The major problem is more a question of general economic policy than a problem of nuclear power financing.

A "double difficulty"

Nonetheless, financing projects of $1.5 to 2 billion under present conditions is not an easy task. A rough simplified example can give an idea of the difficulties. Let us take a $2 billion project. It is often requested that 20% be financed locally in order to ensure the real interest of the importing country (generally to cover local expenditures such as site preparation and some basic civil works). Most developing countries will face difficulties in mobilizing the equivalent of some $400 million within their own banking systems or through government donation. For the remaining share, no more than 75% can be granted by export-credit agencies of exporting countries under the present conditions of the OECD Consensus of August 1984, which stipulates guidelines for the export conditions of nuclear power among OECD countries.* This means that the remaining 25% ($400 million in our example) will have to be financed through commercial loans. As any commercial bank is likely to limit its participation to $20 to 30 million or less, some 20 banks will most likely have to participate in the syndicated loan of $400 million.

It is not so much the total funds that cause difficulties, as the amounts are undoubtedly available on the market. There are extremely complex problems in arranging for this kind of financing and it will involve getting together a significant number of the some 100 banks worldwide which could be interested in this type of project.

In view of this "double difficulty" – the need for more foreign exchange in most developing countries and the inadequacy and complexity of present international financing systems for supporting financing requirements on the order of a nuclear power project – the question is now open for additional approaches and complementary mechanisms.

No magic solutions

It goes without saying that no new magic mechanisms may solve the problem if the country's creditworthiness and risk as perceived by the exporters are not improved. Both are dependent on the economic policy of each individual developing country and discussions on this matter would go far beyond the scope of this article.

Foreign suppliers of nuclear plants will continue to look for continuous improvements in the maintenance and operation of electric networks and power plants with skilled and effective staff as major conditions to keep plant availability and reliability at satisfactory levels. In parallel, lenders (foreign and local) will request adequate tariff levels for electricity to ensure debt reimbursement. A pre-requisite for the possibility of setting up adequate tariffs is to demonstrate the need for the produced electricity and to show, through coherent planning studies, that the foreseen power investment programmes are the most economical way of providing this electricity. In particular, nuclear power programmes should be carefully assessed within overall national energy planning studies and not be decided from political considerations.*

If all the various conditions mentioned above are satisfied in a given country – national creditworthiness; sufficient supply of foreign exchange through exports; country risk estimated at a satisfactory level (which implies coherent and continuous economic policy of the government); satisfactory operation and management of electrical utilities with qualified manpower; reliable electric network; and overall well-justified energy planning demonstrating the need for nuclear power – then and only then will bankers and financial institutions accept looking for a financing solution.

Additional approaches

As already indicated, the traditional financing approach is mainly based on a double buyer credit: one from the export-credit agency from the exporting

* See "Export financing in France", a related article in this issue.

* See "An assessment of nuclear energy in developing countries: How the Agency can help", *IAEA Bulletin*, Vol.24, No.3 (September 1982).

country and the remaining part that should be covered by financial loans from commercial lenders. The export credit is generally limited to about 75% of the cost of export and is subject to the present condition of the OECD Consensus on nuclear power financing (i.e., maximum duration of 15 years and a rate varying between 10.85% and 13.25% according to the wealth of the country).

Some additional mechanisms can be introduced to improve the present situation. These include:

- *Creation of a joint venture* between the exporting and the importing country, such as what has been proposed by the Canadian and Turkish authorities for the first nuclear power plant (Akuyu) in Turkey. Such joint ventures are, in fact, new companies created for 15 or 20 years, composed of personnel of both the exporting and the importing country, with governmental guarantees from both sides. In such a way the exporter-supplier of the nuclear power plant is better covered against the risk of the plant not being completed and the risk of low operational reliability due to shortage of qualified personnel. It also has better guarantees for the repayment of the loan in foreign currency. There are different schemes of joint ventures and it is up to both parties, buyer and supplier, to find an acceptable solution.
- *Implementation of an international investment fund* that would have as a goal to share the risks at a multinational level. In fact, such joint international funds are already studied by the World Bank under the name of "Multilateral Investment Guarantee Agency". This idea, which is in fact not new, is not easy to implement but could help to partly solve difficulties.
- *The multi-country financing approach* is also an idea that is being considered in some cases. It undoubtedly could be an effective way of risk sharing. This has already been done in other domains. It could be executed either with or without a turnkey contract.

Several other approaches could be envisaged (such as leasing or counter-trade) but each needs careful analyses among lenders, suppliers, and potential buyers. There is a need for creative and realistic proposals to solve this problem of nuclear power financing in developing countries.

New working relationships

During the seminar, the IAEA's competence and neutrality for technical and economic assessment of nuclear power was recognized as being helpful in providing confidence to lending agencies regarding the suitability of nuclear power in specific cases. It was suggested that the IAEA could broaden its scope of technical assistance to developing countries, in particular by providing information on financing techniques and by promoting feasibility studies which could lead to a better risk appraisal. How far the Agency could go in the area of helping the preparation of financial feasibility studies was not clearly defined and will require further investigations. It was suggested that the IAEA could, for example, either commission such studies from reputable third parties experienced in such matters, or provide a function which could audit the country's methodologies and procedures. Such preparation of financial feasibility studies jointly with the host country would carry great weight with lenders and export-credit agencies.

The catalytic role that the IAEA could play to establish new working relationships on the part of potential buyer countries, suppliers, and lending organizations was strongly emphasized:

- Vis-à-vis developing countries, the IAEA should continue to help in the objective definition of the role of a nuclear power programme within their national energy development plans, and with assessment of their infrastructures for nuclear power and formulation of associated development programmes.
- Vis-à-vis suppliers, closer co-operation could stimulate them to develop techniques and systems better adapted to developing countries, e.g., small- and medium-sized reactors, standardized plants, etc.
- The IAEA could also contribute to a better information flow to commercial lenders, on the technical proveness of nuclear power and on the specific financial requirements and conditions of nuclear projects that are quite different from those of other industrial domains.

Therefore, it was recommended that the Agency develop and strengthen its contacts with commercial lenders and export-credit agencies, in order to enlarge its role in assisting development of new financing concepts better adapted to the nuclear domain. Some examples provided include joint ventures (such as the one currently being negotiated between Turkey and Canada, which provide the lenders with more confidence for project completion and operation); development of a central fund in industrialized countries for project financing in developing countries; development of schemes of multi-national financing; and development of mechanisms for re-scheduling of financial loans (complementary loans offered by commercial banks to complete loans of export-credit agencies).

A point of major interest was the World Bank (IBRD) presentation, which clearly stated that the IBRD has an open mind on nuclear power and would be prepared to consider requests for financing for well-justified nuclear projects. However, given the limited resources of the IBRD for loans in the power sector, the indications at the present time are that the external financing for nuclear power will continue to come mainly from bilateral and private lending sources.

Seminar participants regarded IBRD co-operation as a major contribution to an objective judgement of the appropriateness of nuclear projects in a specific country. It was clear that such and other co-operation of regional banks (such as the European Investment Bank and the Asian Development Bank) would provide more confidence to commercial lenders.