

Nuclear power in developing countries: Requirements & constraints

A review of IAEA's assistance to countries pursuing the nuclear option to help meet energy demands

by B.J. Csik and Kurt Schenk

Developing countries, in comparison with industrialized countries, generally have higher growth rates of population, energy, and electricity. There are currently also striking disparities of total and per capita energy and electricity consumption. To achieve economic development and industrial progress, an increased supply of energy and of electricity is of vital importance, and for this, nuclear power constitutes a viable alternative energy source.

Several developing countries have already launched nuclear power programmes. (*See accompanying table.*) As a whole, however, the contribution of nuclear power to fulfill the energy needs of the developing world has been very modest to date. According to current forecasts, it will continue to be so, in spite of the rapidly growing energy requirements and benefits that nuclear power could offer.

Nuclear power poses specific demands on national infrastructures that have to be satisfied by any country to achieve success in its introduction and its safe and reliable use. These demands include nuclear power's technical complexity, the required high level of investment, and strict safety requirements. They are especially relevant to developing countries, where a lack of resources or capabilities to meet requirements may constitute the principal constraints to the development of a nuclear power programme.

Problems facing a developing country in the introduction of nuclear power are not insurmountable, as shown by the experience of those developing countries that have already done so. However, the effort required to strengthen or to build up national infrastructures and capabilities to necessary levels may exceed available national resources, or they may not be compensated for, or justified, by nuclear power's expected benefits. In such cases, a country would most likely delay the decision to launch a nuclear programme.

The IAEA has a long-standing reputation for providing advice and technical assistance to developing Member States seeking to launch a nuclear power programme. This promotional effort has been part of the

Agency's activities since its inception in 1957 and has been accomplished through all available means. These include advisory missions, training courses and study tours, fellowships, guidebooks, meetings, maintenance of data banks, provision of opportunities and channels for worldwide information and data exchange, and the development of planning tools, such as the Model for Analysis of Energy Demand (MAED) and Wien (Vienna) Automatic System Planning (WASP). These two planning models have been and are currently the mainstay tools available to developing Member States in energy and electricity planning, and to assist them in determining the economic role of nuclear power in their electric power systems.

Essential infrastructure requirements

In providing assistance to developing Member States, the Agency has found that adequate infrastructures were often lacking that would ensure a smooth and successful introduction of nuclear power in developing countries. To better assess the needs, the IAEA has defined infrastructure requirements that are considered prerequisites for developing countries seeking to launch a nuclear power programme. Experience clearly shows that most delays or problems in programme development and project implementation can be traced back to infrastructure inadequacies. These are:

- Planning and decision-making capabilities
- Organizational structures (including legal and regulatory frameworks)
- Electricity grid size and structure
- Qualified manpower
- Industrial support
- Financing

During the planning stage, the major task of a developing country is to identify, assess, and analyse available resources and potential weaknesses, and to devise measures to strengthen weak infrastructures.

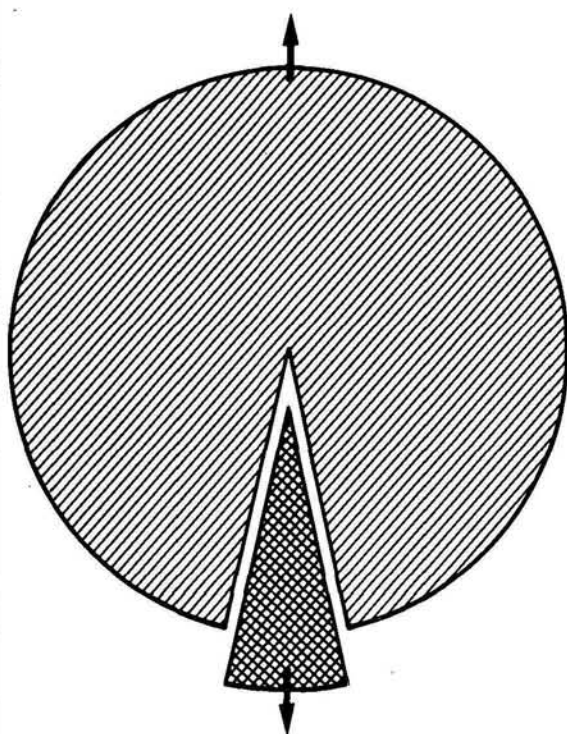
This task has to be performed with objectivity and requires both an in-depth knowledge of the country and expertise in the requirements derived from nuclear power technology. The first can only be contributed by national staff, but regarding technology requirements,

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Distribution of installed nuclear generating capacity in the world, 31 December 1986

Industrialized countries: 92.9%

USA	30.9%	Spain	2.1%
France	16.3%	Belgium	2.0%
USSR	10.1%	Switzerland	1.1%
Japan	9.4%	Finland	0.8%
Germany, Fed. Rep. of	6.9%	South Africa	0.7%
Canada	4.1%	German Dem. Rep.	0.6%
United Kingdom	3.7%	Italy	0.5%
Sweden	3.5%	Netherlands	0.2%



Developing countries: 7.1%

Korea, Republic of	2.0%	India	0.4%
Taiwan, China	1.8%	Argentina	0.3%
Czechoslovakia	1.0%	Brazil	0.2%
Bulgaria	0.6%	Yugoslavia	0.2%
Hungary	0.5%	Pakistan	0.1%

Source: IAEA PRIS

the Agency's assistance can be of substantial help. For instance, a series of technical guidebooks has been developed that contain advice and recommendations based on the experience of countries that have already launched nuclear power programmes.

Manpower and financing

Experience indicates that manpower and financing usually constitute the most crucial constraints for developing countries seeking to start a nuclear power programme. The IAEA has provided much assistance to developing countries in the assessment of their man-

power development needs and in setting up manpower development programmes.*

To examine the issue of financing, along with other requirements and constraints in more detail, the IAEA convened a meeting in 1986 of experts in the field. (Senior Expert Group on Mechanisms to Assist Developing Countries in the Promotion and Financing of Nuclear Power Programmes.) Its work is expected to be completed in the middle of 1987 and a report will be published. It will include consideration of conditions specific to the financing of nuclear power projects, as well as the current schemes of export finance to determine their responsiveness to developing country needs.

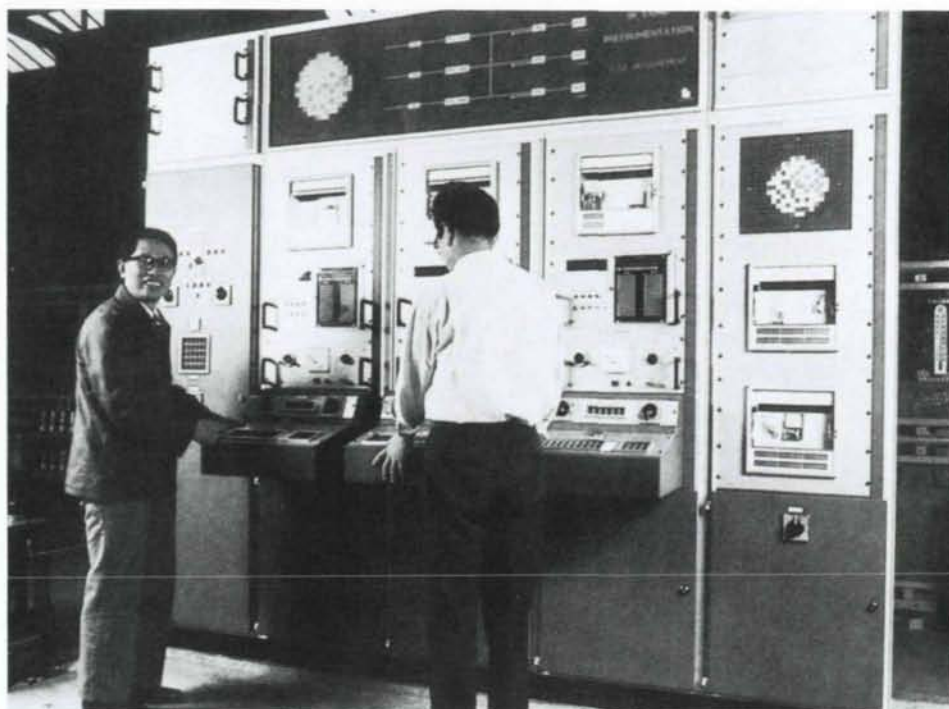
Without pre-empting the conclusions of the expert group, it can be stated that difficulties in obtaining adequate and supportable financing continues to be a crucial factor that has hindered many developing countries in their plans to introduce nuclear power. It must also be recognized, however, that, though the economic soundness of a project is a pre-condition to obtain financial backing, the creditworthiness of the particular country and utility is of paramount importance to secure reasonable financing.

The Agency's role regarding financing is very much limited because it is not a bank or financial institute and has no monetary resources for Member States pursuing nuclear power projects. It can and does, however, provide advice and assistance to countries and to financing institutions, regarding the technical, economic, and financial soundness of nuclear projects. For several years, the Agency has been co-operating with the World Bank in particular. This has included participation in various national energy, electricity, and power planning studies, by contributing its expertise in nuclear power planning and infrastructure assessments. The Agency can also play a catalytic role in establishing new working relationships between potential buyer countries, suppliers, and lending organizations.

Nuclear power and energy planning

In addition to general guidance, the IAEA has provided technical assistance through co-operative projects in various areas. Based on experience gained through such technical co-operation projects, a comprehensive assistance package has been developed. During the planning stage, this consists of an approach that includes (1) the required planning and preparatory studies and activities to establish an adequate basis for a sound decision to launch a first nuclear power project, and (2) the establishment of a definite sequence and schedule for implementation to permit building up, on a step-by-step and integrated basis, an adequate infrastructure, and to avoid unnecessary delay. (See accompanying box.)

* See "Manpower development: Moving to meet challenges", by B.J. Csik, *IAEA Bulletin*, Vol. 28, No. 3 (1986).



The in-core instrumentation for the 300-MWe Qinshan nuclear plant being built in China. (Credit: Framatome)

Main planning and preparatory activities

Listed below are the main planning and preparatory studies and activities relating to the introduction of nuclear power. The list is in a sequence that could be considered desirable, but which would have to be adjusted to prevailing conditions and characteristics of each particular country.

Prepare for planning

- Prepare a legal framework for nuclear safety, radiation protection, and regulatory activities
- Define the organizational structures and responsibilities for project planning, execution, operation, and regulation
- Establish a qualified planning group

Establish the viability and desirability of launching a nuclear power programme

- Perform a national energy market analysis, including survey of past trends and current situation, energy demand forecast, and assessment of energy resources and energy supply options
- Perform an electricity market analysis, including review of past trends and present situation of the electricity demand and supply, the study of the electricity generating system, and the determination of demand forecasts
- Perform an electricity generating system expansion planning study on the basis of available options and the comparative evaluation of alternative expansion plans
- Assess the national infrastructure requirements, capabilities, constraints, and development needs, in particular regarding qualified manpower and industrial support

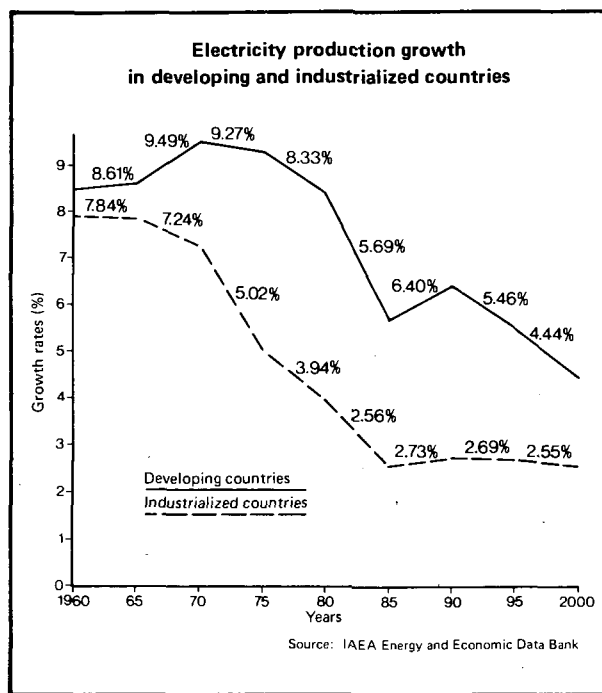
- Survey the international supply situation for nuclear power plants, fuel and technology, including technical, economic, financial, and policy aspects
- Assess and evaluate the benefits, disadvantages, requirements, and constraints of the introduction of nuclear power
- Establish the regulatory organization

Define the nuclear power programme

- Establish the sequence and timing of nuclear power projects on a medium- and long-term basis
- Determine a policy and strategy for national participation development and technology transfer
- Define the tasks and activities to be undertaken domestically, taking into account the available manpower and industrial capability
- Establish overall schedules, as well as investment and financing requirements
- Develop programmes for manpower and supporting industry development
- Decide to proceed with project-oriented studies and establish the planning organization and group

Define the first nuclear power project

- Perform a project feasibility study
- Perform a siting study
- Perform a detailed industrial support infrastructure assessment
- Launch the manpower development programme
- Establish regulatory requirements and procedures
- Decide to proceed with acquisitions



During project execution, the package is tailored to provide country-specific assistance in project management and related activities. Project management is a critical area where expertise is lacking in many developing countries. Coupled with project management is quality assurance as a management tool. The IAEA also assists national regulatory bodies in support of specific functions, and operating organizations in all aspects of plant operation and maintenance.

A Member State may wish to ask the Agency to provide assistance based on this overall comprehensive package approach, or it may wish to request aid only for some studies or activities. Even in the latter case, the "integrated package" approach can be applied up to a point. For example, in the area of energy and electricity planning, the approach includes an energy and nuclear power planning (ENPP) study. This consists of a joint effort between Agency experts and national counterpart

teams. The Agency's role is to provide the methodology, general guidance, and data and information regarding the nuclear power option. The national team is in charge of carrying out the study, using the Agency's computer analysis programs, MAED and WASP.

Such an ENPP study, however, does not by itself provide an adequate basis for a sound decision to launch a nuclear power project. All other necessary studies and activities should also be performed by the country concerned, either separately or with the Agency's assistance.

There are some 15 developing Member States performing nuclear power planning activities. A few are at an advanced stage, with declared intentions to start their first project. Most others are at a more preliminary planning stage and have intentions for going nuclear in the medium and long term. Various IAEA technical co-operation activities are in progress in practically all these countries at their request. As planning is an activity that does not stop when the first project is launched, the Agency is also assisting several developing Member States that already have on-going nuclear programmes.

It is expected that IAEA planning assistance will remain a continuing activity for many years, with the trend towards the comprehensive, or integrated, approach. The work to develop general guidance and methodologies can now be considered as essentially completed. Yet work remains to be done to ensure that information remains current and that technical guidance stays at appropriate levels, in keeping with new developments that may occur.

In the future, a shift of emphasis is foreseen towards assistance on a country-specific, case-by-case basis, through integrated packages that would involve multi-year projects. There is also a clear trend to increase Agency activities that support development of infrastructures. The aim is to improve the capabilities of developing Member States to execute projects and to operate nuclear power plants in as safe and reliable a manner as achievable.

