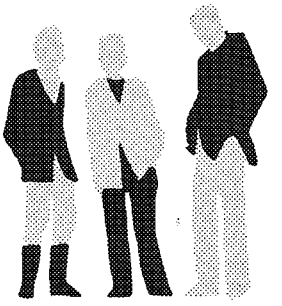
Participants in the IAEA's interregional training course on radiation protection in the mining and milling of radioactive ores in Poços de Caldas, Brazil. (Credit: J. Ahmed, IAEA)

In many countries, national and industry training programmes are an integral element of nuclear programmes. The photos show the use of training aids in the USA, and Filipino students receiving instruction in gamma spectrometry through a training programme in Australia. (Credits: INPO, AAEC)

Energy, electricity and nuclear power planning in developing countries



Strengthening capabilities through an integrated approach

by K.F. Schenk

Energy, in particular electrical energy, is one of the fundamental requirements for economic growth and social improvement for developed and developing countries. In most countries the rate of growth in electrical demand exceeds substantially the rate of growth in total useful energy demand. The result is that a higher proportion of primary energy is expected to be used for electricity production in the future. In developing countries, the rate of growth of electricity exceeds that for industrialized countries and is also higher than that experienced in industrialized countries at similar stages of development.

A Senior Expert Group convened by the IAEA has studied the ways and means to assist developing countries to promote and finance nuclear power programmes. The group's final report stated that only nuclear power with the highest practical reliability and safety standards, and coal-based power with suitable environmental protection standards, could become significant substitutes for oil in the generation of the large amounts of electricity necessary for general socioeconomic development in developing countries.*

Over the years, the IAEA has developed a comprehensive framework of information, tools, methodologies, and expertise to assist its developing Member States in strengthening their capabilities in energy, electricity, and nuclear power planning. Based on experiences with these individual activities, the IAEA has the necessary elements for organizing an integrated package of assistance to be administered on a multi-year country-specific basis tailored to the requirements of a particular developing country.* The integrated assistance package is based on the following premises:

- Nuclear power is considered only when the country is at a stage where nuclear power is technically feasible and when it would be part of a least-cost long-term energy and electricity supply strategy considering all alternatives and relevant economic factors.
- A nuclear programme is launched only when it has a definite chance of being successful, i.e. it can be executed within the planned schedule and financing availability.
- A nuclear power project is finally committed only after comprehensive planning, and when steps have been taken to meet all necessary supporting infrastructure requirements, including assurance of financing.

The IAEA offers an integrated assistance package to assist in alleviating two main problems faced by developing countries involved in or considering a nuclear power programme, namely:

- Inadequate ability to establish, maintain, and develop the planning capability for energy demand and supply that is required for assessment of alternative energy and electricity supply options, including the assessment and planning of financing requirements and mechanisms.
- Lack of the necessary infrastructure. Many developing countries already involved in or considering a nuclear power programme need impartial advice and assistance in developing the infrastructures required to support the execution of such a programme, including the development of adequate personnel training programmes.

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* *Promotion and financing of nuclear power programmes in developing countries*, report to the IAEA by a Senior Expert Group. The report is available upon request to the IAEA Division of Publications. See also article in *IAEA Bulletin*, "Nuclear power programmes in developing countries: Promotion and financing," by L.L. Bennett, Vol. 29, No. 4, pp. 37–41 (1988).

* Recommendation 1 of the Senior Experts Group report states that the IAEA should :"Offer an integrated package of assistance, with training in the use of IAEA methodologies as a basic component, for studying the needs for energy, electricity, and nuclear power within the overall context of economic development of a country, for analyzing the economically optimized choices of energy options, and for assessing the required local infrastructures and the plans for their development. The environmental and other impacts of energy options should be included in the analysis."

Integrated approach

The integrated approach unifies individual IAEA activities in energy and electricity demand analysis and generation expansion studies, which establish the economic justification for a nuclear power programme, with those activities in infrastructure and, particularly, manpower development.

Training in the use of the IAEA methodologies comprises a basic component of the integrated assistance package to study the needs for energy, electricity, and nuclear power within the overall context of economic development of a country; to analyse the economically optimized choices of energy options; and to assess the required local infrastructure and the plan for development, with particular emphasis on manpower development.

The technical co-operation (TC) programme is the IAEA's primary vehicle for delivering the integrated assistance package. Depending on the specific situation in the individual country, the planning project could include either all or specific elements of this integrated package. For each requesting country, the scope of a TC project will be defined through detailed pre-project planning which will include reconnaissance missions for assessing specific requirements. Financing of these projects is mainly with TC and/or UNDP funds.

In administering the integrated package of assistance, all available means are extensively used. These include the exchange of information and transfer of experience, meetings, workshops, transferring planning methodologies, training courses, on-the-job training, seminars, technical reports, guidebooks, nuclear safety guides, expert services, fellowships, advisory missions, and scientific visits.

The following assistance packages are provided:

● ***Assistance in developing a nuclear power programme plan.*** In this phase, which may be considered a pre-feasibility study phase, the salient components relate to the overall planning requirements of the utility or country and therefore are based on national energy strategies and economic/industrial development. The planning activities in the pre-feasibility study phase comprise mainly those activities related to medium- and long-term planning. They also include those which directly concern the introduction of nuclear power and which should already be started or considered at the pre-feasibility study phase. These will be considered in turn.

Factors which are related to overall planning requirements include: energy and electricity demand projections; energy resources assessment; electric power system generation expansion planning, including a review of existing, committed, and projected electric power generating and transmission facilities; and overall national development strategies and policies.

The IAEA's integrated assistance in the overall planning process is carried out primarily with an energy and nuclear power planning (ENPP) study. It assists the particular developing country in detailed economic analysis and planning studies to determine whether a nuclear power programme is a valid economic option. The nuclear power programme should be based on a comprehensive national energy plan. This in turn should recognize long-term economic development goals and consider energy and electricity supply and demand options within the economy. The economic planning effort should be one basis for policy formulation, but the planning must not be too narrow and should take into account the environmental risks of different supply options and the total cost of building new supply facilities.

The particular factors associated with the introduction of nuclear power include legislative requirements, organizational requirements, siting, reactor type review, contract approach strategies, and public acceptance.

Regarding legislative requirements, actions should already be started at the pre-feasibility study phase to consider the steps to be taken by the government to license nuclear power plants and facilities. The establishment of the requirements for the nuclear regulatory and licensing organization and for the utility's nuclear power planning group further should be considered. The IAEA's role in these tasks is mainly one of guidance through advisory missions and publications. Actions should also be directed at providing the necessary basis for reactor site selection at a later stage. IAEA assistance includes site-related safety missions, training courses for implementing the nuclear safety standards (NUSS) guides on siting, on-the-job training, information exchange, and technical publications. The reactor type is among the first questions which arise when nuclear power is first contemplated. In the pre-feasibility study phase, this question is considered to establish criteria necessary for an energy resources assessment and developing cost data.

Regarding contract approach strategies, IAEA helps the country identify the approach that offers the most acceptable compromise between risk and cost. A decision on which type of contract approach to employ for the first nuclear power plant is a matter that can be finally decided after the feasibility study is performed. However, this question is one which requires some early consideration since it is strongly related to national participation.

Regarding public acceptance of nuclear power, IAEA assistance is planned in the form of seminars and information packages. The seminars are geared to the basic issues and general requirements of nuclear power programmes for political leaders and other decision makers. The information packages include answers to the questions most frequently raised in relation to public acceptance.

● ***Infrastructure development planning and feasibility studies.*** Adequate national infrastructures are a fundamental requirement for the successful implementation

The primary means to carry out the packages of IAEA assistance in nuclear power programme planning (including infrastructure and manpower development) are:

Training courses

- Interregional, regional, and national training courses on electric system expansion planning
- Interregional training courses on electricity demand forecasting for nuclear power planning
- Regional training courses in radiation protection and nuclear safety
- Interregional training courses on the introduction of nuclear power
- Training courses on manpower development and assessment of industrial infrastructure

Methodologies

A number of analytical tools and methodologies are available:

- Wien Automatic Electric Generating System Expansion Planning (WASP)
- Model for Analysis of Energy Demand (MAED)
- Energy and Power Evaluation Program (ENPEP)
- Financial Planning Model (FINPLAN)
- Energy and Electricity Demand Model for Developing Countries (EDE)
- Supply and Demand Model for Energy and Electricity (TUV)
- Hydro/Thermal System Simulation Model (VALORAGUA)

Guidebooks

Published in the IAEA's Technical Report Series, they cover:

- Introduction of nuclear power
- Energy and nuclear power planning in developing countries
- Energy and electricity demand forecasting
- Expansion planning for electrical generating systems
- Interaction of grid characteristics with design and performance of nuclear power plants
- Introducing nuclear power plants into electrical systems of limited capacity (problems and remedial measures)
- Manpower development for nuclear power
- Engineering and science education for nuclear power
- Research and development in support of nuclear power
- Industrial support
- Nuclear power project management
- Economic evaluation of bids for nuclear power plants
- Bid invitation specifications for nuclear power plants
- Industrial infrastructure to support a programme in nuclear power

Other publications

Studies, analyses, manuals, and other reference publications cover:

- Mechanisms to assist developing countries in the promotion and financing of nuclear power programmes
- Experience in the use of the Agency's WASP computer program in IAEA Member States of Asia and the Pacific Region participating in the Regional Co-operative Agreement
- Model for analysis of energy demand (MAED) : User's manual for version MAED-1
- Experience with the Agency's WASP for nuclear power planning in developing countries
- Improvements to WASP-III
- Nuclear safety standards
- Quality assurance for nuclear power plants
- Quality assurance programme auditing
- Training, qualifications, and certification of quality assurance personnel
- Costs and financing of nuclear power programmes in developing countries
- Small- and medium-power reactors
- Long-term uranium supply and demand analyses
- Nuclear fuel cycle facilities

Missions

Expert and advisory missions extend to areas including:

- Legal frameworks and legislation
- Nuclear safety
- Implementation of nuclear safety standards
- Organizational requirements
- Nuclear power planning advisory teams (NUPATs)*
- Financial aspects (joint missions with the World Bank)
- Manpower
- Establishment of nuclear reactor training centres
- Feasibility studies
- Assessment of industrial infrastructures
- Quality assurance
- Industrial surveys
- Assessment of financial requirements of a nuclear power plant

Workshops

The following are conducted under the IAEA/UNDP Regional Co-operation Agreement in Asia and the Pacific:

- WASP user's workshop
- MAED user's workshop
- WASP/VALORAGUA user's workshop

Other means

- Visits to regulatory organizations
- Country visits
- On-the-job training
- Seminars for decision makers on the introduction of nuclear power
- Seminars for decision makers on financing schemes
- Expert advice
- Fellowships
- Energy and Electricity Demand Studies (EES)
- Market surveys for nuclear power
- WASP Studies
- Power Reactor Information System (PRIS)
- International Nuclear Information System (INIS)
- Energy and Economic Data Bank (EEDB)

* This is a new activity to be implemented in 1989, to assist developing countries in carrying out an overall assessment of their level of preparedness to undertake a nuclear power programme. Based on the level of preparedness of a country, as determined by a check list of requirements-to-be-satisfied as outlined in Table I of the SEG report, all or particular elements of the assistance package are provided.