Prospects for Utilization of Nuclear Power in Africa

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Electric energy plays a key role in developing the infrastructure of countries all over the world, and increase in consumption of electricity is a definite indicator of economic development. Although there is no nuclear power plant in Africa yet, it is not too early for long-term planning of the role of nuclear energy in fulfilling the electricity demands of the future economies of African countries.

A realistic assessment of the future role of nuclear power in a given electric system requires much more than the determination of an economically optimal plant mix. It calls for optimization under a series of constraints. Among these are licensing and regulatory factors, public attitudes and the degree of commitment to nuclear power by national governments. For many developing countries, the problems of financing additional foreign exchange expenditures are so acute as to force them to defer otherwise highly profitable ventures.

In the case of nations with large low-cost fossil fuel and hydro resources a great degree of flexibility has been and is likely to be maintained in establishing medium and long-term objectives for nuclear energy.

THE IAEA NUCLEAR MARKET SURVEY

In 1974 the International Atomic Energy Agency up-dated and extended its market survey to additional developing countries. The latest data indicates the very much increased market for small and medium power reactors (SMPR), compared with the 1973 market survey reports.

The results which came out could be summarized as follows. There may exist a potential market for nuclear power in developing countries of 220 000 MWe, which could be divided in the following manner:

- In the range of 150 to 400 MWe (i.e. small and medium power reactors) there might be a market for 140 nuclear power plants which would, by 1990, represent around 38 000 MWe.
- In the range of 500 to 600 MWe, there might be a market for 86 plants totalling 50 000 MWe capacity.
- In the range above 600 MWe, the market appears to be 129 plants for an installed capacity of 133 000 MWe.

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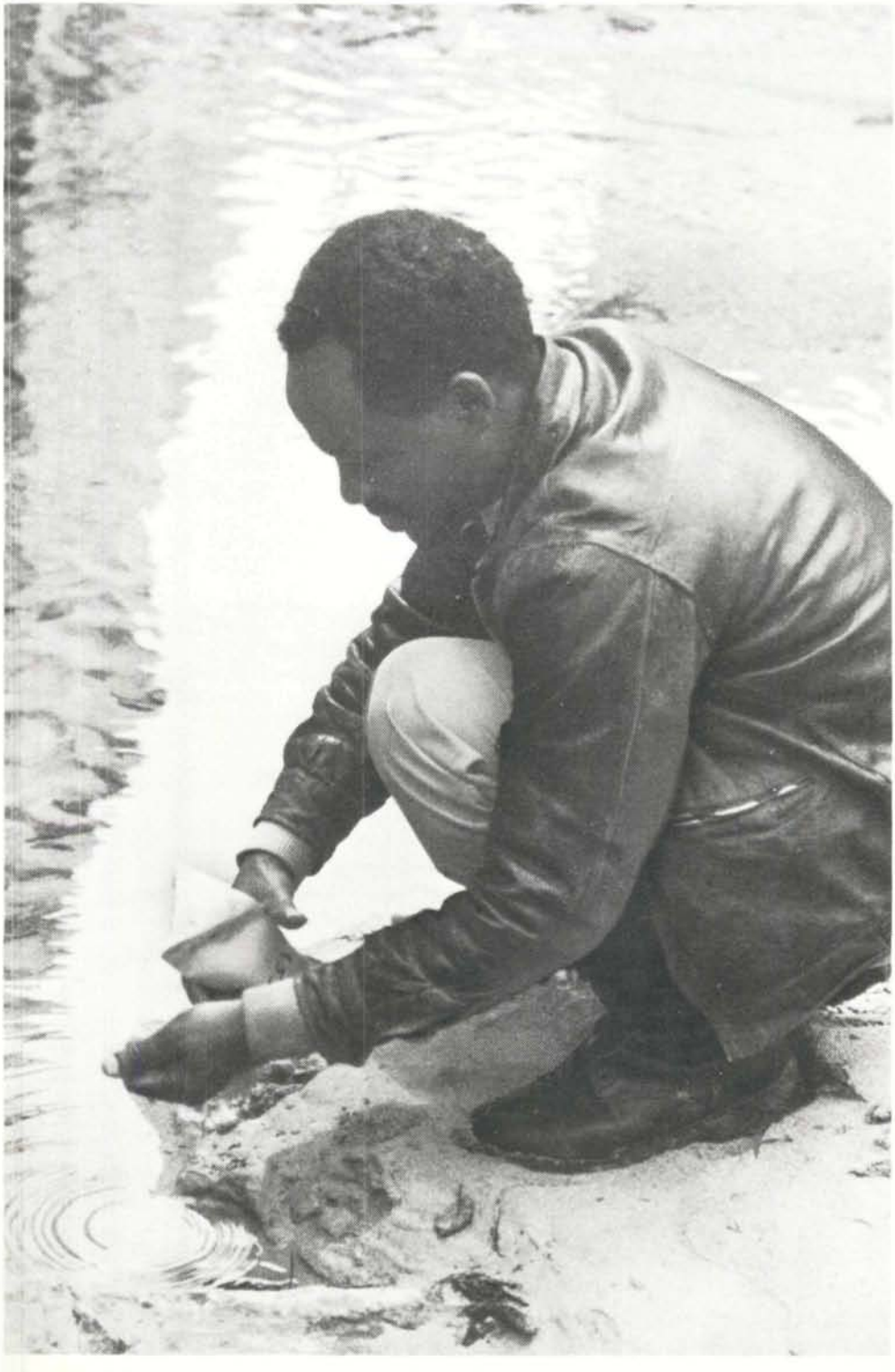
One of the participants of the IAEA International Training Course on Uranium Geochemical Prospecting Methods which was held in Austria in October 1975 collecting stream sediment samples to be analysed for uranium content. Photo: IAEA ▶



As regards the African countries, **Table 1** shows the possible market:

TABLE 1. Schedule of Nuclear Capacity Additions, 1981–1990 (MW)
1974 Edition – Market Survey – Africa

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Algeria				150			150			150	450
Egypt			600		600	600	600	2X600	600	800	5000
Ghana					150			150			300
Morocco							200		200		400
Nigeria							150	150		200	500
Tunisia									150		150
Uganda									150		150
Zambia									150		150
Total											7100
Morocco – Algeria – Tunisia				150			350	150	350		1000
Cuba (for comparison)	250	250		300	300		300	300	400		2100

The Arab Republic of Egypt appears to be the developing country in Africa which can first make good use of nuclear power to serve its energy demands. With the size of the Egyptian grid, plants in the range of 600 MWe are already fully competitive and conventional thermal additions may not be necessary since peaking demand can easily be met by existing or planned conventional plants as well as by existing hydroplants.

The situation is quite different in the other African countries listed in **Table 1**. This shows that a total of more than 2000 MWe installed capacity, from nuclear plants in the range of 150–200 MWe, might be installed. This situation arises from the fact that as far as it is possible to ascertain their costs, small and medium power reactors have become competitive with oil plants since the quadrupling of crude oil prices in recent years.

One possibility for earlier realization of nuclear power projects in Africa is through international co-operation. Interconnected transmission systems between states could make possible the earlier utilization of nuclear power and perhaps of a larger unit. Examples of such interconnections are those in Morocco-Algeria-Tunisia, as well as Ghana-Togo-Benin-Upper Volta. Cuba is shown for comparison to Morocco-Algeria-Tunisia as an example of increased nuclear possibilities by inter-connection. Cuba's estimated peak capacity needs are similar to the three African countries and have thus been chosen for the comparison.

AVAILABILITY OF SMALL AND MEDIUM POWER REACTORS

The problem of availability of power reactors smaller than those used in the industrialized countries has been important for the developing countries at least for ten years but the upper size limit has slowly increased from 150 to 600 MWe during that time.

The IAEA has consistently tried to promote the availability of such reactors, for instance, by clearly showing the size of the market, if they were available, in its "Market Survey for Nuclear Power in Developing Countries". The prospects of obtaining such plants have recently improved.

With the higher oil prices, the competitive situation for smaller power reactors has changed in the industrialized countries too. While large units will still dominate the market for electricity production, smaller units are now competitive and needed as local energy sources, e.g. for production of electricity in isolated locations, of process steam for industries and district heating. There is also a renewed interest in nuclear ship propulsion.

Three organizations (Technicatome, France; Interatom, F.R. Germany, and UKAEA and/or Fairey Engineering of UK) which have designs for plants in the size range 92–345 MWe have informed the IAEA that they would respond reasonably promptly to a bid invitation. The reactor systems (pressurized light water and steam generating heavy water) which these organizations propose are stated to be based on present, proven reactor technology. The light water reactors are essentially land-based versions of French and German ship propulsion reactors while the heavy water reactor design is based on the SGHWR plant at Winfrith in the United Kingdom.

LACK OF QUALIFIED MANAGEMENT STAFF

Constraints related to a new technology manifest themselves often in the lack of qualified management staff. The previous experience of developing countries in electric power production will not be adequate for the planning, preparation and implementation work which will be required for a nuclear power project.

To illustrate the problem the Agency estimates that in 1980 about 5000 trained local engineers may be required to work on nuclear power projects in the developing world. In 1985 twice that number would be needed. Much training will have to be given particularly by national institutions to create the needed infrastructure.

This is why the Agency has started a programme of training courses of totally new character, of which the first was given in Karlsruhe, Federal Republic of Germany, from September to December 1975. In 1976 there will be four more training courses of this kind: from 6 January to 16 April in the Argonne National Laboratory, USA; from 30 March to 9 July in the INSTN, Saclay, France, and from 6 September to 17 December in Karlsruhe, Federal Republic of Germany and Argonne, USA. It is gratifying to note that a number of African countries are participating in these courses.

AVAILABILITY OF FINANCING

Another problem is that nuclear power programmes require higher expenditures for a relatively long period until the savings in fuel offset the additional capital costs. This applies not only to demand for capital, but for energy itself, since the energy investment in nuclear stations and the supporting fuel infrastructure are initially larger than those involved in a conventional programme.

It is worth noting that some developing African countries may even now be able to participate actively in the world development of nuclear power, i.e. through their contribution to uranium resources. Although knowledge of the geology of uranium is relatively new and prospecting has been concentrated on particularly favourable regions, developing countries in Africa, and more precisely Niger, Gabon, Central Africa and Zaire, have a sizeable potential of reasonably assured uranium resources (approximately 80 000 tonnes uranium)[1]. There is also an estimated additional resource amount of 50 000 tonnes uranium. Contributions from those developing African countries to world supplies may well increase as a result of the new efforts in uranium prospecting that have become necessary because of a possible uranium shortage in the 90's. The IAEA is devoting an important part of its activities in uranium prospection to assist certain African countries, for example, Morocco and Somalia.

ENVIRONMENTAL PROTECTION AND PUBLIC ACCEPTANCE

Constraints also arise from the specific risks inherent in the operation of nuclear power stations and in the control of their fuel cycles. These problems are specific to a nuclear programme and original solutions must be found; other energy technologies have of course their own problems.

Nuclear power can be expected to play a significant role in the developing world in the future. Not unexpectedly the constraints for introduction will be more important in most of the African countries e.g. in relation to grid size and the unit size of plants, manpower development and financing.

[1] See Table 1 in the article "Uranium Resources and Supply" in this issue.