Introduction

Options for the long term

by Leonard Konstantinov and Hans-Juergen Laue

If nuclear power is to be a permanent large-scale source of energy for the long run, a transition is required from today's thermal reactors to a second generation of advanced nuclear reactors and the associated fuel cycle.

Based on IAEA's experience working with Member States, such a transition already has begun in several countries, albeit slowly and not without problems for many.

When analysing the role of advanced systems, it must be recognized that the nuclear contribution already has achieved an impressive level. Today more than 13% of the world's electric energy is produced by nuclear power plants. There are strong signs the present trend will continue, with the nuclear share of world electricity generation reaching 20% in the year 2000.

In terms of development on a larger scale beyond 2000, however, the present thermal reactor technology with once-through fuel cycle can only be considered a relatively short-term energy source. The estimated 15 to 20 million tonnes of uranium resources that could be economically extracted will be exhausted within about 50 years.

The transition to advanced nuclear systems, then, requires decisions to be taken now and, even more, requires a long-term investment policy. Yet in most economies today, investments are driven by more short-term considerations, superimposed on present economic conditions and the corresponding uncertainties of future energy demand.

As a result, there is a dichotomy in some countries between – on the one hand – the actual technical status and investments for research and development, and – on the other hand – the perception and absorption of the potential of advanced systems into the long-term policies needed to assure energy supply in the next century.

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In several countries, policy-makers question whether advanced nuclear systems are needed at all. For instance, politically influential groups in the United States, as well as in some other countries, doubt that it is necessary to have advanced reactors. One result has been a drastic slowdown of the US fast reactor programme. In other countries, there are official statements, such as in the USSR, saying that the assured need for advanced systems requires their development without any delay.

Although conflicting, both viewpoints seem to be based on thorough assessments of the resource base and future energy requirements. Yet the result is that policy-makers in several countries are confused and need information and advice to understand the situation and to arrive at a well thought-out development philosophy for nuclear energy's future.

Toward the objective of fostering understanding, this issue of the *IAEA Bulletin* looks at the status and trends of advanced nuclear systems from the standpoint of Agency experience in major advanced reactor programmes in a limited number of Member States. Articles are intended to provide these and the majority of IAEA's 112 Member States with an objective view of the technical and economic aspects of a development of importance for future energy policy.

What do we mean by advanced nuclear systems? Advanced nuclear fission reactor technology does not only refer to reactors having higher fuel utilization capabilities than present commercial reactors. It also refers to technologies for extended energy applications, beyond large-scale electricity generation.

Such technologies include:

- Plutonium and uranium-233 recycling with advanced converter and breeder reactors;
- Reactors for low- and high-temperature heat production for district heating;
- Low- and high-temperature process heat for the production of hydrogen and hydrocarbons, chemical feedstocks, steelmaking, and gasification or liquefaction of coal;

• Small-size nuclear units that could make a significant contribution to nuclear power's further expansion, not only in developing countries but also in industrialized countries, under specific conditions. Such conditions include meeting slower load growth or reserve capacity requirements and faster reimbursement of investment. Small-size reactors also offer a chance for more conservative layout, fully tested modular and standardized designs, simplicity, and improved safety through inherent features.

Fusion power technology has not been considered in these articles, since it should be classified as part of the third nuclear generation, available commercially for electricity production within a time horizon after the year 2030 in our opinion. It should, however, be mentioned that the IAEA is playing an important role in the worldwide exchange of information on fusion power. An example is INTOR,* one of the most important areas of international co-operation, to speed up the development of controlled nuclear fusion in general, and to demonstrate the technological feasibility of sustained generation of fusion energy by a tokamak system in particular.

It is hoped that this series of articles will be useful not only to those countries currently developing advanced reactor technologies, but also to those that may eventually apply such systems to their future energy needs. Beyond the turn of the century, increasing amounts of energy in its various end-use forms will be required in the developing regions of the world, and today's advanced nuclear systems are one option to meet those demands.

* International Tokamak Reactor.