Nuclear power: Keeping the option open

Though slowed in some countries, nuclear power development is rapid where the demand for electricity runs high

by
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Generating electricity from nuclear power is a well-established technology. More than 30 countries were operating or building altogether more than 480 nuclear power plants at the end of 1994. Collectively over the past 40 years, the world has accumulated over 7200 operating years of experience with nuclear power, and the plants have generated about 20,000 terawatt-hours of electricity.

The increasing world population, the universal desire for an improved standard of living, and improving economic conditions will all lead to an increase in global demand for energy. The problems are compounded by the need to study and then reduce the emissions from burning fossil fuels. These factors inevitably mean an increase in demand for electricity. In the developing world, for example, electricity demand is increasing at a higher rate than either energy consumption or gross national product.

The choice of electric power sources in a country will depend upon many factors. They include existing capacity, availability and cost of fuel, capital funds, and political conditions. Many countries will adopt an approach which provides a balanced mix of fuel sources to guard against price and supply "shocks". Generating companies will also seek to stabilize the security of supplies and electricity prices to their customers. Diversity is seen as a key benefit for stabilizing the supply and cost of electricity. In this context, nuclear power will remain a viable option for future electricity generation.

In the industrialized world, the rate of demand for new nuclear power plants will be tempered by various factors. They include the magnitude of current excess generating capacity, the replacement rate of old and relatively inefficient conventional fossil burning plants, and the demands of meeting international agreements on the control of emissions. But in the developing world, the availability of money and other resources may be the controlling factor in the rate of implementation. The situation is not simple.

Currently, the demand for energy appears to have saturated in some regions of the world. However, this is thought to be mainly due to economic recession and the social changes in Central and Eastern Europe, rather than any underlying medium or long-term trend in energy usage. The demand in the rest of the world continues to increase inexorably and this is where the majority of the world's population lives.

In short, the global energy and electricity picture has changed over the past decade, with demand strongest in countries experiencing healthy economic growth. In September 1994, this changing picture and nuclear power's place within it were examined at an international conference at the IAEA in Vienna. About 150 participants from 37 countries and six international organizations attended. Recently, the IAEA published the Proceedings of the conference. This article reviews selected issues raised at the conference that are influencing nuclear power's future development.*

National and regional nuclear growth

As they do today, various factors could impede the use of nuclear power in years ahead. They are related to issues of public acceptance, radioactive waste management, safety, economics, the environment, and legal liability.

In many countries developing nuclear power programmes, many of these factors have been

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addressed and overcome. National and regional reports at the conference from Eastern, Central and Western Europe, North and South America, and Asia indicated that nuclear power is well established, economic, and a significant source of electricity. Over the long term, continuing demand for electricity is expected to lead to greater nuclear development, as well as investment in other options. In these regions, nuclear power is seen to be competitive and environmentally advantageous.

The rate and timing of nuclear growth will vary between countries. Worldwide, nuclear power can be expected to continue to grow at the present level of three to eight gigawatts (GWe) per year, though increases of 10 GWe per year and higher are projected early in the next century.

At the national level, the prospects for growth are generally tied to economic and energy conditions, based on conference reports. In China and India, where energy demand surpasses supply, the limited availability of capital and other resources has served to constrain nuclear development though its growth is considered urgent. Russia, Ukraine, and other Eastern European countries also have urgent and continuing needs to improve and increase their generating capacity, but they face serious difficulties. In Latin America, countries generally have well-defined needs for electricity yet have a shortage of resources. In France, Japan, and the Republic of Korea, nuclear programmes are robust. In North America, where utilities currently have excess generating capacity, an expansion of nuclear power, as well as other sources, strongly depends on the pace of electricity demand.

Plant management and performance

Among the conference's key topics was the management and performance of nuclear power plants.

In many countries, lessons have been learned from problems encountered during plant construction and operation. Equipment, operating, and maintenance procedures, as well as training programmes, have been upgraded. In some countries, the need to improve project management skills was identified as especially important, particularly for countries moving from a centrally planned to a market driven economy.

Greater cooperation and communication between operators of nuclear plants have resulted in improved performance. The World Association of Nuclear Operators (WANO) reported that the operational availability of plants has increased while the number and severity of reportable incidents has decreased. A report from Nuclear Electric in the United Kingdom described a remarkable improvement in the performance of their advanced gas-reactors over the past 4 years, with load factors increasing from 40% to 79%. By taking a broad approach to safety culture, Nuclear Electric has been able to take advantage of lessons to be learned from a wide range of industries. Through research programmes, for example, a study of the management and organizational factors behind recent severe accidents in nuclear, chemical, transport, space, and petroleum industries has been conducted with the aim of determining organizational characteristics that would prevent such accidents. These studies and other national and international programmes have led to considerable progress over the last 5 years in efforts to improve safety culture and hence the safe performance of plants.

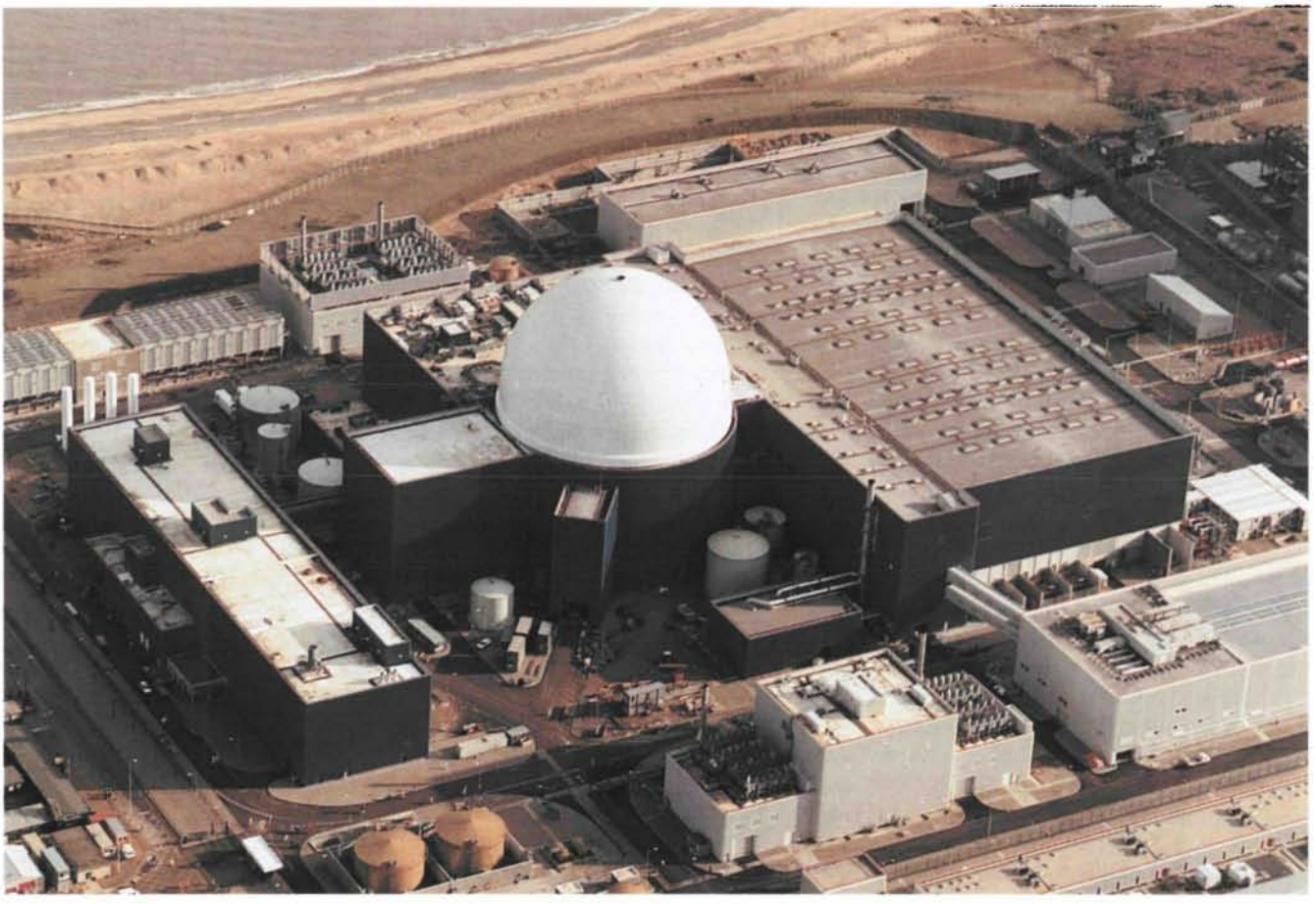
A number of reports emphasized the value of opening plants to outside international safety reviews and publishing performance data in the IAEA's Power Reactor Information System (PRIS), particularly from the standpoint of public perceptions. One report analyzed the good production record of WWER-440/230 plants, a fact that contrasted with safety concerns expressed about these plants. The performance of the successor design, the WWER-440/213, has been generally better, whereas that of the larger WWER-1000 has not been quite as good as expected.

Economic and related issues

With regard to the economic viability of nuclear power, studies carried out by the IAEA, Nuclear Energy Agency (NEA), International Energy Agency (IEA), and Union of International Producers and Distributors of Electricity (UNIPEDE) show that electricity generation costs for nuclear plants are closely competitive with those for coal and gas-fired plants. However, the economic margin in favour of nuclear generation has declined in recent years, primarily because of increases in operation and maintenance costs for nuclear plants, at least in several countries.

Projected costs for plants that could enter service around the year 2000 or shortly thereafter show that nuclear power should be able to continue to compete with fossil plants. Whether nuclear is the cheapest option will differ from country to country, and will be strongly influenced by the price of fossil fuels and by the costs and duration of construction.

It is essential, if the nuclear option is to be



Sizewell "B", the UK's most recent nuclear power plant.

competitive, that nuclear projects be well managed during construction and operation. New nuclear plant designs, drawing upon the lessons learned from existing plants, should lead to plants that are simpler and cheaper to construct, while maintaining high safety levels. Improvements in fuel performance, including higher burnup, together with the trends towards lower prices for uranium and fuel cycle services, will lead to stable or declining nuclear fuel cycle costs.

In addition to being economically competitive, nuclear plants are beneficial from the environmental viewpoint, since they do not emit any greenhouse gases or other damaging air pollutants, such as sulphur dioxide and nitrogen oxides. Thus, nuclear power can play an important role in strategies aiming towards limited or reduced levels of greenhouse gas emissions.

Quality assurance. The management of quality in nuclear power organizations and equipment suppliers varies quite widely across the industry. The efforts that have been made to produce documented systems and to audit compliance with those systems has often resulted in little benefit in quality terms. The IAEA and several regional organizations have long since recognized the problems. Highly pragmatic solutions are now emerging in line with and in many cases ahead of developments in the broader industrial scene. The evolution of quality management into a "culture" which promotes improved performance of all staff, not just addressing the production of "quality" documentation, was described. Performance-based quality management, which focuses on processes, provides a refreshing approach to the assurance of quality. The approach is described in a recently revised IAEA code and supporting guides prepared for publication in 1995.

Siting and plant life. Other topics receiving close attention at the conference related to the siting and operational lifetimes of nuclear plants. A number of participants emphasized the importance of retaining existing sites, and of maximizing the operational lifetimes of plants for economic reasons.

Extending the lifetimes of existing plants reduces the demand for new ones and defers decommissioning and its associated waste disposal requirements. Although there seems to be no technical impediment to the construction of a large number of new plants, the limiting factor could be associated with choice of new sites.

With the time approaching for decisions about the construction of new plants, whether or not such decisions are made, plant lifetimes are extremely relevant to keeping the nuclear option open. How long a nuclear plant operates is predominantly a business decision of the owner, even though associated regulatory requirements are mandatory. For building new plants, given the 10-year lead time for licensing, construction, and commissioning, participants stressed the importance of taking decisions now to meet needs early in the next century.

Public attitudes. On the matter of public attitudes toward nuclear power, both Japan and France commended the advantages of the "good neighbour" approach by utilities. The importance of creating "symbiosis" between plants and the community was emphasized. Building trust comes from listening to the issues raised by the community and from an open approach to communication. This technique is also employed in other countries, with communities near power stations in particular. The Russian public, during the current crisis of the national economy, was said to perceive nuclear power as an "island of stability".

It was also noted that, in the United States, public support was often underestimated, which leads to hesitation by government officials and others to speak out and take strong action in support of nuclear energy. New approaches are being taken to improve the industry's understanding of public concerns.

Waste and nuclear safety issues

Presentations covering the management of spent fuel and radioactive waste all emphasized that safety was the paramount consideration. France described the development of a complete inventory of all radioactive waste in the country and reported that media coverage of that activity had been generally favourable, again demonstrating the value of openness in gaining public confidence. Several speakers noted that technical solutions for waste disposal existed, but more progress in establishing sites and demonstrating the reliable operation of operational waste disposal facilities in the near term was vital to public acceptance of the nuclear power option.

The session on safety included topics related to safety assessment methods and implementation of a safety culture. Some speakers emphasized the need for cost effectiveness of safety improvements, a view not shared by the regulatory community. Concern was expressed about a proposed feature of some new plant safety requirements, namely that no accident should require off-site emergency planning. This would cause much difficulty if it was intended to be applied retroactively to existing plants. There was strong general agreement and support for the need to keep demonstrating the safe and productive operation of current plants, a fact that would help sustain public confidence.

Nuclear liability. Based on discussion surrounding a joint IAEA and NEA paper, there is disagreement between East and West on the question of liability for accidents. Participants from Eastern countries generally expressed the view that suppliers should remain responsible in the event of equipment malfunction, while those from Western countries generally endorse the concept of limited liability and place responsibility with the operator of the plant.

Human resources and training. The need to attract and train more qualified staff was noted with some concern. Again, public perceptions about nuclear's prospects were noted. They were generally seen as a factor behind the lack of interest in nuclear-related studies at high school and university levels. The contraction and diversification of nuclear research and development institutes also has led to a serious reduction of available qualified staff, which will take many years to rebuild. Governments were urged to take action soon to ensure that this trend is reversed if they wish to preserve the nuclear power option.

A mixed picture

The demand for and interest in nuclear power are seen to be increasing but it is not homogenous. In his closing remarks, Dr. Boris Semenov, the IAEA's Deputy Director General for Nuclear Energy and Safety, noted that the conference had reached consensus on the continued viability of the nuclear power option, and that in many countries, it was the preferred option as a proven, economically competitive, and environmentally sound technology. However, he pointed to a number of prerequisites for expanding nuclear development. They include the safe and reliable operation of existing nuclear power plants; the need for convincing solutions to waste storage and disposal problems; and a predictable licensing process. These provisions, together with a supportive and consistent government policy, are needed to achieve greater public acceptance of nuclear power, which he said constitutes probably the most important prerequisite.

He concluded by noting that these tasks cannot all be accomplished at once. However, steps must be taken soon to sustain the nuclear power option in the best interests of meeting the world's electricity and environmental needs. ❐