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The Future of Nuclear Power — The Role of the IAEA

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In the past 50 years, nuclear power has grown from being a nascent technology to becoming an important part of the energy mix in many countries. At the end of 1998, some 434 nuclear power reactors in over 30 countries produced about 16% of world electricity supply. Major performance indicators point to continued improvement in the safety and reliability record of nuclear power plants.[1] Last year sixteen countries relied on nuclear power for 25% or more of their electricity supply.

Global energy demand, particularly for electricity, is clearly on the rise; the main driving force is increasing need in the developing world.[2] A conservative estimate from the World Energy Council is that global electricity demand will triple in the next 50 years. What is certain is that, in the coming years, many countries will need to decide on the nature and extent of new investments in energy production. Their decisions will be influenced by several factors. Of course, energy security and the preference for low price and low risk will, as always, strongly influence the choice of investment. In addition, the pace and direction of economic development and the increasing awareness of the need for benign energy service supplies are two other variables that will increasingly shape investment choices.

In the next two decades, nuclear power, along with hydropower, is likely to be widely recognised as one of the few options that can help countries meet base load electricity demand with virtually no greenhouse gas emissions.[3] In this context, nuclear power can be seen as a mature energy technology — one that can satisfy growing energy needs while assisting compliance with the carbon dioxide emission targets set out in the Kyoto Protocol. It is also significant that nuclear power does not exacerbate other pollution problems such as smog and acidification; this fact — or asset — will become increasingly pertinent in view of the process of urbanisation that is changing the landscape of our societies.

These factors, in themselves, would seem to suggest that the share of nuclear power in global energy production will grow, or at least, remain stable. However, International Atomic Energy Agency (IAEA) projections show a less conclusive picture. Today, in Western Europe and North America, nuclear power is at a standstill. Yes, in a few rapidly-developing countries in Asia and in parts of Eastern Europe, it continues to grow.[4] But overall, despite a slight increase in absolute terms until 2010, the share of nuclear

power as a proportion of global electricity production is actually projected to fall, to about 13% in 2010 and to around 10% in 2020, as countries invest in other energy options.

I should point out that, despite these projections, the total phase-out of nuclear power is by no means foreseen. Investment plans in Asia have been scaled down in response to financial circumstances but the trend may be reversed in the future. Energy market privatisation and deregulation are causing a shake-up in the nuclear industry, and this shake-up is indeed likely to result in fewer nuclear plants in Europe and North America; but the plants that do remain will be the more efficient, safe and competitive ones. It should be noted that current experience points to the fact that the most competitive plants are also the safest. They will — I hope — be well-positioned to positively influence public confidence in nuclear power, thus enhancing the prospects for the industry in general.

I would caution, however, against the assumption that environmental considerations, by themselves, can trigger a resurgence of investment in nuclear power generation. Even safety, in and of itself, is unlikely to guarantee the future of nuclear power. Nor is "cheap" nuclear power going to be enough. Only if the nuclear power industry consistently reflects three crucial attributes — safety, competitiveness and public support — can it be assured of a long-term future. A profitable plant that is not safe will close down. Conversely, a safe plant that is not profitable will also close down. Lastly, even with safety and profitability, a plant that does not enjoy public confidence is likely to close earlier than planned.

In other words, a revival of nuclear power will require action on three fronts. These are:

- continued improvement in the global nuclear safety record, including the back end of the fuel cycle;
- further improvements in the economic competitiveness of nuclear power;
- enhanced public understanding of, and confidence in, nuclear power.

I shall address each of these in turn.

Nuclear Safety

Contrary to popular perceptions in many countries, comparative risk assessments show that nuclear power and renewable energy systems tend to be at the lower end of the risk spectrum. The main health concerns relating to nuclear power are connected with major accidents, of which there has been one in the past 40 years.

Of course, I refer to the Chernobyl accident of 1986. That event was a turning point in public opinion on nuclear power. It brought home three important points. First, that the health and environmental effects of nuclear accidents do not respect national boundaries and, hence, the importance of international co-operation. Second, that nuclear safety requires continuing investment in safety culture and advanced technology. Third, that the long-term acceptability and credibility of nuclear power will depend on a consistent track record of safety and transparency.

As the centre for international co-operation in the field of nuclear safety, the IAEA contributes to the development of an effective worldwide safety regime that comprises:

- international conventions that prescribe the basic legal norms for the safe use of nuclear energy;
- internationally-accepted safety standards;
- measures to assist states in the implementation of these conventions and standards;
- the promotion of technological solutions for improving safety.

This year the IAEA has also focused on assisting member states manage the year 2000 (Y2K) computer system problem.

In the 1990s, member states have significantly strengthened the nuclear safety regime in two directions. The first direction has involved a movement towards the development of comprehensive legal norms (in areas such as notification of nuclear accidents, liability, assistance in case of an accident, nuclear power plant safety and the safety of management of spent fuel and high level waste). The second direction includes increased openness to peer review of safety practices and procedures, and greater transparency.

The positive results of this process were evident earlier in 1999 at the First Review Meeting of the Convention on Nuclear Safety and the International Conference on Strengthening Nuclear Safety in Eastern Europe. Several points emerged during these meetings:

- the importance of universal adherence to conventions and other safety-related international instruments;
- the need for more transparency and openness in the safety field;
- the importance of technical co-operation and assistance for those who need it to improve engineering and design safety features and upgrade safety culture.

Agreed safety standards — an important component of the safety regime — constitute a basic tool and important guide for national regulators. By 2001, the IAEA expects to complete the revision of the entire corpus of safety standards (some seventy documents) to ensure that they are comprehensive and scientifically up to date. But the key to an effective safety regime is the full application of conventions and standards at the work place, with particular attention to managerial and organisational practices. Throughout the past decade, the IAEA has expanded the range of services it can offer to states and nuclear operators in this area. These include various types of review missions, training, the fostering of scientific research, technical co-operation and information exchange.

The application of advanced technology for improved safety features in nuclear power plants is another important area of the IAEA's safety-related work. Over the past decade there have been improvements in practically every field of nuclear power technology. Of particular importance is the development of a new generation of nuclear power plants with "passive" safety systems. By relying on natural laws, the properties of materials and

internally stored energy, these systems reduce the need for early human intervention in cases of an anomaly. Through information exchange and other support activities, the IAEA encourages and facilitates such research and development in this important area.

The safety record for nuclear power plants indicates continuous improvement throughout the past decade. Nonetheless, the IAEA's Nuclear Safety Review for 1998 identifies several areas where increased attention to nuclear safety, including management practices, is required.

One concern is the safe management of radioactive waste and spent fuel. An advantage of nuclear power over other energy sources is the relatively small volume of waste generated. Few other large-scale industries could safely store the entire volume of wastes from decades of production on an area of a few hectares. Why is this major advantage of nuclear power so often perceived negatively?

Last week, an IAEA-sponsored international symposium reviewed experience worldwide and reconfirmed that technologies exist for the safe, environmentally-sound and cost-effective management of radioactive wastes. In other words, from a technological point of view, the safe management of radioactive wastes and spent fuel is far from a mystery.

For example, the technology to reprocess spent fuel has been applied for decades in some member states and is commercially available today. Research continues on technologies to separate and transmute actinides and long-lived fission products in reprocessed high level wastes. The collective opinion of waste management experts is that high-level wastes and unwanted spent fuel can be safely isolated in certain types of deep geologic repositories.

However, in order not to foreclose options, a number of member states now plan to dispose of waste in a manner that is reversible, so that the waste can be retrieved in the event of a future decision to do so. In my view, however, only when final high-level waste repositories are built will the public start to perceive that the waste issue has been resolved.

Economic Performance and Competitiveness

Profound changes in the global electricity sector — brought about by liberalisation, privatisation and increased competition — have placed an unprecedented premium on cost-effectiveness. Information exchange and peer review services such as those provided by the IAEA and the World Association of Nuclear Operators (WANO) have made important contributions to improving the performance of many nuclear plants. It is essential, however, that the new-found emphasis on efficiency and profitability not be allowed to overshadow safety. Indeed, cutting corners will raise the likelihood of mistakes in an industry in which public opinion is quick to judge and slow to forget.

The second point I would like to make with regard to profitability is that investment in research and development (R&D) is an important key to the future of nuclear power. Only through higher levels of investment in R&D can we realistically expect to achieve greater efficiency, more public

confidence in safety and non-proliferation, and new horizons in the global market for nuclear energy.

Scientific and technical research must focus not only on how to improve nuclear fuel cycle technology but also on how to develop new designs of varying sizes of reactors, with higher efficiency and greater availability, shorter construction times, and lower capital costs. Applying these gains commercially will imply a conceptual shift from the idea of constructing plants to that of manufacturing them and their related components. It also implies a need for safety features consonant with new developments and multiple applications. Later in 1999, an IAEA group of experts is scheduled to investigate ways of further supporting international R&D for innovative nuclear fuel cycles and power plants that are also more proliferation resistant.

The IAEA is presently assisting South Africa in carrying out a feasibility study and a safety review of a new design for a 100 MWe pebble bed modular reactor. The design has attractive features such as its modular character, inherent safety and potential for low generating costs. Should the feasibility study and safety review confirm the potential of the design features, and should a pilot plant be successfully demonstrated, the new design could have a significant impact on nuclear power in general, and may be particularly attractive to developing countries.

I should stress that the choice of nuclear power and of a particular energy mix is a national decision that can be made only in the light of national priorities and considerations. And yet, for states considering the nuclear power option, there is a clear need to have the most accurate information and the best tools to make informed energy supply decisions.

Since 1992, in co-operation with eight other international organisations, the IAEA has pursued an intensive programme of helping member states to develop their own capacity for decision-making in the energy sector in general and in the electricity sector in particular. Through a number of sophisticated databases and methodologies (such as the DECADES[5] programme, WASP[6] software, and FINPLAN[7]), states can conduct their own objective comparative evaluations of available energy options, taking into account environmental, economic and risk factors throughout the fuel cycle.

Over 90 countries are presently using some of these tools, many under the aegis of two major IAEA co-ordinated research projects. Several international organisations such as the World Bank and the European Bank for Reconstruction and Development also utilise data from these programmes when considering loans in the power-generation sector.

If we are to take seriously the threat of global climate change, then the full costs of different energy options, including their environmental impacts such as emissions of greenhouse gases and other pollutants, must be factored into comparative assessments. The IAEA is contributing to the work of the Intergovernmental Panel on Climate Change and is working together with the UN and other organisations to prepare for a world energy assessment by the UN Commission on Sustainable Development in 2001. Our objective is to ensure that nuclear power is given a full and fair hearing.

The IAEA is also analysing the implications for nuclear power of the various mechanisms envisaged in the Kyoto Protocol. Of particular interest is the Clean Development Mechanism (CDM) which aims to create a means of transferring the credit for reducing emissions from projects in developing countries to the sponsors of those projects among the industrialised countries, the so-called Annex 1 States. The IAEA secretariat is conducting a preliminary analysis of the implications of the CDM for the prospects for nuclear power. Among the scenarios being considered are two Chinese case studies on the application of CDM to the construction of nuclear power plants instead of coal fired plants of similar capacity.

Public Confidence

Finally, a few words on the importance of public support, which together with safety and competitiveness, represents one of the three legs of the tripod on which the future of nuclear power stands. The public's understanding of the contribution of nuclear science and technology to human well-being has proven to be a powerful control lever on the fate and fortunes of nuclear power.

Let me begin with some questions that illustrate the nature of the challenge. Why is it that the public is suspicious of nuclear power plants but has no qualms about taking a transatlantic flight, where a single crossing exposes passengers to more radiation than one year's residence next to a nuclear plant? Why is it front page news even when a safety system works at a nuclear power plant, whereas other industries get such coverage only in cases of major system failure? Why is radiation perceived as more harmful than atmospheric and other pollution?

Clearly, the answer to these questions is that there is a great deal of public misunderstanding and lack of knowledge about radiation and nuclear power plants. This is not entirely surprising — nuclear science and technology are complex subjects. Nonetheless, complexity can no longer justify such widespread misperception. Public understanding is a prerequisite for public acceptance. And public acceptance is the key that will allow nuclear power to realise what informed observers see as its considerable potential. The role of the industry and nuclear societies in promoting public understanding cannot be overemphasised. Key in this process is openness and transparency.

The IAEA has a modest public information budget, but the quality, relevance and objectivity of our publications is widely appreciated. Our internet homepage (www.iaea.org) now receives over one million hits per month, and we have expanded our public information seminar programme in different parts of the world. In June 1999, I approved a new public information and outreach policy which is intended to enhance the IAEA's interaction with the media, civil society and opinion leaders. This policy also aims to improve the quality and timeliness of information on all aspects of the our work. Part of this effort will focus on establishing dialogue with private industry groups and other non-traditional partners such as nuclear research centres, bearing in mind the IAEA's intergovernmental and non-commercial character.
Even the most effective IAEA information programme, however, can yield only limited benefit in generating a more balanced public view of nuclear

power. If there is to be a political climate conducive to rational energy decisions in the next century, it is the nuclear industry itself, along with those who recognise its importance, which must carry the preponderant burden of public education as to the relative benefits of nuclear energy. Nothing is more important than reaching the political and intellectual elite, who are often little better informed on nuclear realities than is the general public. By way of example, let me call your attention to a cover article entitled "Nuclear Green" in a recent issue of the British magazine *Prospect*. Written by the US representative at the IAEA, this article is a forceful exposition of the advantages and limited risks of nuclear power. Unfortunately, Ambassador John Ritch's article is also noteworthy for the rarity of this kind of exposition. With so much at stake, the energy debate urgently needs many more such interventions in the public debate.

While on the subject of public confidence, I should also add that public attitudes towards nuclear energy are often influenced by apprehension about the possible misuse of peaceful nuclear activities — both equipment and knowledge — for military purposes. The attempts by Iraq in this regard were clearly not reassuring. The IAEA's current efforts to strengthen its verification system — so as to cover declared activities and to detect possible undeclared activities — should go some way to providing assurances to the international community about states that are subject to the non-proliferation regime. But we need to continue to work towards the universality of that regime, towards nuclear disarmament and towards a better system of collective security. These are the best disincentives against using nuclear energy for weapon purposes.

In the coming months the IAEA's outreach activities will include a meeting with various industry groups, research institutes and civil groups in the arms control and disarmament communities (the meeting with industry will take place in Vienna during the period 25–26 January 2000). Last year we initiated a scientific forum at the time of our annual General Conference in September for the discussion of scientific and technical issues with a broad range of participants. In 1999 the topic is "Sustainable Development: A Role for Nuclear Power?". I look forward to participation from members of the Uranium Institute.

Year 2000 Computer Systems Problem

Before concluding I would like to comment on the Y2K computer systems problem. Successfully managing the Y2K transition would be an important demonstration of the safety of the nuclear industry. It would send a reassuring signal worldwide. For the past two years, the IAEA has been heavily involved in assisting its member states to address the Y2K issue in respect of nuclear facilities as well as medical facilities that use radioactive materials. This effort has included developing and publishing guidance documents, organising workshops for the exchange of information and experience, and conducting preparatory and review missions to nuclear power plants at the request of member states.

As far as nuclear power plants and research reactors are concerned, member states have reported that they have all established Y2K readiness programmes; the actions needed to demonstrate Y2K compliance, including

assessment, testing, validation and solutions, will be completed by the end of September. The remaining part of the year will be devoted to contingency planning.

Conclusion

Three decades ago, nuclear energy was hailed as the energy of the future. Today, in parts of the world, its future is in doubt, and accurate long-term forecasts are now difficult to make. But it is obvious that the world would not be well served if an important energy source were to be foreclosed prematurely or unnecessarily. It is now self-evident that safety, competitiveness and public confidence — the three issues I have addressed in this presentation — will prove to be the global pivots on which the future of nuclear power lies.

A strong and effective global safety regime (which includes waste management), well-focused programmes aimed at more competitive nuclear technology, and a culture of communication and transparency must all be seen and acted upon as priorities. Successfully pursuing these priorities is a prerequisite for the long-term viability of nuclear power.

FOOTNOTES

1. Better production figures, fewer unplanned outages and increased average annual availability, which grew from 70% in 1989 to 78% in 1996.
2. The UN Population Division projects that world population will increase from 6 billion in 1999 to between 7.9 and 11.9 billion by 2050.
3. According to projections by the World Energy Council, even with substantial research support and subsidies, non-traditional, renewable resources will grow to no more than 3–6% of global energy supply by 2020.
4. In 1998, 36 nuclear power plants were under construction: 14 in Eastern Europe; 12 in the Far East; seven in the Middle East and South Asia; two in Latin America; one in Western Europe (France).
5. Database and Methodology for the Comparative Assessment of Different Energy Chains and Conversion Technology Options.
6. Wien Automatic System Planning.
7. Financial Planning.