Trends in Nuclear Power

Nuclear energy development

At the end of 2001, 360 nuclear power units were connected to the grid in OECD countries, generating approximately 24% of total electricity supply. Eleven units were under construction: one in the Czech Republic, four in Japan, four in Korea and two in the Slovak Republic. In the next decade, while total electricity generation in the OECD area is projected to increase steadily, the nuclear share is expected to decline, although less than previously anticipated due to plant lifetime extensions already authorised or being planned in several countries.

The impacts of "September 11" on nuclear power projects and programmes are difficult to predict. On the one hand this type of terrorist action enhances the relevance of policies aiming at energy independence and security of supply, while on the other hand it brings to the fore the issues of security of nuclear facilities and proliferation risks. Considerable work is being done in OECD countries to maximise security in this respect.

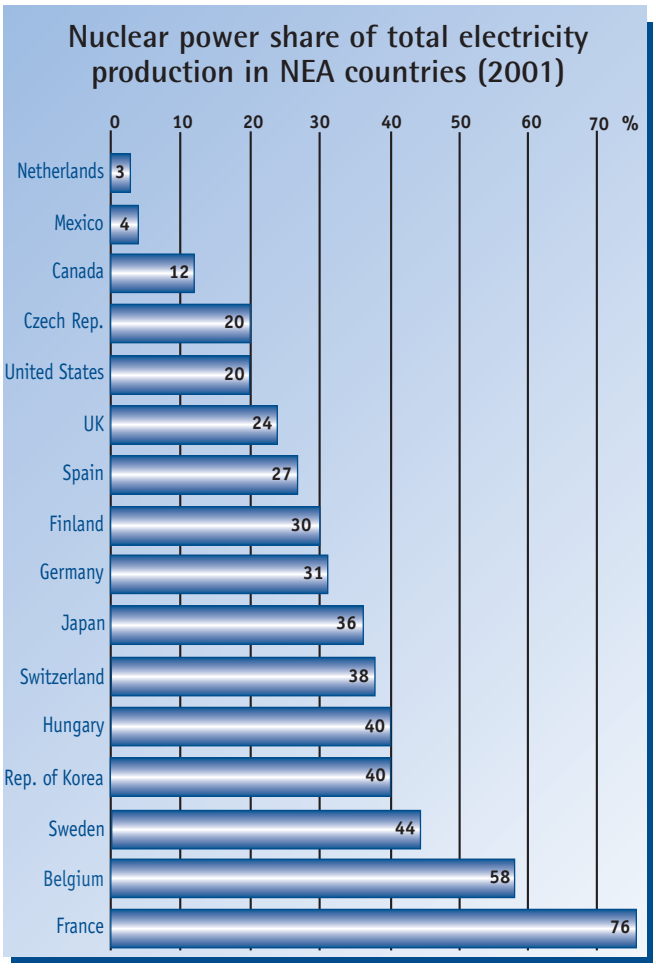
Several Member countries reviewed their energy policies recently. Reviews include the report of the AMPERE Commission in Belgium, the national energy review, within the framework of the National Climate Strategy, in Finland, the government's energy review supervised by the Cabinet's Performance and Innovation Unit (PIU) in the United Kingdom and the report by the National Energy Policy Development Group in the United States. In addition, the European Commission issued a Green Paper on security of energy supply.

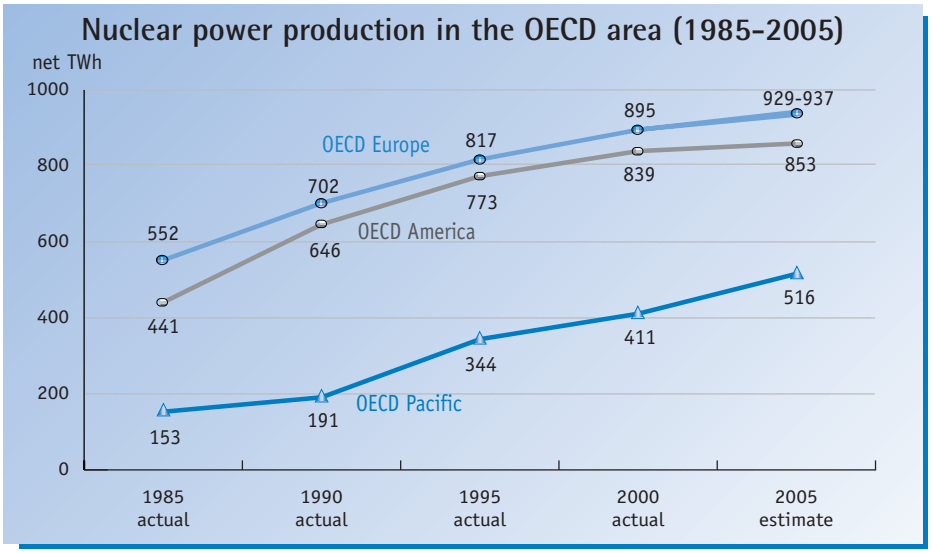
National and regional contexts and views differ on policy issues such as the importance of energy supply security, the need to alleviate or mitigate climate change and the role of various energy sources and technologies in this regard. However, recent reviews generally note the relevance of re-assessing the potential role of nuclear energy and have triggered renewed interest in the nuclear option. International projects on innovative reactor technology and advanced fuel cycles initiated in this context, such as the Generation IV International Forum (GIF) and the IAEA International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), have progressed steadily. GIF pursued its "roadmap" process, which is expected to lead by fall 2002 to the selection of the most promising reactor concepts and a multilateral R&D programme that would enable their development.

Trends towards electricity market deregulation were confirmed, inciting producers to emphasise economic efficiency and cost reduction in their business strategies. At the same time, electricity shortages and even the blackouts that occurred in California raised concerns in the public and highlighted the need for policy makers to ensure that market mechanisms do not jeopardise security of supply.

Existing nuclear power plants generally perform well in deregulated markets due to their low marginal costs and the effectiveness of technical and managerial measures taken by operators to increase the average availability factors of the plants and to reduce operating, maintenance and fuel costs. Nuclear power plant lifetime extension has proven to be a least-cost energy option in many countries and, accordingly, a number of operators requested and obtained license renewals.

Although nuclear energy already contributes to reducing greenhouse gas emissions, its future role in alleviating the risk of climate change will depend on national policies and international agreements. Nationally, several countries have recognised nuclear energy's positive contribution in this area and are looking to expand or maintain their generating capacity; others have renounced this option.





Internationally, nuclear energy can help meet the targets set out in the Kyoto Protocol. Decisions were nevertheless taken in 2001 by the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) to exclude nuclear energy from the Clean Development Mechanism and Joint Implementation. However, they are unlikely to have a significant effect on the development of nuclear projects in NEA Member countries, which are being undertaken based on a range of criteria.

Nuclear safety and regulation

Steady improvement in the operational safety performance of nuclear power plants in OECD countries continued in 2001, as reflected in many published performance indicators. An analysis of operating experience shows, however, that many events are recurring. Several events involving failures of electrical systems occurred during the year.

Analyses carried out during the year did not reveal any safety-related events which were directly associated with the introduction of competition in the electricity market. It is generally agreed, however, that continuing vigilance is required since competition-related experience to date is limited, and effective methods to detect early degradation of performance need to be developed further.

Regulatory bodies in OECD countries continue to be concerned with maintaining an adequate level of competence and research capability in the long run. In many countries, these bodies are examining their activities and seeking ways to increase their effectiveness and their contacts with stakeholders, including through the development of indicators of effectiveness.

Radiation protection

Change continues apace in the international radiation protection field. Even as the currently accepted international recommendations, established in 1990, are being adopted into international standards and national regulations, work to improve these recommendations has begun in earnest.

Experience with the 1990 general recommendations of the International Commission on Radiological Protection (ICRP) has led to the identification of certain discrepancies and points that require clarification, including the issue of natural radioactivity. In addition, new approaches to risk governance are emerging, including the need to clearly recognise the boundaries between the scientific aspects of risk assessment, the social aspects of risk evaluation and management, and the regulatory aspects of risk management. Such distinctions are essential in defining the roles and responsibilities of all stakeholders in decision-making processes. To address these challenges, the international radiation protection community has begun work, through the ICRP, to refine and improve its recommendations to better meet the needs of decision makers, regulators and practitioners.

Fifteen years after the Chernobyl accident, significant lessons have been learnt in the areas of emergency preparedness and the management of contaminated territories. National and international radiation protection policy has increasingly focused on improving emergency communications through various international conventions, bilateral agreements and technological initiatives. Stakeholder

Radiation protection measures
at the Chinon nuclear power plant, France.

Marc Morceau, EDF, France

issues and the need for flexibility have emerged as key aspects in addressing the needs of populations living in contaminated territories and developing new radiation protection recommendations as discussed above. Finally, it has been shown that contaminated soils have become environmentally stable, such that the further removal of radionuclides will progress primarily through natural decay. The 30-year half-life of caesium-137, one of the most radiologically significant remaining contaminants, means that policy makers will need to continue to address this situation for some time.

Radioactive waste management

Important steps were taken in the area of geologic disposal programmes for long-lived radioactive waste in 2001. In Finland, the government's "Decision in Principle" to evaluate a site for a deep geologic repository for spent fuel in the Olkiluoto municipality was ratified by the Finnish Parliament. Based on the comprehensive "SR-97" study on the experience of site-independent safety analyses, the Swedish national programme for geologic disposal moved a decisive step forward in the investigation of three possible candidate sites for a deep geologic repository. In the USA, the project for a geologic repository for spent fuel reached an important milestone, with key documentation being finalised for the site recommendation process, including an NEA/IAEA international peer review. (Since then, the Secretary of Energy formally recommended the Yucca Mountain Site in Nevada, and the US President, George W. Bush, approved this recommendation and transmitted it to Congress.)

Other programmes have undergone major reorganisation or legal changes. In Canada, a new bill for long-term management of nuclear fuel waste was introduced into the legislative process. It calls for nuclear utilities to form a waste management organisation that would report regularly to the Government of Canada. In France, nuclear regulatory reforms passed the Council of Ministers and will result in the reorganisation of the main regulatory agency, DSIN, and its research support institutions. In Italy, in the framework of the privatisation of the national utility ENEL, all of its nuclear liabilities and assets were separated into an industrial branch called SOGiN, and a new decree was issued, establishing plans and procedures for funding the decommissioning of nuclear facilities, including waste disposal. In Germany, a broad initiative to establish new general criteria for a final repository has gained momentum and is nearing its final report, which should become the basis for a public consensus initiative. While most major waste producing countries have policies not to import radioactive waste, the Russian Duma passed legislation which will allow the country to bring foreign waste into Russia.

Nuclear science

Growing interest in the next generation of nuclear reactors, exemplified by the Generation IV International Forum, has renewed the debate on the most promising future reactor systems and fuel cycle concepts. Analyses are being conducted of over 100 potential nuclear systems to determine which six or so designs merit the R&D necessary to develop these concepts for potential commercialisation, including the scientific research that has to be undertaken before any prototype can be constructed.

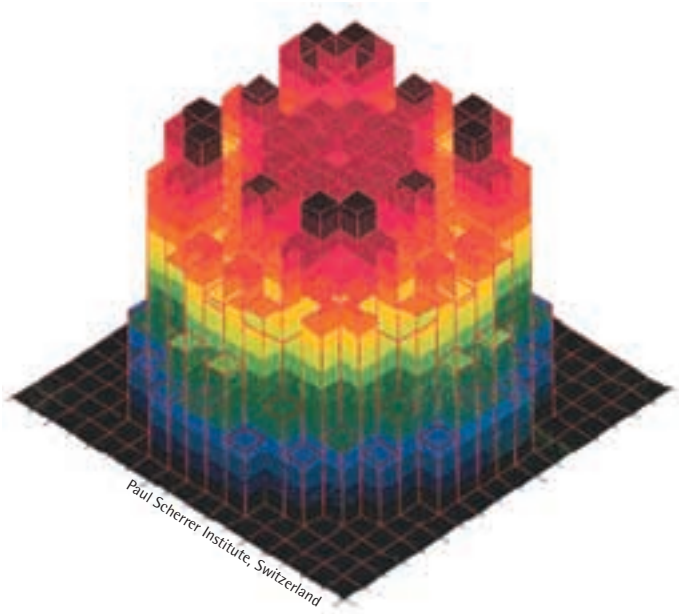
Important scientific issues for existing nuclear reactor systems concern fuel cycle and reactor stability applications. For the fuel cycle, emphasis is being placed on studying higher burn-up of fuels and the

Storage of vitrified high-level waste at the ONDRAF site in Belgium.

Administration de l'énergie, Belgium

use of both reactor-grade and weapons-grade plutonium in mixed-oxide fuels (MOX). Research related to reactor physics is focusing on advanced modelling of reactor stability problems, using computer programs that incorporate a full three-dimensional reactor core model into system transient codes in order to study the interaction between reactor core behaviour and plant dynamics.

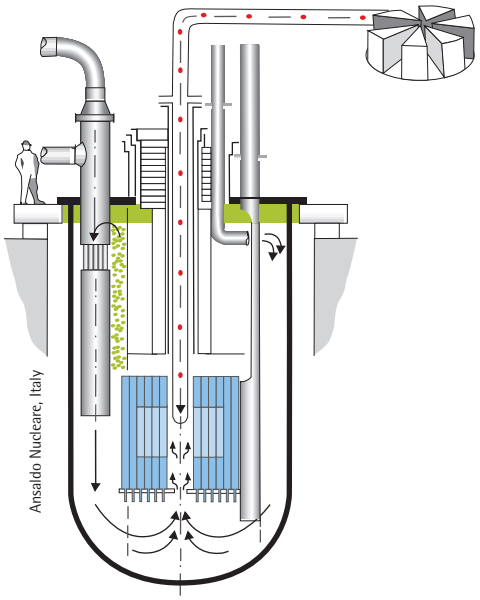
Power distribution modelling in an advanced reactor.



Nuclear data and software

The need for precise, experimental, neutron-induced and charged-particle-induced nuclear data remains very strong. The neutron-induced data are needed to improve predictions of different reactor parameters in existing reactors. This enables potential economies related, for example, to new fuel designs and higher burn-up to be made. These data are also needed in developing advanced reactor systems, such as actinide burner systems. The charged-particle-induced data are needed in many different applications, for example, in nuclear waste transmutation, medicine and astrophysics. The possibility to theoretically predict charged-particle nuclear data is also being pursued through the development of different statistical nuclear model codes.

The trend to use the statistical simulation method, mainly Monte Carlo methods, in many different nuclear applications persists. The continued increase in computing power makes it possible to better model more complex physical phenomena, such as radiation transport in materials. In addition, it is now possible to obtain good accuracy within reasonable computing times.



Schematic diagram of an accelerator-driven system (ADS). This type of system is often considered for burning actinides and/or long-lived fission products.

Nuclear law

The existence of sound national and international legal frameworks is essential to the safe use of nuclear energy worldwide. More particularly, modernising the international nuclear liability conventions and encouraging adherence to them will help ensure the equitable compensation of nuclear damage in the event of a nuclear incident, while at the same time facilitating international trade of nuclear materials and equipment. In response to efforts made by the international community in 1997 to reform the Vienna Convention on Civil Liability for Nuclear Damage and to establish a global Convention on Supplementary Compensation for Nuclear Damage, the Contracting Parties to the Paris and Brussels Supplementary Conventions advanced their negotiations on the revision of both Conventions, with a final meeting to approve the texts of both amending Protocols scheduled for early 2002. Approval will ensure that increased amounts of compensation will be available to a greater number of victims for a broader range of damages incurred, as well as compatibility with other international instruments in the nuclear liability field.

The strengthening of the institutional and legislative frameworks in the field of nuclear energy in the countries of Central and Eastern Europe and the New Independent States is still taking place. Countries from these regions are continuing their efforts to adhere to the international nuclear liability conventions and to adopt or modify their national legislation accordingly.

Growing concerns in OECD Member countries over the need to maintain nuclear education and training have also been experienced in relation to nuclear law. The marked decrease in young qualified professionals familiar with the specialised area of nuclear law led to widespread support by Member countries for the establishment of the International School of Nuclear Law at the University of Montpellier 1, in co-operation with the NEA, to provide high-quality education in this discipline.