

- **Very high temperature reactor system (VHTR)**

The VHTR is a graphite-moderated, helium-cooled reactor with a once-through uranium fuel cycle. Also designed for hydrogen production and process heat application, this system's aim of operating above 1000°C presents significant challenges in terms of fuel and materials development, as well as safety under transient conditions.

As detailed in its charter and subsequent policy statements, the GIF is led by a policy group. The policy group is

responsible for the overall framework, policy formation and interactions with third parties. An expert group advises the policy group on R&D strategy, priorities and methodology and evaluates the research plans for each of the Generation IV systems. The GIF policy group meets two to three times a year to review past activities, provide guidance to the expert group and systems steering committees (one per system under development), and determine the programme's future direction. The GIF policy group is currently chaired by the United States, with vice-chairs from France and Japan.

At its January 2005 meeting, the GIF policy group confirmed arrangements under which the OECD Nuclear Energy Agency will provide Technical Secretariat support to the GIF, including the funding of this activity by GIF members through voluntary contributions. The NEA is able to offer long-standing experience with international working groups, neutrality, long-term continuity and a comprehensive approach to both the organisation and substance of the GIF R&D activities. ■

More information about the GIF is available at www.gen4.org.

Nuclear power for the 21st century

An international conference on Nuclear Power for the 21st Century was held in Paris on 21-22 March 2005. Organised by the International Atomic Energy Agency (IAEA) in cooperation with the OECD and the NEA, the conference was hosted by the French government. The aim of the conference was to analyse the potential contribution of nuclear energy to meeting the world's energy needs in an economic manner, while respecting social and environmental concerns. The conference was attended by ministers, high-ranking officials and experts from 74 countries and 10 international organisations.

The conference¹ on Nuclear Power for the 21st Century came at a very important time, with the twin demands of ensuring the security of energy supply and meeting the challenge of climate change pressing on all governments. It is in this context that a number of NEA member countries have been re-examining the potential role of nuclear energy in their national energy mix.

What emerged from the two days of ministerial interventions and roundtables with invited experts was a widely

held opinion that nuclear energy can, under the right conditions, be part of a response to the challenge of meeting expanding energy demand, and ensuring the security of energy supply while addressing climate change. But nuclear energy is not necessarily a solution for everyone, and some countries have made clear, including through nuclear phase-out policies, that nuclear is not their preferred option. In his keynote address to the opening session, Mohamed ElBaradei, IAEA Director-General acknowledged "...each

country and region faces a different set of variables when choosing its energy strategy, and energy decisions cannot be made on a 'one-size-fits-all' basis." Patrick Devedjian, French Minister Delegate for Industry highlighted, *inter alia*, the multifaceted nature of energy policy, which requires consideration of a number of factors including economic, social and environmental concerns.

Climate change

OECD Secretary-General Donald Johnston highlighted, as did many of the ministers

and participants in the roundtables, the likely consequences of climate change. "Climate change must be addressed quickly, seriously and objectively by the developed and the developing world," he told delegates. He also warned that the energy industry must be transformed worldwide. From transportation to electricity generation, major changes must take place, not only to attempt to stabilise the greenhouse effect, but also to adapt to the dwindling supplies of oil and gas in the longer term.

The climate change prognosis delivered by James Lovelock was even starker, "...I consider that the earth has now reached a state profoundly dangerous to all of us and to our civilisation." He went on to outline how climate scientists are sure that when carbon dioxide levels in the air rise to about 400 to 500 parts per million, the earth crosses a threshold beyond which global warming becomes irreversible. "We are now at 380 parts per million and at the present rate of increase, it could reach 400 parts per million in a shorter time than seven years," he warned.

What can be done? Nearly all conference speakers emphasized that all forms of energy generation need to be pursued, and that nuclear energy is not in competition with renewable sources of energy. As Mohamed ElBaradei remarked at the press conference on the first day "...we need all the energy sources that we can put our hands on – whether it's oil or gas or nuclear or renewables."

In a round table chaired by the NEA Director-General Luis Echávarri on world energy needs, International Energy Agency (IEA) Executive Director Claude Mandil told delegates that "there is no one single solution" to the world's energy problems. He outlined how more vigorous policies would significantly curb the

rate of increase in energy demand and emissions, but pointed out that a truly sustainable energy system would need faster technology development and deployment than is currently the case. He said that nuclear energy could play an important role in the global energy mix, while stressing that industry and governments will have to make this happen. This was a point that some later speakers also raised, particularly AREVA Executive Chair Anne Lauvergeon, who further noted that nuclear energy has been excluded from the present clean development mechanism (CDM) of the Kyoto Protocol. Under the CDM, countries can claim "emission credits" for financing emission-reduction projects in another country through the supply of clean energy technology. In his closing statement to the conference, Minister Devedjian explicitly called for nuclear and hydroelectric energy to be included in these mechanisms.

Security of supply

Another often cited reason for including nuclear power in the national energy mix was to maintain a stable energy supply, a point made during the Japanese, Czech and Hungarian ministerial statements. Nuclear energy may practically be considered as a domestic source of energy to the extent that uranium resources are widely distributed around the world and nuclear fuel can be easily and cheaply stored. Significant resources exist in Australia, North America, Africa and Central Asia. This distribution provides both security and diversity of supply. Dana Drabova, Chair of the Czech State Office for Nuclear Safety considered that it is "...the state's responsibility for creating conditions for reliable and permanently safe supplies of energy at acceptable prices and

for creating conditions for its safe and efficient use that will not threaten the environment and will comply with the principles of sustainable development."

Koichi Hirata, the Japanese Parliamentary Secretary for Economy, Trade and Industry emphasized that if the development of a fast breeder reactor cycle could be realised, "...Japan will be able to secure a semi-perpetual supply of energy." A comprehensive public evaluation of different energy scenarios from ten different perspectives, undertaken in 2004, led the Japanese government to conclude that the current policy of working towards a closed nuclear fuel cycle with reprocessing was the right choice. Other countries, notably France, have also chosen or are considering the reprocessing of their nuclear fuel in order to recover unused uranium and plutonium in the spent fuel elements and reduce the volume and radiotoxicity of material to be disposed of as high-level radioactive waste.

Radioactive waste management

A nuclear-specific challenge is radioactive waste management (RWM). Although acceptable solutions have largely been found and implemented for low-level and short-lived, intermediate-level waste, considerable progress still needs to be made regarding the disposal of long-lived, intermediate-level and high-level radioactive waste. In his statement read to the conference, John Efford, the Canadian Minister of Natural Resources noted that in accordance with Canada's Nuclear Fuel Waste Act, the Nuclear Waste Management Organisation is developing through public dialogue and consultations long-term options to be considered by

the government at the end of 2005. By making progress on this issue, it demonstrated that nuclear energy is compatible with sustainable development, said Efford. Christian Bataille, member of the Parliamentary Office for the Evaluation of Scientific and Technological Options, notably in charge of the radioactive waste management assessment mission, outlined the current plans in France, as proposed under the 1991 law that bears his name. On the scientific front these include: the introduction of advanced reprocessing and transmutation on an industrial scale by 2040; reversible geological storage of long-lived, high-level radioactive waste in underground repositories currently being researched; and the development of long-term storage solutions that could last between 100 and 300 years. On the policy front, Mr. Bataille emphasized three essential areas: continuing the dialogue with parliament and civil society on the RWM issue; the national responsibility for continuing to fund RWM research; and expanding the role of the national agency ANDRA to include long-term storage. A number of speakers underlined how closely the American and Finnish RWM projects at Yucca Mountain in Nevada and at Olkiluoto are being followed for the policy lessons that they might provide.

Economics

The economic position of nuclear energy seems to be growing stronger, and is being cited as such in an increasing number of sources. In his statement read to the conference, U.S. Secretary of Energy Samuel Bodman cited a new University of Chicago study that found that nuclear energy can become cost-competitive in liberalised markets with

electricity produced by coal and natural gas once the additional costs associated with building the first plants have been absorbed.

Being capital-intensive to develop and to build, nuclear power plant projects are increasingly the provenance of joint ventures. The advanced technologies being developed over the long term under the aegis of the Generation IV International Forum (GIF) were widely cited as examples of the sort of international co-operation necessary to bring these systems to market in a timely and cost-effective manner. Other means proposed to improve the economic prospects of nuclear energy included the further international harmonisation of safety criteria and the increasing use of regional initiatives, whereby nuclear power plants would provide electricity to several countries. Shunsuke Kondo, the Chairman of the Japan Atomic Energy Commission, suggested that the capital cost of new plants could be reduced by shortening their licensing and construction time through the use of standardised designs, sharing one-time engineering and licensing costs, developing modular cost-effective construction technologies, and developing associated planning and information management tools that reduce the labour intensity of these projects.

Governance

“Governance” was characterised by Antonio Carlos de Oliveira Barroso from the Brazilian National Nuclear Energy Commission as “...who has influence, who decides and how decision makers are held accountable.” There was widespread agreement amongst conference speakers that the governance of the nuclear industry is something of a special case. According to

Dominique Maillard, the French Director-General of Energy and Raw Materials, “...the particular features of nuclear energy mean that, more than any other form of energy, nuclear energy needs frameworks for use, which the government alone can establish and provide.” The particular features that he identified were the need to manage long-term economic interests, risk elements (including safety), non-proliferation issues and relations with civil society. His sentiments on governance were largely shared in the ministerial statements from Canada, Korea and Russia.

European Parliament Vice-President Alejo Vidal-Quadras Rocca saw the need for a European legislative framework for nuclear safety and radioactive waste management, using the EURATOM treaty as its legal basis. He emphasized that the aim was not to supplant either the competencies of member states or interfere with the existing international co-operation instruments established by the IAEA and others. In his ministerial intervention, Italian Minister Antonio Marzano stated that “...a single [European] nuclear market could also be advocated, which might be characterised by harmonised technical safety standards, shared criteria for physical safeguards and enhanced co-operation on nuclear waste and decommissioning.” This approach, should it be agreed by other European member countries, would benefit from economies of scale and existing institutions and eventually lead to a more coherent European nuclear policy and long-term strategy regarding our energy future.”

It is also worth noting the particular case of developing countries that are seeking to introduce nuclear in their energy mix. In order to be able to bring these plans to fruition,

international co-operation and transfer of nuclear knowledge will be necessary. These countries were widely represented at the conference and made requests to this effect.

Closing remark

Whilst the issues discussed over the two days will already

be familiar to regular readers of *NEA News*, the level of participation at the conference – in terms of both the number of countries that participated and the senior level of representation of nearly all the delegations present – is unique, and augers well for continued international dialogue on the risks and benefits of nuclear energy. ■

Note

1. Presentations given at the conference are available online at www.parisnuclear2005.org.

This news brief was prepared by Andrew Macintyre, NEA Central Secretariat.

Projected costs of generating electricity

The NEA and the International Energy Agency (IEA) have recently published their sixth report in a series of studies on projected costs of electricity generation. This latest study was conducted by a group of experts from nineteen member countries and two international organisations, the International Atomic Energy Agency (IAEA) and the European Commission (EC). The latter provided input data from three non-OECD countries. The overall objective of the study was to provide reliable information on key factors affecting the economics of electricity generation using a range of technologies. The report can serve as a resource for policy makers and industry professionals seeking to better understand generation costs of these technologies.

The report presents and analyses projected costs of generating electricity calculated with input data provided by participating experts and generic assumptions adopted by the group of experts. The

levelised lifetime cost methodology was applied by the joint IEA/NEA Secretariat to estimate generation costs for more than a hundred plants relying on various fuels and technologies, including coal-fired, gas-fired, nuclear, hydro, solar and wind power plants; cost estimates are also provided for combined heat and power plants using coal, gas and combustible renewables. The plants included in the study rely on technologies available today and considered by participating countries as candidates for commissioning by 2010-2015 or earlier. Generic assumptions for the main technical and economic parameters included an economic lifetime of 40 years for most plants, an average load factor for base-load plants of 85% and discount rates of 5% and 10%. The appendices to the report address a number of issues such as generation technology, methodology to incorporate risks in cost estimates, impacts of integrating wind power into electricity grids and effect of carbon emission trading on generation costs.

Electricity generation costs calculated are bus bar costs, at the station, and do not include transmission and distribution costs. The costs associated with residual emissions – including greenhouse gases – are not included in the costs provided because they are not yet borne by electricity producers, and therefore, are not reflected in the generation costs calculated in the study.

The cost estimates do not substitute for detailed economic evaluations required by investors and utilities at the stage of project decision and implementation, which should be based on project-specific assumptions using a framework adapted to local conditions and a methodology adapted to the particular context of the investors and other stakeholders. Moreover, the reform of electricity markets has changed decision making in the power sector and led investors to take into account the financial risks associated with alternative options as well as their economic performance. In view of the risks they are facing in