Nuclear Energy in the 21st Century

Addressing Energy Needs and Environmental Challenges

Proceedings of an International Ministerial Conference
Beijing, 20–22 April 2009

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NUCLEAR ENERGY IN THE 21st CENTURY: ADDRESSING ENERGY NEEDS AND ENVIRONMENTAL CHALLENGES

PROCEEDINGS SERIES

NUCLEAR ENERGY IN THE 21st CENTURY: ADDRESSING ENERGY NEEDS AND ENVIRONMENTAL CHALLENGES

SUMMARY OF AN INTERNATIONAL MINISTERIAL CONFERENCE
ORGANIZED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY
AND CO-SPONSORED BY THE OECD NUCLEAR ENERGY AGENCY
AND THE CHINA NUCLEAR ENERGY ASSOCIATION,
HOSTED BY THE GOVERNMENT OF CHINA
THROUGH THE CHINA ATOMIC ENERGY AUTHORITY
AND HELD IN BEIJING, 20–22 APRIL 2009

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2009

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Sales and Promotion, Publishing Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
fax: +43 1 2600 29302
tel.: +43 1 2600 22417
email: sales.publications@iaea.org
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FOREWORD

The International Ministerial Conference on Nuclear Energy in the 21st Century was organized by the IAEA and co-sponsored by the OECD Nuclear Energy Agency and the China Nuclear Energy Association. The conference was hosted by the Government of China through the China Atomic Energy Authority and held in Beijing. A total of 16 ministers participated in the conference, and a further 13 ministers provided statements to be presented on their behalf.

The aim of this conference was to provide an opportunity to review the status and prospects of nuclear power, including progress in the evolution of technology, and to discuss the actions necessary to carry forward the positive momentum that nuclear power has experienced in recent years. The conference also offered a forum for many countries considering the potential benefits of introducing nuclear power into their national energy mix to further assess the viability of the nuclear power option.

These proceedings contain the conference summary and the presentations made during the opening ceremony, as well as the concluding statement by the President of the conference. This material, as well as all the ministerial and technical presentations from the conference, is included on the attached DVD. The IAEA officers responsible for this publication were M. Bermúdez-Samiei of the Office of External Relations and Policy Coordination and R.I. Facer of the Division of Nuclear Power.

EDITORIAL NOTE

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CONFERENCE SUMMARY

INTRODUCTION AND BACKGROUND

The aim of this conference was to provide an opportunity to review the status and prospects of nuclear power, including progress in the evolution of technology, and to discuss the actions necessary to carry forward the positive momentum that nuclear power has experienced in recent years. The conference also offered a forum for many countries considering the potential benefits of introducing nuclear power into their national energy mix to further assess the viability of the nuclear power option.

The conference was designed to allow participants to discuss developments and emerging issues relevant to the role of nuclear power in providing clear and sustainable energy for national and regional development. Energy supply security, the long term stability of costs, reliability and environmental impact, including climate change, play a major role in the energy planning of States. Nuclear power, as a proven technology with virtually no emissions of greenhouse gases or pollutants, is expected to play an increasing role in meeting the rapidly growing global requirements for electricity.

In addition to recognizing the benefits of nuclear energy, it is important to ensure the continued safe operation of the current fleet of nuclear power reactors. This is needed in order to address public and political concerns about the use of nuclear technology and as a prerequisite to nuclear power's making an increasing contribution to world energy supplies throughout the 21st century and beyond. Furthermore, to ensure acceptable levels of protection, the global application of safety standards and appropriate security measures is required. Effective control measures are necessary to ensure that non-proliferation commitments are honoured, and in some areas these may need to be strengthened. Handling nuclear waste safely and securely is technically achievable, but remains a public concern.

Note: The views and recommendations expressed here are those of the conference and the participants, and do not necessarily represent those of the IAEA.

OBJECTIVES

The broad strategic objectives of the conference were the following:

(a) To recognize the positive momentum towards nuclear power and to further raise the profile of nuclear energy;
(b) To provide a forum for discussions between high level participants from a large number of countries about the role of nuclear power in meeting energy demands in a sustainable manner;
(c) To discuss the different aspects of, and conditions for, the development of nuclear power in developing and developed countries;
(d) To discuss the interrelationship between nuclear energy, the use of resources and the environment.

ORGANIZATION OF THE CONFERENCE

The conference consisted of two major parts. The first comprised invited ministerial presentations on the current and future role of nuclear power in the context of national energy strategies. The second consisted of technical sessions involving renowned international experts, with discussions on the following topics:

(1) *Energy resources and the environment*. This technical session allowed for a discussion on climate change impacts, the potential role of nuclear power and options for sustainable energy mixes in different national circumstances. It included a discussion on energy, social, economic, environmental and development issues, as well as on the potential role of nuclear energy.
(2) *What technology is available now or is expected to be available in the near future, and what are the long term perspectives*? This session included discussions on current designs, the availability of manufacturing facilities, potential technical impediments to expansion programmes, improving safety levels in new designs, and the future availability and potential role of different reactor designs. The last of these also included a discussion on the use of nuclear energy for non-electricity-producing applications such as desalination and process heat. The discussion addressed safety, security and safeguards requirements associated with the increasing use of nuclear energy, including technological and institutional issues and solutions.

(3) *Infrastructure development and safety and legal issues.* This technical session provided an opportunity to discuss the range of infrastructure challenges facing countries considering introducing nuclear power, and the options available to meet these challenges. Considerations of the implications of infrastructure development for achieving safety and regulatory objectives were also discussed, as were the legal issues associated with preparing for a nuclear energy programme.

(4) *Reliable fuel supply, spent fuel, waste management and strengthening of non-proliferation.* This session included discussions on the security of energy supply in general, addressing current and future trends in the availability of nuclear fuel, including the security of nuclear fuel supply. This topic allowed for discussions on options to reduce the spread of spent fuel and on waste storage facilities. The role of national and international organizations and of industry in supporting nuclear energy development was also discussed.

All the above issues were presented by internationally recognized experts and were followed by panel discussions with and among the participants.

Opening speeches were given by the Vice Premier of the State Council of China, Mr. Zhang Dejiang; the Director General of the IAEA, Mr. Mohamed ElBaradei; the Secretary-General of the OECD, Mr. Angel Gurría; and the Chairman of the China Atomic Energy Authority, Mr. Chen Qiufa, on behalf of the President of the conference, Mr. Li Yizhong, Minister of Industry and Information Technology of China.

CONFERENCE OVERVIEW

The conference was attended by ministers, high ranking officials and experts from 61 IAEA Member States and 7 international organizations, with a total of 808 participants and observers. Presentations were made personally by 16 ministers on their vision of the future of nuclear power. In addition, 13 presentations were made on behalf of ministers. The participation of about 150 press and media representatives and broad media coverage were further indications of the wide interest in the future of nuclear power.

The potentially significant role of nuclear energy in meeting the energy needs of the planet was recognized both in many of the views presented and during the technical sessions, in particular that:

— Developments in technology and improvements in management have resulted in better safety for currently operating plants, and the economics of nuclear power have made it increasingly attractive and fully competitive.
— Nuclear power can contribute to meeting the environmental challenges facing the planet.
— Many countries throughout the world are facing growing pressure to increase their access to high quality energy, and nuclear is seen by many as a potential solution.

Many countries and speakers commended the IAEA for the guidance and assistance being provided to help them in commencing, or expanding, nuclear power programmes. Ministers emphasized the importance of achieving the highest nuclear safety levels and the highest level of security of nuclear material and facilities, of conforming to international non-proliferation objectives, and of managing spent fuel and radioactive waste.

China, as the host government, had consultations with a number of Member States, and the concluding statement by the President of the conference reflected a broad convergence of views among the participants. In his concluding remarks, the President of the conference stated that,

> "While respecting the right of each State to define its national energy policy in accordance with its international obligations, the vast majority of participants affirmed that *nuclear energy, as a proven, clean, safe, competitive technology, will make an increasing contribution to the sustainable development of humankind throughout the 21st century and beyond.* It was widely recognized that:
> — Nuclear power contributes to global energy security while addressing climate change and avoiding air pollution.
> — Nuclear power is a baseload source of electricity that can make a major contribution to meeting energy needs in a sustainable manner in the 21st century.
> — Nuclear energy can make a valuable contribution to worldwide socioeconomic development."

It was also recognized in the concluding statement that:

(a) International non-proliferation efforts should be strengthened.
(b) International cooperation and communication on nuclear safety and security should be strengthened.

(c) Consideration should be given to measures that will help to ensure reliable access to nuclear fuel supply while maintaining normal operation of the international nuclear fuel market.
(d) The safe management of spent fuel and disposal of radioactive waste is of great importance for the sustainable development of nuclear power.
(e) Nuclear energy should have an important role to play in post-Kyoto flexibility mechanisms.
(f) The IAEA plays an essential role in assisting States in developing the use of nuclear energy for peaceful purposes.

ORGANIZATION OF THE PUBLICATION

This publication is presented in three major sections relating to:

(1) An initial summary of the ministerial speeches and technical presentations, and transcripts of the discussions that followed the technical sessions;
(2) The speeches from the Opening Session of the conference, by the Vice Premier of the State Council of China, Mr. Zhang Dejiang; the Director General of the IAEA, Mr. Mohamed ElBaradei; the Secretary-General of the OECD, Mr. Angel Gurría; and the Chairman of the China Atomic Energy Authority, Mr. Chen Qiufa, on behalf of the President of the conference, Mr. Li Yizhong, Minister of Industry and Information Technology of China;
(3) The concluding statement by the President of the conference, Mr. Li Yizhong, Minister of Industry and Information Technology of China.

In addition, a DVD containing all the material described above, as well as the ministerial speeches and the presentations given during the technical sessions, is included in the publication.

Each presentation is available as a file in the original spoken language, and, where available, in the English translation of the presentation.

SUMMARY OF THE OPENING SESSION

Mr. Chen Qiufa opened the conference by stating that he had been asked by the President of the conference, Mr. Li Yizhong, Minister of Industry and Information Technology, China, to welcome all distinguished guests, leaders, experts and media participants to the conference and to act as the Chairperson of the opening ceremony.

Mr. Chen invited His Excellency Mr. Zhang Dejiang, Vice Premier of China, to provide a welcoming address.

Mr. Zhang Dejiang greeted the Director General of the IAEA, Mr. ElBaradei, and the Secretary-General of the OECD, Mr. Gurría, and welcomed all participants. Mr. Zhang recognized that it is a common task of the international community to develop and utilize clean and renewable energy sources and to properly address the growing contradiction between economic development, energy development and environmental protection. He referred to more and more countries placing importance on nuclear energy.

Mr. Zhang discussed China's long history of nuclear energy development, but suggested that China's nuclear energy utilization is rather insufficient. He described the plans for increasing new nuclear power projects. He described China's advocacy of the complete prohibition and thorough destruction of nuclear weapons, and reaffirmed China's cooperation in all international non-proliferation activities. He expressed China's appreciation for the work of the IAEA in this regard.

Mr. Zhang referred to the cooperation between China and the IAEA in several areas and expressed a wish to enhance and expand this cooperation.

Mr. Chen invited Mr. Mohamed ElBaradei, Director General of the IAEA, to address the conference.

Mr. Mohamed ElBaradei discussed the current state of the nuclear energy sector, provided an update on IAEA activities and shared some observations about the future of the IAEA. Mr. ElBaradei stated that, although 2008 saw no new power reactor come on-line, for the first year since 1955, construction started on 10 new reactors, the highest number since 1985. He indicated that, although nuclear power is not a panacea for the world's energy problems, it will continue to play an important role in the global energy mix. He referred to the needs of the 1.6 billion people without access to electricity and the 2.4 billion without access to modern energy systems, and to the fact that there is no development without access to energy. He related these concerns to the need for energy security and to current concerns about the vulnerability to disruption of energy supplies.

He noted that environmental concerns are also a driver towards nuclear power and renewables through potential financial benefit from avoiding

greenhouse gas emissions. He noted, too, that the economics of nuclear power have improved, as improvements in efficiency have produced improved economics and also improved safety.

Mr. ElBaradei noted that a strong focus on safety should be seen as an enabler of further development of nuclear power and that new ideas to address safety and security should be encouraged. He noted that countries that have mastered uranium enrichment or plutonium separation can be viewed as nuclear weapons capable States that could develop weapons if they walked out of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) or developed clandestine programmes. He referred to the establishment of multinational mechanisms to ensure access to nuclear fuel and reactor technology, as envisaged in the IAEA Statute.

Mr. ElBaradei noted that the number of requests for IAEA assistance with nuclear power projects has grown significantly and that the IAEA's advice has the advantage of being impartial and comprehensive. He explained that the IAEA has developed guidance for States considering nuclear energy and has developed a methodology that countries can use to perform a self-assessment, which can be supported by an Integrated Nuclear Infrastructure Review carried out by the IAEA. He stressed that the primary responsibility for all aspects of a nuclear programme rests with the countries concerned, and that suppliers of nuclear technology also have responsibilities and in particular a duty of care to the recipients. He noted the continuing public concern over the management of spent fuel and disposal of radioactive waste.

Mr. ElBaradei noted that the IAEA needs additional resources to implement its mandate, as well as sufficient legal authority, if it is to do its job properly. He identified two key recommendations from the Commission of Eminent Persons. The first is that global security standards should be made binding rather than voluntary, as at present, and the second is that the IAEA should lead an international effort to establish a global nuclear safety network, also based upon binding agreements.

He concluded by thanking the Government of China and the China Atomic Energy Authority for their generosity and support in hosting the conference.

Mr. Chen then invited Mr. Angel Gurría, Secretary-General of the OECD, to address the conference.

Mr. Gurría began by stressing the high significance of the OECD partnership with China and reflected that this was based on a mutual interest in developing global solutions to global challenges.

Mr. Gurría indicated that he would address three issues: security, financing and nuclear energy.

In relation to energy security and sustainability, Mr. Gurría noted that sustainable growth cannot be fully restored without access to energy and electricity, and that the development of low carbon or carbon-free energy sources is an essential prerequisite for the achievement of sustainable energy policies.

He noted that financing nuclear facilities is an issue, as the current generation of reactors is very capital intensive and takes a long time to build, which involves risks that investors may find difficult to accept. He indicated that the current financial crisis is adding to the challenge of financing the nuclear power industry, as well as wind and solar projects, and suggested that new means for financing these projects should be explored.

Mr. Gurría commented that the current global trends in the energy sector are unsustainable, as they prepare a dirty, insecure and expensive future. He added that it seems crucial to reconsider the role of nuclear energy and to drop its exclusion from the flexibility mechanisms of the Kyoto Protocol.

He suggested that, in order for nuclear power to provide clean energy in a safe and cost effective manner, it is necessary to increase public confidence that waste will be managed safely in the long term, and to ensure more political and regulatory stability and that governments have a major role to play in these areas.

Mr. Chen stated that the China Atomic Energy Authority is the organization responsible for China's nuclear industry development and that, as its Chairman, he wished to share his views on this. He noted that, as a proven, clean and safe source of energy, nuclear energy already plays an outstanding role in the economic and social development of humanity. Reflecting on China's more than 50 years of nuclear development, he identified six areas that should be prioritized to achieve sustainable and healthy development of nuclear energy for the benefit of society, namely, overall planning, strict regulation, consolidation of the foundation of knowledge and capability, putting in place effective controls for all activities, human resource development, and strengthening of international cooperation.

Mr. Chen explained how China is addressing each of these issues and stressed that this conference is seen as a significant contribution to many of the topics.

On behalf of Minister Li, Mr. Chen declared the conclusion of the opening ceremony.

Each of the presentations of the opening ceremony is included in this publication in full.

SUMMARY OF MINISTERIAL PRESENTATIONS

MONDAY, 20 APRIL 2009

Morning session

The full text of all the ministerial presentations is included on the DVD provided with this publication. The following is a brief summary of some of the key comments from the speeches.

H.E. Ms. Seiko Noda, Minister of State for Science and Technology Policy, Japan, noted the importance of nuclear energy as a measure against global warming. She stated that, in order to achieve a significant reduction of global greenhouse gas emissions while ensuring secure energy supply, expansion of the peaceful use of nuclear energy is essential, along with the maximum implementation of other effective measures such as energy conservation, energy efficiency improvement and the use of renewable energy. She indicated that this role of nuclear energy has been widely recognized throughout the world.

Ms. Noda commented that, in order to achieve this expansion, it is essential that nuclear non-proliferation, nuclear safety and nuclear security be ensured. Japan will try to encourage the development of an internationally accepted common perception that the peaceful use of nuclear energy is an essential measure against global warming. Japan will offer active cooperation to address the needs of those countries that try to develop the infrastructure for the peaceful use of nuclear energy.

Ms. Noda noted that Japan will play a key role in the promotion of the global expansion of the peaceful use of nuclear energy, through the activities of the IAEA.

Dr. Anil Kakodkar, Chairman, Atomic Energy Commission, India, made several key comments about the reasons for the growing interest in nuclear energy, and also the factors that have led to barriers to this growth. He noted that the appropriate technologies for countries differed according to their size and needs, and that safety, security and proliferation have become a constraining factor in the context of technology transfer.

Dr. Kakodkar also noted that India is developing technologies that would address the needs of many States and stands ready to share its experience with friendly countries. He mentioned that India's experience is more likely to be relevant and beneficial to developing countries than some other available options. He described India's technological development activities.

Dr. Kakodkar noted that it is necessary for the IAEA budget to place greater stress on technical cooperation, nuclear power, the fuel cycle and nuclear science. He indicated that the concerns related to safety, security and proliferation fears could, by creating a delay in the deployment of nuclear power, pose an even greater threat to humanity through the non-availability of energy resources, leading to barriers to development, and through the disasters that could come about as a result of climate change. He looked to the IAEA to consider these issues in a holistic way to find appropriate answers.

Mr. Qin Sun, Vice Minister, Chairman, China Nuclear Energy Association, provided background on the role of the CNEA. He referred to China's national nuclear development, from its beginnings to today's position of rapid development. China currently has 9 GW in operation, 25 GW under construction and a plan by which installed capacity will reach 40 GW by 2020, with a further 18 GW under construction. China has guiding principles to promote international cooperation, while relying mainly on independent efforts. To achieve this, the CNEA supports China's industries, institutes and academies engaged in the peaceful use of nuclear energy to establish international collaborative relationships focusing on human resource development and technical training to facilitate common development and advancement.

H.E. Dr. Hassan Younes, Minister of Electricity and Energy, Egypt, noted that Egypt has considered nuclear power for electricity and freshwater production for over 30 years. Recent developments have motivated Egypt to reconsider nuclear power; among them are the increasing demand for electricity, the lack of indigenous fossil fuels and the instability of their prices, the full utilization of hydropower resources, and the acceptance that nuclear energy is a technically sound and economically viable source of energy. Dr. Younes described several activities that have been undertaken in Egypt to facilitate the introduction of nuclear energy, and thanked the IAEA for its continuous technical support.

Dr. Younes indicated that Egypt is willing to cooperate and share its experience with countries in the region that are parties to the NPT.

H.E. Dr. Byong-man Ahn, Minister of Education, Science and Technology, Republic of Korea, referred to the Republic of Korea's development of nuclear energy from 1978 until today. The country ranks sixth in nuclear energy development. He stated that the Government of the Republic of Korea recognizes the importance of nuclear power technology in achieving its low carbon, green growth strategy. As part of this strategy, the Republic of Korea has committed to reducing national dependence on fossil fuels and to significantly increasing the share of nuclear and renewable

energies. Dr. Ahn referred to the development of the country's standard plant to use high efficiency nuclear fuel and to future plans for further development.

Dr. Ahn noted that the right to use nuclear power is bestowed only upon those that have earned international trust and transparency. To support this, the Republic of Korea hopes to share its experience and knowledge with countries that wish to cooperate with it, and will expand its scope of cooperation with the IAEA and its Member States.

Mr. Adiwarjoyo, on behalf of the Minister of Energy and Mineral Resources, Indonesia, noted that Indonesia is party to the NPT and commented that the inalienable right of every State party to the NPT to develop nuclear energy for peaceful purposes without discrimination should be fully respected by all States. He referred to legislation enacted by Indonesia and to international conventions to which Indonesia is party in order to establish the framework for nuclear energy in Indonesia. Mr. Adiwarjoyo indicated that Indonesia believes that nuclear power should be used not only for generating electricity, but also for other peaceful purposes such as hydrogen production, coal liquefaction, enhanced oil recovery and desalination.

Dr. A.M. Agapov, on behalf of the Minister and Director of the State Atomic Energy Corporation 'Rosatom', Russian Federation, described the Russian Federation's current and future commitment to the use of nuclear energy, as well as how, beyond 2020, the country expects to make a transition from light water reactors to fast breeder reactors with a closed nuclear fuel cycle. Dr. Agapov referred to the mandatory compliance with safety measures and the continuing efforts to improve several key factors. He indicated that an important element of developing the nuclear industry in the Russian Federation is participation in international projects for developing new technologies (e.g. INPRO, Gen IV, ITER) and strengthening the non-proliferation regime through establishing an international uranium enrichment centre in Angarsk. He noted that a national strategy for nuclear power development should be implemented in close cooperation with other countries.

H.E. Dr. Khaled Toukan, Chairman, Jordan Atomic Energy Commission, Jordan, informed the conference that, although the international perception is of an oil rich Middle East, Jordan is suffering under the burden of high oil prices, and 20 per cent of the national budget is spent to import energy. This places a major burden on Jordan. Renewables will be developed to their fullest extent but have their well known limitations. Dr. Toukan described the vision of utilizing nuclear energy to transform Jordan from a net energy importer into a net electricity exporter by 2030, with 30 per cent of national electricity needs met by nuclear power. He noted that Jordan has indigenous uranium resources which will be exploited.

Dr. Toukan urged the conference to call for the inclusion of nuclear energy in the clean development mechanism (CDM) in any future climate change negotiations. He noted that a common challenge is the development of the requisite human resources and described actions to address this. He mentioned that Jordan has concluded several bilateral nuclear cooperation agreements. In closing, Dr. Toukan called for the establishment of a nuclear-weapons-free zone in the region and full adherence to the NPT regionally, in order to achieve greater sharing of nuclear technology and expertise.

Ambassador G. Schulte, on behalf of Mr. S. Chu, Secretary of Energy, United States of America (USA), noted that US President Barack Obama has stated that it is time to consider a new framework for civil nuclear cooperation that allows all interested countries to enjoy the benefits of nuclear energy while limiting the associated risks of nuclear weapons proliferation. Ambassador Schulte noted the IAEA's development of a high level framework (Milestones document) that charts a safe, secure and safeguarded path to nuclear power, while recognizing that it is the responsibility of every State to assess its own needs, identify its own priorities and develop its own strategic objectives to meet this framework.

Ambassador Schulte stated that the USA is committed to working with the IAEA and others to establish a new international nuclear energy architecture, including an international nuclear fuel bank, international fuel cycle centres and reliable fuel supply assurances. He noted that, in the USA, nuclear energy must remain a significant component of the energy mix. He stated that there is an unprecedented level of interest in nuclear energy worldwide and that, if deployed with the highest possible standards of safety, security and non-proliferation, nuclear energy would play an essential role in combating climate change while advancing peace and promoting sustainable development worldwide.

Dr. Mohammed bin Ibrahim Al-Sawaiyel, Minister and President of King Abdulaziz City for Science and Technology, Saudi Arabia, noted that Saudi Arabia is one of many countries that have begun to seriously consider nuclear energy. He recognized the assistance from the IAEA that is available and indicated that the IAEA fully deserves international support in providing this guidance. He suggested that, in order to achieve the universality of the NPT, efforts should be made to extend nuclear-weapons-free zones across the globe, and particularly in the Middle East. He noted that the greater use of nuclear energy would make a significant contribution towards health and education worldwide.

Afternoon session

Mr. Mauri Pekkarinen, Minister of Economic Affairs, Finland, noted that, although most of Finland's energy must be imported, oil represents only 24 per cent of Finland's energy consumption. In order to meet European Union requirements, Finland needs to improve energy efficiency and technology, and in this context nuclear power will prove important. He described the current and ongoing nuclear programme and noted that further nuclear power is a future option. He stressed that the finance and initiatives must come from industry, as the Finnish State does not finance nuclear projects. He described the progress of the new nuclear plant and of an underground rock characterization facility that might be used as a final repository for spent nuclear fuel by 2020.

Arch. Yeafesh Osman, State Minister of Science and Information and Communication Technology, Bangladesh, stated that, to ensure sustainable development, energy security is the most important strategic issue for all in the 21st century. He noted that Asia is seeing a high growth rate in population and economic development, leading to a rapid increase in energy demand. He called for increased cooperation among Asian countries in their collective response to future energy demand and the expansion of nuclear power programmes. He noted the commitment to ensure access to electricity to the whole population of Bangladesh by 2021. Arch. Osman stated that, if used at the current rate, Bangladesh's existing natural gas reserves would be exhausted within a short time, which leads to the consideration that nuclear power is an inevitable option for Bangladesh. He described the work in place to prepare for a nuclear power plant and thanked the IAEA for its active support. He called for the IAEA to play a more proactive role in helping Member States in introducing nuclear power, and committed Bangladesh to help make this happen.

Mr. Mohammed Saeidi, on behalf of the Vice President of the Islamic Republic of Iran (Iran), presented some background on world energy and nuclear use. He related this to Iran and indicated that, despite the country's national oil reserves, there were difficulties in meeting all the demand for gas, and hence the use of gas for the expansion of power production was not possible. He noted that Iran has established a Development Vision document showing considerable growth in electricity demand, and that the national fossil resources cannot be considered an ideal resource for supplying energy security in the long term. Mr. Saeidi noted his Government's commitment to nuclear power and the intention to achieve peaceful nuclear technology capable of generating 20 GW. This would require the construction of nuclear power plants and the establishment of the nuclear fuel cycle in order to supply fuel for these plants. Iran has announced an international tender for the construction of two new nuclear plants and plans to start construction of 5 GW of capacity in the next five years.

Morning session

H.E. Ms. Natalya Shumkova, Deputy Minister of Fuel and Energy, Ukraine, described Ukraine's commitment to nuclear non-proliferation. She indicated that Ukraine currently generates about 50 per cent of its electricity from nuclear power plants and plans to retain this level until 2030, which will require the nuclear capacity to increase from 13.8 to 30 GW. She also noted that Ukraine has large uranium reserves, which will help to reduce the dependence on imported fuel, and that it will invest so that, by 2015, all the required uranium will be supplied from national deposits. She noted that Ukraine has decided to defer a decision on spent fuel and will establish a long term dry spent fuel store so that, in about 100 years, a decision can be taken on reprocessing or burial. Ms. Shumkova noted that, owing to the $46 billion scale of investment in new nuclear plants, Ukraine will look for global international cooperation. International cooperation will also include participation in the international centre for uranium enrichment at Angarsk. Ukraine looks to develop international partnerships in all areas of the nuclear industry.

H.E. Mr. Wannarat Channukul, Minister of Energy, Thailand, noted that Thailand is looking for new and promising alternative sources of energy to meet increasing demand and avoid the depletion of existing resources. In 2007, the nuclear energy option was approved and efforts to develop guidelines on the establishment of a nuclear power plant commenced. Mr. Channukul indicated that the target for the contribution of nuclear to the future energy supply is 2 GW in 2021. He noted the necessity of a long lead time to establish the necessary infrastructure and skills, and indicated that it is very important to develop close relationships with foreign entities with nuclear experience in order for Thai staff to obtain skills and experience. He referred to regional cooperation to achieve a more environmentally friendly energy alternative using nuclear energy.

Dr. F.E. Osaisai, on behalf of H.E. Dr. Alhassan Bako Zaku, Minister of Science and Technology, Nigeria, noted that energy usage is a major index of human development, and that Nigeria has a current installed electricity generation capacity of 6 GW, which for a population of 140 million people is grossly inadequate and will prevent the attainment of the Millenium Development Goals. He stated that Nigeria plans to extend its generating base up to 10 GW by 2010 and to diversify the generating base to include nuclear and other renewable sources such as solar and wind power. Dr. Osaisai reaffirmed Nigeria's commitment to the ideals of the IAEA in promoting the peaceful use of nuclear energy for sustainable development. Recognizing that

some 60 countries are considering introducing nuclear power, Nigeria hopes to be one of the few countries that is able to successfully introduce nuclear power by 2020. Dr. Osaisai indicated that Nigeria has developed a strategic plan that seeks to position the country to generate at least 1 GW within 10–12 years and 4 GW within 20 years.

Msgn Michael W. Banach, on behalf of H.E. Archbishop Dominique Mamberti, Secretary for the Holy See's Relations with States, stated that the Holy See has no intention of building a nuclear power plant. He added that nuclear technology presents not only risks but also great opportunities for humanity. Mr. Banach noted that a wise energy policy leads to the development of peoples, and that, while energy security and nuclear security require the adoption of appropriate technical and legal measures, these alone can never be the only response. Threats to security come from attitudes and actions hostile to human nature. Mr. Banach stated that, if, on the one hand, it is necessary to look without prejudice to the use of nuclear energy, then, on the other hand, it is also necessary to renew the commitment to a general and complete nuclear disarmament. He stressed that energy policies should be viewed from the perspective of the integral development of the human being.

Afternoon session

H.E. Mr. Angelo T. Reyes, Secretary, Department of Energy, Philippines, spoke from the perspective of a developing and non-oil-producing country. He indicated that his country's renewed interest in nuclear energy was primarily driven by concerns about energy security, the volatility of fossil fuel prices and rising carbon dioxide emissions. He stated that the Philippines wishes to meet energy needs locally and to diversify energy sources. Mr. Reyes noted that they are studying nuclear energy without bias against other energy sources. He also noted that nuclear is competitive with coal, and is cheaper than other power sources such as wind and solar, and that the country is aiming to reduce carbon dioxide emissions. He expressed concern over the final disposition of nuclear wastes, and challenged the developed economies to find a solution to the final disposition that will be acceptable to prospective users in particular.

Mr. Ansar Parvez, on behalf of the Minister, Chairman, Planning Commission of the Government of Pakistan, described the increasing energy needs of Pakistan. He noted that Pakistan has limited oil and gas reserves, and hence coal and nuclear power are projected to play a vital role in meeting the base load electricity generation requirements of the country. He stated that Pakistan plans to have a nuclear capacity of 8.8 GW by 2030, and that, in order to achieve this, it will have to increase the national contribution to future nuclear power projects. Mr. Parvez noted that Pakistan's nuclear programme is under

complete IAEA safeguards, and that Pakistan welcomes international cooperation for its nuclear power programme development. He indicated that nuclear plants can also be built and operated as joint ventures or on a build–own–operate basis in specified nuclear parks under the IAEA umbrella.

Mr. Moubarak Abdelkader El Mikki, on behalf Mr. M. Chakib Khelil, Minister of Energy and Mines, Algeria, noted that nuclear energy presents a credible alternative, not only for the country's electricity needs until 2030, but also for preservation of the environment and fossil fuels. He indicated Algeria's intention to introduce a nuclear plant by 2025 for this reason. To achieve this, it is giving priority to human resource development, research and development, and local integration into equipment and services. Mr. El Mikki noted that this strategy is fully integrated into his Government's socioeconomic policies, which also include the promotion of renewable energy and the development of less polluting applications of natural gas. He also noted the assistance received from the IAEA in the development of a national law on nuclear energy.

Mr. Rokas Bernotas, on behalf of Mr. A. Sekmokas, Minister of Energy, Lithuania, noted Lithuania's experience with nuclear power, and added that the current reactors supply 70 per cent of Lithuania's electricity needs. The final plant will be shut down by the end of 2009. Mr. Bernotas identified the need for the development of electricity interconnections in the region and also for additional electricity generation capacity in the region. He described the plan for a new nuclear plant, jointly with Latvia, Estonia and Poland, with a potential capacity of 3.4 GW. He noted the need to train additional human resources for this project and mentioned that the further development of competence and capacities in many areas of the nuclear field has become a top priority for Lithuania.

Ms. Soad Shilli, on behalf of Dr. Ali Gashut, Secretary of the Atomic Energy Establishment of the Libyan Arab Jamahiriya (Libya), noted Libya's long history and consideration of the peaceful applications of nuclear energy and reminded the conference of Libya's decision in 2003 to remove all programmes and equipment that might lead to the production of nuclear weapons. She noted that all countries have the right to use nuclear energy for peaceful purposes and called upon all States that possess nuclear weapons to draw up a step by step programme to eliminate their nuclear arsenals, to be verified internationally by the IAEA. She noted that Libya has announced its intention to introduce nuclear power into the energy mix for the production of electricity and water desalination. She asked all technology holders not to put obstacles in the way of technology transfer for peaceful applications according to the NPT.

WEDNESDAY, 22 APRIL 2009

Morning session

Ms. Madeleine Tchuinte, Minister of Scientific Research and Innovation, Cameroon, referred to the unequal distribution of energy resources in the world and noted that even some countries with considerable potential resources are unable to exploit them owing to the weakness of their economies. She noted that Cameroon has considerable hydroelectric potential, but only 15 per cent of the population has access to electricity. Ms. Tchuinte said that they have plans for additional hydroelectric and thermal power plants, but nevertheless the Government intends to consider nuclear energy as a potential reliable energy source with due regard to climate change. She noted that Cameroon has ratified the NPT and the Additional Protocol, and recently ratified the Pelindaba Treaty. In addition, she asked for other participants to consider human resources, the development of reactors of a size appropriate for the needs of developing countries, control of the fuel cycle and management of radioactive waste.

Prof. Mohamad Eltayeb, on behalf of Prof. Ibrahim A. Omer, Minister of Science and Technology, Sudan, recognized that Sudan anticipates an energy gap and has commenced a technical cooperation project aimed at understanding the infrastructure needed for a nuclear power programme. He described the actions to achieve technical requirements and political support, including the preparation of a new Atomic Energy Act. Noting that a nuclear power programme requires highly trained human resources, Prof. Eltayeb described new training and education courses established in Sudan. He noted that there are issues that require international action, such as an assured supply of fuel that is not subject to discriminative measures, improvement of spent fuel processing and waste management, and further availability of small and medium reactors, which better suit the grid capacity of developing countries.

Prof. Tissa Vitarana, Minister of Science and Technology, Sri Lanka, expressed agreement with the earlier calls for a complete ban on nuclear weapons. Prof. Vitarana noted that, for the first time, the nuclear option is being considered by Sri Lanka, although he stated that careful assessment of the feasibility and cost effectiveness is needed before a final decision is taken. He raised some specific issues relating to Sri Lanka, among which are the possibility of considering reactors that might use thorium from the outset, the issue of suitable sites for long term disposal, public awareness and human resources.

Afternoon session

Ambassador William Ehrman, on behalf of Mr. Mike O'Brien, Minister of State for Energy, United Kingdom, reminded the conference that the UK Government has taken the decision that it is in the public interest that new nuclear power stations should have a role to play in the UK's future energy mix, alongside other low carbon energy sources. He noted that this decision was reached in the context of climate change and energy security. Mr. Ehrman stated that the UK Government believes that it is for energy companies to fund, develop and build new nuclear plants and to meet the full cost of decommissioning and waste management. He described how the UK has introduced a Generic Design Assessment to reduce regulatory uncertainty, and has legislated to ensure that developers put money aside for eventual cleanup and decommissioning funding. He explained that the UK Government's actions will enable the new plants to start up between 2017 and 2020, and that the UK industry will be in a position to support development in the UK and abroad.

Mr. Daniel Omar Cameron, Secretary of Energy, Argentina, described the Argentinian energy position and history. He informed the conference that the installed electricity generating capacity is 26.3 GW, of which 1 GW is nuclear. He described the planned completion of the delayed Atucha II plant. Mr. Cameron indicated that the planned nuclear percentage of electricity generating capacity would rise from about 6 per cent to between 17 and 21 per cent by 2025. He expressed concern that it might be difficult to obtain suppliers if the industry expanded as predicted. He thought that suppliers might prioritize the projects of their own country or those of their principal commercial partners, and that this could lead to developing countries having no access to nuclear energy.

Mr. Pierre Pym, on behalf of the Honourable Lisa Raitt, Minister for Natural Resources, Canada, suggested that the world faces auspicious opportunities and significant challenges arising from increasing interest in the use of nuclear technologies to meet development needs, satisfy energy demands and mitigate the threat of climate change. He indicated that Canada produces 15 per cent of its electricity from nuclear plants, and that there are prospects for new plant construction across Canada. He noted that Canada currently produces some 20 per cent of the world's uranium, 85 per cent of which is exported. Mr. Pym noted that Canada sees a growing interest in proliferation resistant thorium fuel cycles and believes that this would benefit from enhanced international cooperation. He stated that Canada strongly supports the IAEA's efforts in bringing together nuclear technology developers

and users, and in supporting the advancement of nuclear energy for peaceful purposes.

H.E. Ms. Anne-Marie Idrac, Secretary of State for Foreign Trade, Ministry of Economy, Industry and Employment, France, suggested that nuclear energy's current success is explained by the fact that it represents one of the solutions to today's energy challenges. She noted that France made a large scale shift to nuclear energy in 1974, and as a result France emits 30–40 per cent less carbon dioxide per inhabitant than France's large European neighbours. She commented that, since the 2005 Paris Conference, nuclear energy around the world has continued unabated and that the IAEA's vital work has been crucial to this. Ms. Idrac recognized that a number of States are anxious to develop nuclear energy, but reiterated that this implies certain responsibilities and should form part of an overarching energy strategy. She reinforced France's stress on the NPT and the encouragement to sign additional protocols. She pointed out the importance of organizing how the public is informed and consulted, with transparency as the guiding principle. Ms. Idrac commented that France is willing to help those countries that wish to do so to develop the peaceful use of nuclear power, and that France and the IAEA share the requirements and convictions on how nuclear energy should be developed.

Summary of Technical Session 1

ENERGY RESOURCES AND THE ENVIRONMENT

Mr. L. Echávarri, Director-General, OECD Nuclear Energy Agency (OECD/NEA), Moderator, opened the first technical session by referring to the conference on Nuclear Power for the 21st Century held in Paris in 2005. He suggested that the time was now right for nuclear and that China was clearly the right place to consider the future of nuclear energy. He referred to the topics of the session, and suggested that nuclear energy can contribute to the energy security and the development of many countries. He also commented that there is growing concern over climate change and a drive to limit carbon dioxide emissions.

Mr. R.K. Pachauri, Chairman, Intergovernmental Panel on Climate Change (IPCC), made his presentation by video. Mr. Pachauri commenced by indicating the need to highlight greenhouse gas emissions and stated that it is essential to stabilize the emission of greenhouse gases into the atmosphere at around the current level. He noted the increase from 280 to 386 ppm over the period of industrialization. He referred to the IPCC strategy to limit global warming to only 2–2.4°C and stressed that the concentration of carbon dioxide needs to peak by 2020, leaving no more than about 6 years to take significant action to bring this about. Mr. Pachauri indicated that nuclear is one of the options, along with much greater use of renewables. He called upon those with responsibility to put into place policies that would lead to greater investment in low carbon sources of energy. He discussed the relatively higher cost of low carbon options including nuclear, and suggested that these could total some 3 per cent of world gross domestic product. He noted, however, that the benefits from this investment — namely, reduced pollution and improved health, greater energy security through diversity, reduced pressure on global oil/coal resources, and the creation of employment — could more than offset the investment costs.

Mr. Pachauri stated that it is necessary to embark on the path of mitigation of climate change now, using the technologies available. He also suggested that policies could be developed that would encourage the development of new and improved technologies. He suggested that it is necessary to put a price on carbon, as a signal to the market and to encourage investment. He said that this could be achieved through legislation, 'cap and trade' approaches or national regulation. He closed by stating that there is a need to use nuclear energy on a larger scale where national infrastructure permits, and to increase the use of renewables and energy efficiency. He noted

that 1.6 billion people remain without access to electricity and that this also needs urgent attention.

Mr. Li Ganjie, Vice Minister of Environmental Protection and Administrator of the National Nuclear Safety Administration, China, noted that China has a fast growing economy and as a result has an urgent need to strengthen its environmental protection measures, implement energy saving and emission reduction measures, and vigorously develop and use clean energy. He stated that China is experiencing, over a very short period, all the environmental problems that occurred in several phases spread over 100 years during the industrialization of developed countries. Mr. Li commented that China's current nuclear generating capacity reduces carbon dioxide emissions by about 53 million tonnes annually. He mentioned several challenges to the further development of nuclear power in China, foremost among them the shortage of human resources for the construction of the nuclear power infrastructure. Mr. Li described the Chinese Government's plan for nuclear development, which would lead to 40 GW of nuclear generation in operation, with a further 18 GW under construction, by 2020. He noted that there would be a need to rationalize the investment management system to promote the sound development of nuclear power, and to increase the national commitment to reinforcing the nuclear regulatory structure to effectively strengthen nuclear safety regulation. He concluded by stating that, since China is the world's largest developing country, with a fast growing demand for energy and a long way to go in protecting the environment, it urgently needs nuclear power to meet its demand for a steady supply of clean energy.

Dr. F.E. Osaisai, Director-General, Nigeria Atomic Energy Commission, Nigeria, began by referring to the Commission on Sustainable Development and its recognition that the choice of nuclear energy rests with countries, and that, since the World Summit on Sustainable Development, nuclear power has been included in the category of advanced energy technologies. He noted the high level of correlation between per capita gross domestic product and per capita electricity generation, and that developing countries in Africa have low values of both measures. Dr. Osaisai noted that long term energy security is imperative for sustainable development in any country, adding that many countries, particularly in Africa, are dependent on fossil fuels and hydropower for their energy needs. He commented that fossil fuels are finite and that there are limitations to the harnessing of hydropower, concluding that sustainable socioeconomic development and preservation of the environment are dependent on access to a diversified basket of energy options. Dr. Osaisai stressed that the management of fossil fuels should also include conservation for future generations and a recognition of their valuable uses other than electricity production, and hence any electricity generation policy should be

futuristic in content and recognize resource conservation and management. Dr. Osaisai further noted that it is an appropriate development objective to invest revenues accruing from currently available primary resources to ensure long term sustainable energy security. He continued by suggesting that, considering overall economic competitiveness, mitigation of climate change and long term energy security, nuclear appears attractive. He noted that the application of nuclear power technology could also encourage regional cooperation. Dr. Osaisai concluded by stating that a nuclear programme requires the development of a reasonable national consensus, achieved through a high degree of openness and transparency, and that governments should demonstrate their national commitment by taking responsibility for the development of the infrastructure and human resource development to create the requisite environment for the successful implementation of a nuclear programme.

Mr. Nobuo Tanaka, Executive Director, International Energy Agency (OECD/IEA), began by noting that the world faces two challenges: energy security and climate change. He also noted that investment in clean technologies will ensure better energy security while mitigating climate change, and that nuclear power has a key role to play. He referred to the IEA *World Energy Outlook*, which predicts world energy growth by 45 per cent by 2030, with 87 per cent of this growth in non-OECD countries. Mr. Tanaka commented that, as energy production accounts for 60 per cent of carbon dioxide emissions, this energy demand would have huge implications for climate change, and in a 'business as usual' scenario the increased carbon emissions would lead to a predicted global temperature increase of around 6ºC. He reported analysis that, in order to limit temperature rise to about 2ºC, actions to limit atmospheric carbon dioxide to 450 ppm would be needed. To achieve this 450 ppm target would, he said, require a revolution in the energy sector, requiring a 54 per cent improvement in energy efficiency, the introduction of carbon capture and storage (CCS), and the use of nuclear power and renewables. Mr. Tanaka stated that the investment needed for these additional measures is significant and would require a transformation of the power sector with a declining share of fossil fuels such as coal and natural gas in electricity production, and an increasing share of clean energy technologies such as renewables and nuclear. He noted that in this scenario nuclear would become the third largest electricity source by 2030, and its contribution would almost quadruple by 2050. Mr. Tanaka added that nuclear has several challenges to overcome to achieve these targets, which need to be resolved if the world is to overcome climate change. He suggested that governments should act to introduce stable energy policies that would give industry the incentive to invest in cleaner technologies and policies for improving public

acceptance. He also suggested that governments should consider providing additional financial support and making arrangements for the management of radioactive waste and spent fuel. Mr. Tanaka concluded by noting that the economic crisis is an opportunity to place a Clean Energy New Deal at the heart of economic stimulus packages everywhere.

Discussion

L. Echávarri (OECD/NEA, Moderator): The message emerging from the presentations is clear. In order to lower carbon dioxide emissions while ensuring security of energy supply, we need to promote the use of nuclear and renewable sources of energy, which are complementary. This needs to be incorporated into national energy policies and facilitated through international cooperation, and must go hand in hand with social and economic development. We have to be aware of the challenges, such as meeting high costs, developing human resources, providing manufacturing capacity and quality control, building a legislative and regulatory infrastructure, managing waste, ensuring safety and gaining public acceptance. Some governments are actively finding solutions to meet these challenges, always following the 'safety first' principle. Building technical capacity, especially in developing countries, and long term political commitment are key elements. For this, political and social stability is essential. While much money will need to be invested in technology and infrastructure, many opportunities will be created for the nuclear industry to help meet increased demand for clean energy and to increase efficiency of production and supply.

M. Cojuangco (Philippines): (1) Waste disposal is a major issue with regard to public acceptance. With US President Obama reconsidering the Yucca Mountain project, more doubt than ever has been sown in the public mind. Why not promote and demonstrate borehole waste disposal as a final and simple technical solution? (2) What will happen to the sub-sea option for waste disposal? The United Nations is supposed to be taking this up for discussion this year. Will the IAEA try to preserve this option pending further study so that it will not be outlawed prematurely?

L. Echávarri (OECD/NEA, Moderator): Wednesday morning's session will focus on that. The problem is political rather than technical.

M. Cojuangco (Philippines): It is technical for the general public, who are not so well informed. A clear demonstration would give them some assurance.

L. Echávarri (OECD/NEA, Moderator): You are optimistic. Many countries have tried this; few have succeeded. Deep geological repositories exist, for example, in New Mexico, so technically it has been demonstrated. Social acceptance still takes a long time. Finland is going ahead, Sweden and

France have advanced programmes for establishing long term waste depositories, but in the USA, future policy on spent fuel and high level waste is not clear at the moment.

A. Soltanieh (Islamic Republic of Iran): Mr. Tanaka, in estimating the number of nuclear power plants to be built in order to reduce carbon dioxide emissions by 50 per cent to 450 ppm by 2020, have you considered the combined impact of 'business as usual', renewable energy advances and contribution, and the Kyoto Convention implementation?

N. Tanaka (OECD/IEA): Our calculations assume the 'business as usual' scenario, that is, economic growth maintained at 3 per cent till 2030, but reduced carbon dioxide emissions. This can be done by replacing carbon dioxide emitting power plants substantially with low carbon technologies and energy efficiency. We calculated that energy efficiency will play the most significant role, followed by renewables, CCS and nuclear. To achieve this, we calculated that every year, 20 nuclear plants, 30 fossil plants with CCS, 50 hydro plants, 300 concentrating solar power plants and 18 000 wind turbines must be built all together. Of course, for CCS power plants we have to wait until 2020, but what we are trying to say is that to achieve this 450 ppm scenario, we need huge investment — an additional $9 trillion to maintain the 450 ppm scenario, on top of the $26 trillion necessary to maintain predicted growth. As to the Kyoto Protocol, in the 'cap and trade' part, as we approach 2030, we estimate that the carbon price will be $180 per ton of carbon dioxide.

M. Cojuangco (Philippines): (1) Why not a clean development mechanism (CDM) for nuclear? (2) What is the outlook for the level of carbon tax? What is the trend worldwide?

N. Tanaka (OECD/IEA): The negotiating body is the United Nations. I raised the question of a CDM for nuclear with all related players, but, so far, nuclear has not been considered as part of the CDM. With regard to CCS, it has been considered but not applied as such. Nuclear, being carbon free, should be given special consideration in the new framework. The question of the carbon tax level is related to the tool used to reduce emissions. Whether 'cap and trade' on prices or carbon tax, the level I mentioned — $180 per ton of carbon dioxide towards 2030 — is required to achieve a 50 per cent reduction in emissions by 2050.

L. Echávarri (OECD/NEA, Moderator): In the Kyoto Protocol, nuclear is explicitly excluded from the CDM, which is curious. Many consider this exclusion inconvenient for the future and believe it should be eliminated.

Kang Chang Sun (OECD/IEA): With regard to including nuclear as a CDM, global opinion is changing. In February, I presented a paper on nuclear energy at the 4th World Renewable Energy Summit in Kuala Lumpur, Malaysia — a rare chance for a nuclear professional to be invited by such a

group. It was encouraging that they showed interest and started to consider nuclear energy as a renewable.

L. Echávarri (OECD/NEA, Moderator): It is good that attitudes are changing. Nuclear has to take its place as renewable, clean and sustainable.

I. Othman (Syrian Arab Republic): During the 1980s and 1990s, public opinion was a main factor in holding back the development of nuclear power. Now, in the 21st century, how much does public opinion influence decision making? What are the reasons behind the softening of public resistance to nuclear after 2000?

Li Ganjie (China): In China, public acceptance of nuclear power development has been very positive, due mainly to the fact that nuclear power positively affects social development and environmental protection. However, as attitudes diversify, some resistance has emerged. To resolve this, we need to raise public awareness concerning the importance of nuclear power and to keep the public informed about nuclear power development. To reassure the public, we need to ensure nuclear safety and radiation protection, and the proper management of radioactive waste.

L. Echávarri (OECD/NEA, Moderator): Yes, transparency is essential. However, society's attitude towards nuclear power is changing. Society is starting to be concerned about energy security, now that oil and gas supply and prices have become unstable. People are realizing, too, that nuclear power production is environmentally friendly. Thanks to the reaction to Chernobyl, reactor safety has greatly improved. This is all favourable to nuclear power development. So we should do it well. Governments need to take action, industry must be reliable, regulators should be independent, proliferation has to be controlled, and waste has to be dealt with safely. Let us make the most of the opportunity we now have.

Summary of Technical Session 2

AVAILABLE TECHNOLOGY AND THE LONG TERM PERSPECTIVES

Mr. W. Borchardt, Executive Director for Operations, US Nuclear Regulatory Commission, USA, Moderator, welcomed the speakers, anticipating interesting and broad ranging discussions.

Dr. A. Kakodkar, Chairman, Atomic Energy Commission, India, commenced by recognizing the growing demand for energy and suggested that the world will need between 3000 and 4000 nuclear power reactors. Indian studies suggest that the use of uranium in an open cycle would be unsustainable and that recycling and the use of high conversion ratio reactors are essential. Mr. Kakodkar informed the conference that India has selected a three stage approach to move from the existing heavy water and light water reactor mix, through a fast breeder programme with thorium, to a programme largely based on thorium reactors with a very large total power potential. Mr. Kakodkar described the Indian nuclear experience and details of future reactor developments, including the small reactor at Kalpakkam, which uses ^{233}U as fuel. He stressed that the technology options for long term nuclear power development need to be based on a scientific approach to attain sustainability of nuclear fuel resources and the environment, where concerns related to safety, security and proliferation issues are handled through technological means. He noted that the Indian nuclear programme is consistent with these objectives.

Mr. J.V. Lolich, Director, Instituto Balseiro, Argentina, opened by noting that most of the potential newcomers are developing, non-industrialized countries, and that the commercially available nuclear power plants have an electric output of >1000 MW(e). He suggested that a developing country building a currently available reactor could face difficulties from a lack of trained personnel and low national participation in the project. He mentioned that, in his opinion, developing countries need reactors that do not exceed 10 per cent of the national grid, simple and proven technology, significant opportunities for local participation in the nuclear power project, and small human resource requirements for operation and maintenance. He noted that, in the nuclear case, a one size fits all approach has never been so far from the truth. Mr. Lolich said that, although the potential market for small reactors appears to be large and some 60 small or medium reactor concepts have been identified, only two are at the construction stage (Russian KLT and Argentinian CAREM). Mr. Lolich proposed that countries should consider

using small power reactors as a bridge project before embarking upon a large scale reactor, since this could provide some advantages in the development period. He also noted that small or medium reactors are the preferred option for dedicated non-electrical applications of nuclear power such as desalination or district heating.

Mr. P. Pradel, Head of the Nuclear Energy Division, Commissariat à l'énergie atomique, France, noted the world's growing demand for energy and suggested that it is essential to determine which sectors of energy use are the main producers of greenhouse gases in order to face up to the climate challenge. He suggested that worldwide the number of reactors could reach more than 1000 if the nuclear share in the energy mix amounted to 30 per cent, as in Europe. Mr. Pradel recognized that nuclear energy is establishing itself as an integral part of the expanding low carbon energy technologies needed to meet the 2020 objectives set by the European Union. In relation to the development of nuclear power, Mr. Pradel provided estimates from industry that between 30 and 50 per cent of the growth in the global fleet will occur in countries with little or no nuclear industry to date. Mr. Pradel agreed that there is considerable concern over the total quantities of spent fuel that would arise from a growing nuclear programme, and suggested that recycling and reprocessing operations are mature, efficient, safe, clean and cost effective technologies, and that French cooperation with Japan on reprocessing underlines the importance of future international cooperation in this area. He proposed the development of a global service for spent fuel reprocessing and recycling within an international framework, and the establishment of treatment plants on a regional basis. Mr. Pradel noted that the French strategy for future nuclear systems will include the development of fast reactors with closed fuel cycles of both sodium, as the reference case, and gas cooled designs.

Mr. L. Echávarri, Director-General, OECD Nuclear Energy Agency (OECD/NEA), referred to the NEA publication *Nuclear Energy Outlook*. He used this to provide information that electricity generation plants are the largest source of anthropogenic global carbon dioxide emissions. He emphasized that, owing to global population growth and per capita use of energy, there will be great increases in electricity demand according to many scenarios. Mr. Echávarri noted that, to meet the climate change targets, carbon dioxide emissions per unit of energy consumption need to be reduced by a factor of 4, and that nuclear could make a significant contribution to this. He suggested that with breeder reactors the available uranium could provide energy for several millennia. He stressed that, in order to enable nuclear energy's role in the future sustainable energy mix, governments have clear responsibilities to maintain skills and effective safety regulation, foster progress towards facilities for waste disposal, maintain international

non-proliferation arrangements, and provide a stable policy, regulatory and fiscal environment.

Discussion

W. Borchardt (US NRC, Moderator): [Summary] These presentations conveyed four overarching messages. First, electricity and the nuclear power industry are of paramount importance in meeting societal needs and in meeting the carbon emission and climate change challenges we face today. Second, although estimates of the number of new reactors range from a few hundred to a few thousand, there seems to be a consensus that nuclear needs to be part of the energy solution no matter which scenario you endorse. Third, while there are a number of designs and suppliers today, one size does not fit all, that is, one solution does not meet all the needs of each country considering nuclear power. I believe there are numerous infrastructure challenges to meet these needs. Fourth, a number of very important issues remain to be addressed, including radioactive waste, non-proliferation and the fuel cycle.

D. Mosbah (AAEA): Since small and medium power reactors are not available commercially, what is the better choice for a small country in North Africa or the Middle East — a regional project or a go it alone scenario? What are the implications?

J. Lolich (Instituto Balseiro): The problem with a regional reactor is assigning a caretaker of the waste. If that can be resolved, the rest is easier. It would be a good solution for the north of Africa where there is a connected grid, but first establish who will take care of the spent fuel.

T. Vitarana (Ministry of Science and Technology, Sri Lanka): The availability of uranium is a critical determinant for a newcomer country before taking the decision to set up a reactor. Have the uranium deposits been accurately determined? If not, are current estimates reliable?

A. Kakodkar (Atomic Energy Commission, India): The question of uranium availability to meet growing requirements will remain uncertain because assessments of the growth of nuclear power vary widely. I presented figures from the IAEA INPRO GAINS assessment for a high growth scenario. We looked at this profile along with those of IPCC. If you look at energy requirements, on the one hand, and the need to minimize carbon dioxide emissions, on the other, both of which are important to the world community, the INPRO scenario fits in well with that of IPCC where you deliberately limit the carbon dioxide emissions to manageable — though not satisfactory — levels. Once you have fixed the scenario, it is easy to calculate the uranium requirements and compare them with identified resources. When taking a decision to build a nuclear reactor, you have to define the lifetime uranium

requirements. You have to ensure that you can fuel it for 40–60 years of operation. Whether nuclear power will actually grow according to that profile is an open issue. There is the question of purchasing power and of actual preparedness of countries to go in for nuclear energy. Obviously, there are many scenarios where you would get a lower projection. That, in turn, would mean that the carbon dioxide emission control objectives necessary to limit climate change would not be met. The time available for that purpose is not very long.

L. Echávarri (OECD/NEA): Every two years for the past 44 years, the IAEA and the OECD/NEA have been publishing an assessment of resource availability — now we are producing the 22nd edition. Demand, identified resources, estimated resources and future resource scenarios are described in a country by country evaluation. If there is a rapid increase in the number of reactors in the world between now and 2050, according to our analysis there will be no problem with regard to uranium availability. Also after that time we are optimistic, as we estimate that many uranium deposits are yet to be discovered. Now uranium exploration is restarting after very little activity in the past 20 years. Moreover, around 2050, fast breeder reactors should be entering the market, so resources will be readily available.

Y. Ruan (Canada): Please explain the uranium resource requirements related to India's long term three stage programme and how you integrate the stages.

A. Kakodkar (Atomic Energy Commission, India): Scenario building can be viewed in different ways. Assuming that you need 5000 kW·h per capita as a minimum to support a decent quality of life, if you generate less electricity, much of humanity will be left behind in terms of economic and social development. Achieving this minimum is a challenge for all of us, and societies with no buying power will not be able to manage. My suggestion is that the international community should estimate how much energy is required to support minimum development needs and address the challenge. When considering resource availability among the many other issues, you need to look at the once-through mode, comparing available types of uranium, and also at recycling programmes. In India, we did not have enough uranium for our requirements, so we investigated recycling alternatives. A similar situation could arise — sooner or later — worldwide. Recycling, possibly with breeder reactors, may become inevitable. Once you get into that, you need to decide whether recycling with uranium or with thorium is preferable. Here, too, there are different options — for example, in terms of growth or of burning fissile material — that should be compared in the global context.

T. Feroukhi (Algeria): (1) Mr. Kakodkar, is thorium available worldwide, particularly in comparison with uranium? (2) Mr. Lolich, I refer to the 'bridge

project' based on small and medium reactors for newcomers and the CAREM reactor under construction in Argentina. Given that small and medium reactors are less expensive, do you think that there is a difference regarding transfer of technology, taking 'turnkey' experience into account?

A. Kakodkar (Atomic Energy Commission, India): Thorium is more widespread and about three times more abundant than uranium. However, because it has no fissile content, you cannot start up a programme with thorium; for this, uranium is needed. As to the question of which is more advantageous to burn with fissile material: many years ago, when water reactor technology was not sufficiently proven for reaching high burnups, burning fissile material with uranium was more advantageous. Now that the technology for water reactors has reached a level where burnups of 50 000–60 000 MW are quite possible, the answer would be the opposite. In a growth scenario, thorium should not be introduced upfront, but in a scenario of sustained energy production, from a certain level on, thorium is better. Nevertheless, the situation can vary from country to country.

J.V. Lolich (Instituto Balseiro): Concerning the CAREM reactor, the kilowatt generation will be higher in a large plant, but the newcomer country will learn how to operate a nuclear power plant and also how to deal with the supply contractor, and the amount saved will certainly pay for the CAREM reactor. Also, the country will be able to develop its nuclear culture, its human resources and its nuclear infrastructure, so it will save many times the initial cost of the CAREM. And — in contrast to a research reactor — the CAREM produces electricity. As to technology transfer: Argentina's policy is to provide this. We have built reactors in many countries, and we always include host country staff in the design and construction teams, training them where necessary. For the CAREM, we shall follow the same policy.

K. Araj (Jordan): Mr. Echávarri, other than uranium resource constraints, are there any inherent limitations — such as insufficient manufacturing facilities, material scarcity, lack of components — that would hamper the high nuclear scenario long term? Considering rapid growth and the limited human resources available worldwide, and solutions that nuclear power can provide to problems such as global warming, perhaps the provision of new nuclear power resources should be regarded as a 'global common good' with an international nuclear enterprise supplying human resources and know-how where it is needed.

L. Echávarri (OECD/NEA): We need to consider several angles. The increase in new reactors between now and 2030 is very limited. These years are for rebuilding the industrial infrastructure. Comparing this with the 1970s and 1980s — when I was involved in designing and constructing nuclear power plants in my country — firstly, there was no previous generation, and, secondly,

many got into the nuclear business because it was the biggest national investment. Now, there is plenty of time to plan for the increase, as it will happen gradually for the next decade or so. But it has to be done systematically. France and Japan, for instance, are already preparing for the expansion ahead. Also, investment is necessary in the fuel cycle. Early decisions are necessary to avoid a bottleneck.

J. Eibenschutz (Mexico): Nuclear energy faces a variety of challenges. Some of them arise from the first application of nuclear energy — the bomb. This has created confusion, for example, when non-proliferation is discussed in connection with nuclear power. We have to be more explicit. People think that it is relatively trivial to convert a nuclear power plant into a mechanism for proliferation. Also, economic comparisons are unfair to nuclear. Such studies should consider the fact that the cost of the nuclear kilowatt-hour includes all 'externalities' (e.g. fuel cycle, decommissioning), whereas for other energy technologies, this is not so (fly ash disposal, carbon dioxide emissions, decommissioning). This may lead countries to take the wrong decisions. Despite the efforts of organizations such as the IAEA, we are still not playing on a 'level field'.

L. Echávarri (OECD/NEA): You are right. Markets do not create energy policy but respond to it. To deal with problems of energy supply security and climate change, governments have to establish an energy policy framework that leads in the right direction: towards nuclear and renewable sources. Nuclear power is capital intensive. Huge amounts have to be invested for a long time without returns for about 25–30 years, after which the returns are fantastic, but you have to survive till then. Therefore, governments should provide financial as well as policy support for nuclear energy.

R. Sinha (India): With the uranium resources indicated in the 'Red Book', a calculation shows that, once a level of 450 GW(e) installed capacity has been reached from the current level of about 380 GW(e), it will not be possible to commit uranium supply for a reactor life of 60 years for the 450 GW(e) reactor. Mr. Echávarri, for a reactor to be built in the near future, will it be necessary to consider the use of mixed oxide (MOX) fuel at some point in its life, or can one assume continued availability of uranium and accept a reactor designed to use uranium based fuel (without the flexibility of using MOX)?

L. Echávarri (OECD/NEA): We have plutonium — and especially thorium — as a backup. This reassures the policy makers. However, these technologies must be seen in a long term context. We cannot recycle huge amounts of fuel around the world immediately. The same goes for fast breeder reactors. Our analysis is that we will continue using the existing light water reactors. While planning for the future, we also have to cope with what we have

year by year. Uranium will remain important for the next 40 years. The use of MOX and, later, recycling will be limited. As stated before, there is plenty of uranium — enough for the 1400 reactors projected by 2050 — so we should not regard it as a limiting factor. Nevertheless, many people are concerned about figures that appear to be relatively low. Because of low prices — due to supplier stockpiles of uranium intended for planned reactors that were not constructed and of secondary sources released from military for civilian use — there has been little uranium exploration in the past 20–25 years. These secondary sources of uranium accounted for about 60 per cent of the market supply for several years. However, funding for uranium exploration has increased in the last two years as oil prices peaked, and exploration has restarted. On the basis of geological analysis, we are convinced that uranium supply will meet demand for the next 250–300 years. We do not think that the other sources will be significant in the next 40 years.

M. Saeidi (Islamic Republic of Iran): Mr. Echávarri, in your OECD/NEA survey, have you defined the role of fusion energy by 2050? If so, what is the result?

L. Echávarri (OECD/NEA): We have a chapter dealing with fusion. Successful use of fusion will enable plenty of energy to be available for sustainable development. We do not predict this happening, however, before 2050. Fusion is important now for research; feasibility must still be demonstrated. So it does not affect our analysis of energy production for the years until 2050.

Summary of Technical Session 3

INFRASTRUCTURE DEVELOPMENT AND SAFETY AND LEGAL ISSUES

Dr. F.E. Osaisai, Director-General, Nigeria Atomic Energy Commission, Moderator, welcomed the speakers, noting that they had a wide range of experience and that the issues should be very interesting.

Dr. J. Zanelli, Centro de Estudios Científicos, Chile, Chairman of the Presidential Working Group on Nucleoelectric Generation, explained the background to the establishment by the President of Chile of the Working Group and its remit. He said that the purpose of the President's Commission was to assess whether the use of nuclear energy would be a sensible proposition in Chile. Dr. Zanelli described the electricity supply system in his country, noting that additional hydro could only be developed in regions 2000 km from the main population centres, and that the country is heavily dependent on fossil fuels. Because of energy supply problems, nuclear energy was repeatedly mentioned by both supporters and critics in a debate that often lacked objectivity and sound information. Dr. Zanelli described many of the significant challenges facing the introduction of a nuclear programme in Chile, which do not necessarily rule out nuclear but raise concerns requiring careful analysis. These concerns include a small divided electricity grid, seismicity, insufficient regulatory infrastructure, low safety culture and a lack of public confidence in government institutions. Dr. Zanelli stated that the report to the President in October 2007 suggested that nuclear energy is a mature technology and that there are no reasons why the nuclear option should be discarded. However, the report identified many issues that would require further study, and the introduction of nuclear energy would require a political and strategic decision. Dr. Zanelli noted that when the report, with all its issues, was published, the debate changed to a less acrimonious pitch. He noted that the most recent activities were aimed at making sufficient progress in developing knowledge of the nuclear infrastructure needs so that Chile may within 2–3 years be able to make a decision on whether to proceed or not with a nuclear programme. Dr. Zanelli mentioned that Chile has a high international standing with regard to economic freedom and competitiveness, but is weaker in the areas of education and distribution of income. He suggested that the challenge of a nuclear power programme is enormous, but the reward could be a new, clean and reliable energy source, which would bring major changes to society, making it more rigorous, safer, efficient and competitive.

Mr. W. Borchardt, Executive Director for Operations, US Nuclear Regulatory Commission, USA, outlined the essential elements of a nuclear energy programme as being: legislative authorization, a clear regulatory framework and a capable regulator, and a capable operator. He noted that a nuclear energy programme requires a commitment on the part of the country for more than 100 years and legislation to ensure an independent regulator. The ultimate responsibility for safety resides with the licensee/operator. He outlined the duties of the regulator, and indicated that a capable operator may only do what is permitted, needs to maintain adequate resources and must report to the regulator. Mr. Borchardt gave an overview of the US Nuclear Regulatory Commission (NRC), and suggested five principles of good regulation: independence, efficiency, openness, clarity and reliability, which the NRC applies to over 100 commercial nuclear power plants and several thousand large and small users of nuclear material for industrial, medical or academic purposes. He explained that the NRC provides regulations and guidance on licensing, decommissioning and certification, backed up by oversight and operating experience. He described the research and advisory activities that underpin all of these other activities.

Mr. N. Pelzer, Honorary President of the International Nuclear Law Association, stated that, in preparing for a nuclear energy programme, legislators and State authorities have to establish a sound balance between risks and benefits. He commented that establishing a legal framework to tame the hazards of nuclear energy is a much more challenging task than providing a legal basis for promoting the use of nuclear energy. Mr. Pelzer reminded the participants that the use of nuclear energy is not an exclusively national matter. He continued by outlining three key principles underlying a nuclear law: the permission principle, whereby no nuclear activity is permitted without prior permission; the continuous control principle, whereby the legal framework of permission is observed and permanently met; and the compensation principle to ensure adequate compensation if nuclear or radiation damage occurs. Mr. Pelzer described how the basic elements of nuclear legislation are implemented and referred to the binding international conventions on nuclear safety and physical protection of nuclear material. He briefly described the NPT and the Additional Protocol, as well as the general international acceptance of these vehicles. In relation to ensuring compensation for nuclear damage, he described the relevant international conventions and noted that only if national legislation contains and implements these convention principles is it internationally acknowledged as being appropriate. He concluded by referring to the international cooperation principle underlying nuclear law and pointing out that, already at an early stage, nuclear law had become a 'globalized' field of law. This resulted in an extremely close intertwining of

national and international law and rendered nuclear law a most sensitive field of law, which is a challenge for politicians and lawyers.

Dr. K.A. Toukan, Chairman, Jordan Atomic Energy Commission, Jordan, presented an overview of Jordan and noted that it is affected by growing energy demand, increasing costs and a lack of conventional energy sources. He said that, in addition, his country's increased dependence on imported fuel, the scarcity of water resources and environmental considerations have encouraged Jordan to consider nuclear as part of the energy mix. Dr. Toukan mentioned that energy demand is forecast to double by 2020 and to quadruple by 2030, with some of this increase due to predictions of power needs for desalination. Dr. Toukan indicated that Jordan's nuclear strategy seeks to ensure security of supply, to leverage its national uranium resources, to ensure effective technology transfer, and to provide for water desalination and possible eventual hydrogen production, among other benefits. He noted several significant challenges, including siting, exploitation of national uranium resources, fuel and waste management, human resource development, funding and the political environment. He also noted that Jordan benefits from significant international and bilateral cooperation, in particular in the area of uranium exploitation, and that activities to identify potential sites are approaching a consensus. Dr. Toukan explained the activities that are already being implemented and noted that the target date for operation of the first reactor is 2017. He also described ongoing activities in human resource development, training and public awareness, as well as the associated increase in staffing of the Jordan Atomic Energy Commission.

Discussion

F. Osaisai (Nigeria Atomic Energy Commission, Moderator): The speakers can be grouped into two areas. Two speakers talked about new nuclear power programmes to provide energy security for their countries and how they would confront technical and political difficulties (e.g. gain initial public acceptance and benefit from outside experience), where necessary, to make the programme successful. The other two speakers discussed infrastructure issues related to regulation and legislation. A nuclear programme requires a strong regulatory framework to maintain and control the safety and security of material and facilities, and, above all, to ensure that humans and the environment are not endangered because of the nuclear industry. Regulations require a legal basis, and one paper gave us a comprehensive overview of legislative issues involved in developing a nuclear programme.

J. Repussard (France): How does the NRC appreciate the importance of academic education and research for maintaining national capability in nuclear safety, since this is largely a science based activity?

W. Borchardt (US NRC): Research is at the centre of regulatory work in nuclear safety and of the entire national programme. Extensive research activities may not be possible for many countries beginning with nuclear power, but countries with established research programmes can share data through cooperative agreements and multilateral arrangements. A constant theme for emerging nations is understanding technical issues in safety related decision making. That cannot be contracted out. Your regulatory body needs to be able to understand safety relevant information.

J. Eibenschutz (Mexico): Should countries embarking upon a nuclear power programme start by establishing an independent regulatory body, or should it be part of the programme at the beginning and then split things up?

W. Borchardt (US NRC): My personal view is that it may not be practical to establish a completely independent regulatory body at the outset. However, the regulatory function — whether carried out by a separate agency or not — must be completely separate and independent. Many countries, including the USA, quickly learned that regulating and promoting nuclear energy could not be done within the same organization and thus created separate organizations.

A. Al Abri (Oman): If Jordan is considering going nuclear, would it be interested in connecting to the power grid of the regional Gulf Co-operation Council (GCC) interconnected system with neighbouring countries?

K. Toukan (Jordan Atomic Energy Commission): Yes, indeed. Currently, Jordan is connected to an electric power grid system with Egypt, the Syrian Arab Republic, Lebanon and, in the future, Palestine. The GCC has its own interconnectivity grid. The two grids are not connected, but I believe that — as countries in the region acquire nuclear power plants — in the future, they should be connected. In fact, Jordan's projected nuclear power plant will be near the Saudi border, and we are discussing connecting our grid to theirs, as the northern part of Saudi Arabia is disconnected from their own grid. Therefore, it makes a lot of sense to connect the grids in the area.

Y. Sokolov (IAEA): (1) Mr. Toukan, how does Jordan take IAEA recommendations and support services into account in the development of its nuclear power programme? (2) Mr. Pelzer, nuclear legislation has to reflect both the benefits and the risks of nuclear power development. You covered mainly risks. What can you add about the promotional part of nuclear power development in the legislation?

K. Toukan (Jordan Atomic Energy Commission): We are following all the milestones from the IAEA Milestones document. The two laws — the Nuclear Energy Law and the Nuclear Safety and Safeguards Law — follow

IAEA recommendations, for example, on independent regulatory infrastructure, and we are working with IAEA experts. We are studying and rely on many of the IAEA's international guidance documents. As mentioned by our colleagues, indeed IAEA documents are valuable references, which we can adapt to national needs. In combination with IAEA technical cooperation in all the areas I mentioned, we are receiving very strong and useful support.

N. Pelzer (International Nuclear Law Association): I provoked your question when I chose to leave out the promotional part of the legal issues. From the legal point of view, the more complex issue is that of addressing the risks or the 'taming' of nuclear energy. To promote an activity, a State has many options, and a legal framework is not necessarily the way to do it. Certainly, legal issues play a role — tax reductions, for example — but let me return to the 'taming' part. Legal control is also promotional because it gives legal certainty and a secure frame for developing nuclear energy. This is why we need transparency — clear language defining what the authorities require from the operator. This provides security for investment. We all know — when we build a house, for example — that administration can help or torture us in applying the same legal provisions. If a State wants to promote nuclear energy, it will find ways and means. In the existing law, some things promote nuclear energy, for example, if I look at nuclear liability law, it limits the amount, which is a promotional measure. Normally, liability is unlimited; the nuclear industry is a rare exception. Thus, promotion and control are linked. Other forms of promotion are beyond the law; a State can use other means. There is virtually no legal writing about the legal means to promote nuclear energy; even before the 'greens' became active, there was none.

I. Othman (Syrian Arab Republic): Considering the small size of grids in the region, what do you think of partnership? Of course, first a nuclear-weapon-free zone must be established in the Middle East.

K. Toukan (Jordan Atomic Energy Commission): For the grids, yes, indeed, at present, as a 1000 MW grid is too big for a country like Jordan. Once the nuclear power plant is operating, however, the grid will grow to double the size, not to speak of other projects that Jordan is embarking on. Also, grids in the region are being upgraded, for example, our grid with Egypt is being increased from 400 to 1000 MW — similarly with the Syrian Arab Republic and with Palestine — so introducing power plants with a regional grid would be a very convenient solution for meeting the future electricity needs of most of these countries.

Y. El Hag (Sudan): In this morning's technical session, one of the speakers highlighted the importance of building and operating a small power reactor (e.g. 25 MW) for countries whose expertise was confined to running research reactors. Given that Jordan is about to acquire a research reactor, how

do you see its applicability to building and operating a small power reactor for the Jordanian nuclear energy programme?

K. Toukan (Jordan Atomic Energy Commission): If you look at other countries, you see that it is not absolutely necessary to build a research reactor first. The applications are totally different. But constructing a small reactor would provide nuclear engineers an opportunity to get proper training and experience. Currently we are building a 5 MW research reactor to produce radioisotopes to support our geological survey programme, so this is totally independent of the nuclear power plant project. The two projects have to move in parallel because for us, time is of the essence. For the power plant project, part of the contract with the vendor will stipulate training for several hundred operators and technicians at the nuclear power plant, and this is totally independent of what happens at the research reactor. Indeed, having some trained engineers would be useful, but construction of the nuclear power plant should not wait till the research reactor is completed. In addition, we are working on a public–private partnership model where we will have an international operator on board, becoming a shareholder in the future nuclear power plant. As this will be a money generating utility, it will be a win–win situation for both. Vendors have shown great interest, and alliances have been formed between reactor suppliers and international operators who are really interested in becoming part of the project — not just constructing and leaving.

T. Feroukhi (Algeria): Will Jordan be able to establish an independent regulatory framework, the necessity of which was stressed by Mr. Pelzer? I have in mind the important role of the State in the promotion of nuclear energy — shared by a large majority of developing countries in supporting the promotional activities of the IAEA.

K. Toukan (Jordan Atomic Energy Commission): In our case, we are working on a parallel track to develop a regulatory framework. As we work on promotion — talking to vendors and suppliers and building a utility structure — in parallel, the Nuclear Regulatory Commission of Jordan is working with the IAEA on developing the regulatory framework for the nuclear power plant and also seeking consultants from the regulatory agency of a developed country who have previous experience. They will work with us during the plant pre-construction, construction and commissioning phases. Particularly for our first nuclear power plant, we believe international experience can greatly assist us.

F. Osaisai (Nigeria Atomic Energy Commission): (1) As a measure for mitigating cost overruns occasioned by regulatory uncertainties, the US NRC introduced a new regulatory regime whereby a combined licence is issued for construction and operation. Have any reactors been licensed under this new practice? How effective has it been? (2) A number of developing countries that

have started the process of introducing nuclear power do not have the requisite technical know-how or human resource base to conduct detailed design certification and related activities. Are there available mechanisms and cooperative agreements whereby established regulatory agencies can assist?

W. Borchardt (US NRC): (1) Regarding the combined construction/operating licence, some 30 reactors are being reviewed using this process, but none of the 104 currently operating reactors was licensed that way. They all received construction permits and, once built, operating licences. (2) Regarding cooperation between countries with emerging nuclear programmes and those with established ones, both bilateral and multilateral arrangements for exchanging information exist, which are proving to be very useful. Speaking for the NRC, we are most happy to describe our process for making regulatory decisions and performing technical reviews, although we believe that each country is responsible for its own national judgements, so we would try to help you understand what needs to be done but not take the decision for you.

Summary of Technical Session 4

RELIABLE FUEL SUPPLY, SPENT FUEL, WASTE MANAGEMENT AND STRENGTHENING OF NON-PROLIFERATION

Mr. P. Pradel, Head of the Nuclear Energy Division, Commissariat à l'énergie atomique, France, Moderator, opened the session by referring to the wide scope of the topics to be discussed, ranging from the fuel cycle and fuel supply for at least 60 years for new reactors to the management of spent fuel and radioactive waste, and issues of non-proliferation.

Mr. Gu Zhongmao, China Institute of Atomic Energy, China, started by noting that global energy demand will double by 2050; with 2.2 billion people without access to electricity and another billion without access to safe water, the demand will inevitably increase. He suggested that these challenges call for the development of low emission energy sources, in particular nuclear and renewables. He stressed the limitations of non-hydro renewables and suggested that nuclear is the only option to replace fossil energy as a base load. He noted that coal fired power constitutes 77 per cent of China's electricity production, causing a severe environmental problem today, and that the predicted energy capacity will increase by 460 GW in China by 2020. This has led to a major commitment to nuclear power. Mr. Gu noted that China plans a closed cycle option for future nuclear plants and that, in order to work towards this, considerable work on the back end of the fuel cycle is required in cooperation with others. China plans a commercial reprocessing plant by 2025 and is working to develop fast breeder reactor technologies. Mr. Gu said that for high level waste disposal, an underground laboratory is expected to be constructed by 2020 and a geological repository is expected to be built by 2060. Mr. Gu noted that indigenous closed fuel cycles for countries with small nuclear programmes will not be cost effective and that the spread of sensitive technologies may increase proliferation risks. He suggested that, to address this dilemma, there needs to be non-discriminatory access of all countries to the peaceful use of nuclear energy. He supported the idea of international fuel cycle centres that could include the concept of spent fuel take back by the fuel suppliers and increasing regional cooperation of spent fuel management. In concluding, he expressed hope that the IAEA would continue to play an important role in promoting the peaceful use of nuclear energy and strengthening the non-proliferation regime.

Mr. B. Pellaud, Nuclear Consultant, Switzerland, noted that although nuclear power can support sustainable development, its contribution thereto depends on the assurance of fuel supply and on a climate of international confidence, in which the proliferation risks associated with dual use technologies can be minimized. Mr. Pellaud recognized the latent conflict between assurance of supply and the proliferation risks associated with sensitive technologies and suggested that, in his view, there are three potential remedies: first, strengthening safeguards with no special arrangements; second, a partial denial of technology through reinterpretation of NPT provisions; and third, multinational alternatives to national enrichment, reprocessing or fuel supply facilities. Mr. Pellaud indicated that, in his opinion, only the third approach is a realistic option, since it is voluntary. He described why several non-nuclear-weapon States (NNWSs) have concerns over losing their fundamental rights to develop peaceful nuclear technology and why multinational arrangements could strengthen non-proliferation arrangements by putting such national facilities under the scrutiny of peers and partners. Mr. Pellaud described several different multinational arrangements that have been proposed. He then noted some considerations that need to be kept in mind when considering any option. He identified that small nuclear operators want a competitive market, which is not dependent on, located in or controlled by nuclear weapon States (NWSs), possibly through a broader liberalization of the fuel supply market. Mr. Pellaud proposed that the issue of new multilateral fuel supply facilities should be addressed at the 2010 NPT Review Conference with a possible proposal that future sensitive facilities should only be built as part of a multilateral or regional framework. He added that any multinational alternative proposals need to show an economic incentive for the customers and that, if there are proposals under the auspices of the IAEA, the IAEA Board of Governors would need to delegate to the Secretariat the required competence for applying the relevant release criteria for supply. Mr. Pellaud closed by noting that the nuclear community at large must readjust its plans and its vision in order to ensure a smooth expansion of nuclear power.

Mr. V.P. Kuchinov, Advisor to the Director General of the State Atomic Energy Corporation, Russian Federation, said that nuclear power plant operation does not pose proliferation risks, and hence he would concentrate on the interconnection between fresh fuel supply, spent nuclear fuel management and issues of non-proliferation. He noted that although existing uranium enrichment capacities are able to meet current demand growth, there are some opinions that nuclear power plants may lack fuel due to a politically motivated refusal of supply. Mr. Kuchinov referred to the proposal made by the President of the Russian Federation to establish a global energy infrastructure, which is in harmony with the IAEA multinational approaches to the nuclear fuel cycle, in

that it allows equal access to nuclear energy for all parties concerned, as well as strict compliance with the requirements of the non-proliferation regime. He suggested that fuel banks could be established in several different countries. Mr. Kuchinov then turned to the management of spent nuclear fuel. He noted that some countries plan disposal in deep geological formations, whereas many experts agree that reprocessing may help to provide fuel resources for centuries and reduce the volume and toxicity of high level waste. He recognized the concern regarding technologies associated with spent fuel reprocessing to separate pure plutonium and the proliferation risk that may be posed if they were to spread to countries currently without such technologies. Mr. Kuchinov proposed that further consideration be given to the establishment of regional centres for spent fuel and radioactive waste management. He noted the Russian commitment to supply fresh nuclear fuel to reactors of Russian design and to take the spent fuel back to the Russian Federation. He concluded by noting that international cooperation facilitates solving issues of nuclear energy development and strengthening the non-proliferation regime.

Ms. S. Laârouchi Engström, Vice President, Svensk Kärnbränslehantering AB, Sweden, reported that Sweden has 10 operational reactors producing about 50 per cent of Sweden's electricity. She noted that there are different authorities responsible for different activities, and that radioactive waste is generated in many different facilities, not just nuclear power plants. She described the different approaches for the different types of waste, and indicated that Sweden plans to develop a final repository for spent nuclear fuel, without reprocessing it. She described the outline plans and potential locations of the repository and the site investigations that have been carried out. Ms. Laârouchi Engström mentioned that the site investigations took into account safety, the impact of the operations on the environment and the impact upon society, and that the intention is to have trial operation by 2020 and routine operation by 2022. She described and stressed the importance of dialogue with the local people and explained the depth of the discussions, meetings and presentations that have been held. In conclusion, Ms. Laârouchi Engström noted that, following the local dialogue, the population adjacent to the two potential sites showed a markedly different attitude towards a repository than that of the general population of Sweden.

Discussion

P. Pradel (Commissariat à l'énergie atomique, France, Moderator): There were some common themes in the presentations. The first one was the dilemma between nuclear energy and non-proliferation, now in the new context of the nuclear 'renaissance' around the world. The second was the need for

multinational nuclear approaches, the internationalization of nuclear fuel supply and spent fuel management, with supply guarantee, especially for newcomers. The third theme was that the nuclear renaissance would require larger facilities at the front end and the back end of the fuel cycle rather than new facilities in each country — probably a regional approach, especially for the back end — but not only in NWSs, so conditions need to be discussed. The fourth was that the world community must address these problems and not postpone doing so by letting them rest pending discussions in the IAEA. This refers not only to repositories but to all major nuclear concerns.

M. Cojuangco (Philippines): How long will the internationalization of the fuel cycle take, especially the back end?

Gu Zhongmao (China Institute of Atomic Energy): It must be a gradual process — from simple to complicated. It may be simpler for the front end of the fuel cycle, so I think the IAEA's proposal of a three level arrangement — similar to that of the OECD — would ensure a supply of fresh fuel for reactors. For the back end, the most immediate problem is the safe and secure management of spent fuel. Then we need to consider the later processes, including the final disposal of high level waste. I think all this will require more than ten years.

M. Eltayeb (Sudan): As an ensured fuel supply not subject to discriminatory measures is of prime concern to all countries, can this problem be approached regionally? That could be under an international body such as the IAEA.

Gu Zhongmao (China Institute of Atomic Energy): China can participate in regional cooperation in the immediate future — in particular, in South-East Asia. Some newcomers, such as Vietnam and Thailand, have plans to acquire nuclear power, and some other countries are considering it. Regional cooperation needs dialogue and consultation at the expert and government levels.

I. Othman (Syrian Arab Republic): (1) If you do not increase enrichment and reprocessing facilities, how will you meet the rising demand for fuel that will come with the greater number of reactors in coming decades? (2) Do you think multinational staff means multinational partnership for facilities? (3) The classification into NWSs and NNWSs should not be applied for peaceful applications of nuclear technology such as for power reactors. (4) To dispel mistrust, justice and comprehensive peace are the assurance of non-proliferation worldwide.

B. Pellaud (Switzerland): (1) Regarding the expansion of demand for enrichment services, there are plans to expand existing facilities, for example, in the Russian Federation, Western Europe and the USA. My point is political rather than technical or commercial: of course, the Netherlands and Germany are NNWSs; however, under the Urenco agreement, no decision can be taken by a single country alone. Nevertheless, it is the political wish of many that

some of these facilities should be located outside NWSs, and I would give priority to a truly international facility. However, if Brazil and Argentina are working together, it is already a good thing. (2) In some cases there will be international staff, for example, for multilateral arrangements, such as that of Urenco for enrichment, where there is a multilateral agreement between the UK, Germany and the Netherlands and they combined their technologies when Urenco was created in the 1970s.

K. Araj (Jordan): Proposals for multilateral fuel supply should incorporate the principles of technology neutrality and fairness. Thus, any internationalization of sensitive fuel facilities should include NNWSs. Prior to that, the NPT should be made universal, and more serious efforts towards disarmament should be seen. However, new advances in technology could make such arrangements ineffective in terms of their original purpose.

M. Albert (France): (1) My comment with regard to ensuring fuel supply is that the distinction between NWSs and NNWSs does not appear to be the most relevant consideration. In fact, fuel cycle facilities — in particular the most sensitive ones: enrichment and reprocessing plants, and also fuel fabrication facilities — are distributed fairly equitably between NWSs and NNWSs. Therefore, other considerations are more relevant, such as who has the technology. (2) My question refers to the economic and commercial advantages of multilateral facilities. Could you elaborate on these advantages and comment on possible implications for maintaining unbiased competition?

B. Pellaud (Switzerland): (1) I am not obsessed with the NWS/NNWS distinction in this context. However, in Switzerland, we have been burned once by uranium embargos after the 'peaceful' Indian explosion of 1974. Suddenly Switzerland and many other countries were denied uranium delivery by suppliers because of that event — a traumatic one at the time. We did not like that denial and were suspicious of decisions taken rapidly. (2) I do not claim that international/regional facilities would be more competitive than existing facilities or those built in NWSs. I am simply saying that any facilities built anywhere must, firstly, be competitive. There is an economy of scale. You could gain by getting together to produce at a certain level. The rules are the same for everybody, so I see neither penalties nor benefits — except for the assurance of supply for the stakeholders — in joint enrichment projects: it would simply be a new market factor.

W. Gudowski (ISTC): (1) Are technological barriers effective against proliferation? Should not political and economic processes really be guiding non-proliferation? (2) Are non-State actors a real threat to non-proliferation? (3) Is it not inherently contradictory for the IAEA to be a non-proliferation 'watchdog' and — in the face of the nuclear 'renaissance' — to be promoting peaceful uses of nuclear energy?

V. Kuchinov (State Atomic Energy Corporation, Russian Federation): (1) There is no simple answer to the much discussed question of technological versus legal barriers. It is difficult to imagine any fully proliferation-proof technology. Conversely, no legal measure can provide full insurance against proliferation. Therefore, we need a combination of technology enforced by current and future legal instruments. (2) Non-proliferation is a problem addressed mainly to States. It is hard to believe that a subnational group would be capable of clandestinely constructing or operating an enrichment or reprocessing facility. However, there is a risk that such a group could possess and use nuclear material as a threat. The 'illegal networks' are more dangerous. They could distribute sensitive technology, as we have seen in the past. So we should separate these issues and find a proper way to combat pernicious subnational groups, whose development the State would also want to prevent. (3) As an authoritative international organization, the IAEA uses its three main pillars to promote and facilitate the peaceful use of nuclear energy and provides States with guidance for its safe and secure use. It would be quite dangerous to remove one of those pillars.

B. Pellaud (Switzerland): (3) Maybe I can add to the last point, as I worked at the IAEA as Deputy Director General of Safeguards. It is not really an internal issue. There is a clear separation of the duties. The Department of Safeguards operates along strict lines according to safeguards agreements, facility attachments and rules to prescribe all safeguards activities. I have not seen any conflict of interests. On the contrary, I would not like to see safeguards inspectors isolated from a nuclear environment, where they can learn from other colleagues. Embedding the inspectorate in the IAEA carries more benefits than disadvantages. Suppose — 20 or 30 years from now — that an organization exists to verify a fissile material cut-off treaty. I could well imagine a single organization in Vienna as a 'watchdog' applying safeguards to the fuel cycle and overseeing a cut-off treaty, mostly in NWSs. I could also imagine the Comprehensive Test Ban Treaty coming under that single organization. So in the future, the IAEA could be an independent organization. For the time being, however, I think that it is better the way it is, with safeguards able to take advantage of the technical environment.

K. Araj (Jordan): (1) What are the lessons learned from the Swedish and US experience in waste management? (2) How do you initiate dialogue with stakeholders, especially hard-core anti-nuclear ones?

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): (1) Comparing the Swedish and other approaches, there is no 'one size fits all', because of differences in legal frames, cultural heritage and even climate (a French colleague once told me that we have so many meetings because we do not know what to do with all the long, dark nights!). One common feature that we

could all share is being open to dialogue — not one-way information but two-way dialogue — listening to what the local communities are asking. Mostly you will find the answers in the questions. Also, have waste management as part of the initial planning for acquiring a nuclear facility. Swedish law requires this, and also decommissioning planning — really from the cradle to the grave. (2) The hard-core anti-nuclear ones I do not convince, because we have different agendas: they have a political one — where all nuclear is in the wrong — and we want to establish a facility. We do have dialogue, but they are not our first priority for engaging in debate. We focus on the people in the host community.

I. Othman (Syrian Arab Republic): I think the back end of the fuel cycle is riskier than the front end and — I agree with you — we should look at it carefully. The earth's resources are a gift of God but the nuclear industry is human made. Therefore, why should countries without the appropriate technology be denied it? They could have it in cooperation with technically advanced countries under the auspices of the IAEA. Why must this industry be the exclusive property of NWSs? Are they the only States with wise leaders who would not harm the world, and all the others have questionable, adventurist leaders? Why should civil nuclear power be treated differently from military power? In his presentation, Mr. Kuchinov said that balanced international cooperation must be the way to introduce new power for the prosperity and interest of humankind and to reinforce the non-proliferation regime.

R. Bernotas (Lithuania): We heard how solid radioactive waste is handled and stored. What about radioactive gas, like radon?

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): In underground facilities, radon is filtered and ventilated; not stored. The filters are processed as solid waste.

M. Cojuangco (Philippines): Ms. Engström, you said that you sometimes found the answers in the questions. Could you give us an example?

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): Listening carefully to people's questions, you may learn the issues that you should be working on. For example, with one community we were discussing technology and safety, which was important, but their questions were about their quality of life and how a final repository would alter their lifestyle, health and environment. Sometimes they are not looking for answers; just a dialogue will be fine. I wanted to emphasize the listening part of the dialogue. As engineers, we tend to try to solve problems, but we are not experts on people's lifestyles in their own communities. They are the experts.

J. Eibenschutz (Mexico): Ease of detection of infinitesimal amounts of radioactivity is one of the main arguments in favour of simplified radioactive waste storage systems, because you can always react quickly to a detected leak.

However, this argument is not being used. The reason for this, perhaps, with regard to spent fuel, is not only avoidance of harm to people but also ensuring that the material is difficult to retrieve. Moreover, generally governments are reluctant to support nuclear if it runs counter to public opinion. In Sweden, I understand that you had government backing for your dialogue with communities, which required a commitment on the part of the government to a national waste storage system. Please comment on the role of government with regard to exploitation of public opinion.

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): You differentiate between the opinion builders and the politicians. I have been meeting politicians for the past 20 years on both the community and the national level. They are very sensitive to opinion builders and the ideas flourishing in their communities. In Swedish law, local communities have a veto right, so they can prevent government approved construction from being built. So local politicians stay in touch with the opinion builders in their communities; they do not work in opposition. All governments want to solve the waste management problem, which has been used as a tool of obstruction to nuclear production.

M. Daud (Malaysia): One of the major challenges for newcomer countries is waste management — at least for Malaysia — and that of convincing the public at large. Despite your intense engagement and dialogue, over 50 per cent of the Swedish public are anti-nuclear, while the communities around the nuclear sites apparently strongly support a nuclear waste repository. How do you see the trend in the future?

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): Lots of social research has been done, particularly in the USA and later in Sweden and in the UK. The results concur: communities in the vicinity of a facility, or potential facility, are always the most in favour. The further away you go, the greater the opposition you encounter. Is this a contradiction? Not really, because those immediately affected try to get better informed. They feed their feelings with facts; they don't simply react emotionally. The more you know, the less frightening it is. Monsters live in the dark.

M. Cojuangco (Philippines): Was there any fiscal incentive to the local community in Sweden for the siting of the repository?

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): At the beginning, no. Sweden has a very Lutheran attitude towards bribery. No money should exchange hands before the work was done. One year ago, once the siting investigations and analyses had been performed, the two local mayors stepped forward and asked for infrastructure subsidies that might be beneficial for both the industry and the community. We reached an agreement — in effect for two weeks now — for the equivalent of €200 000, modest by world standards, to be invested in infrastructure and competence building.

F. Osaisai (Nigeria Atomic Energy Commission): For countries interested in starting a nuclear power programme, considerable knowledge and experience in waste management is available. Sweden has operated a central spent nuclear fuel storage facility for some time. Were the processes that led to its siting difficult? How can we learn from this experience?

S. Laârouchi Engström (Svensk Kärnbränslehantering AB, Sweden): Selecting sites 20 years ago was easier than now. Then, siting nuclear facilities was an issue between the industry and government safety authorities. The third party — the community — was engaged on a very modest level. I think that siting an interim storage facility today would require the same kind of dialogue that we have been engaged in for the last 14 years on final storage for spent nuclear fuel — a major effort.

G. Schulte (USA): I am the permanent representative to the IAEA from the USA. I heard two important statements on Monday. First, IAEA Director General ElBaradei told us that he hoped to present proposals on fuel assurance to the IAEA June Board. Second, our Chinese hosts told us that they were prepared to participate actively and constructively in the discussion of these proposals and, on that basis, authorize the IAEA to develop mechanisms to ensure nuclear fuel supply. I propose we follow the lead of our hosts and give these proposals serious, constructive consideration. The IAEA has been discussing reliable access to nuclear fuel for 50 years. Now we can move from theoretical discussion to consideration and implementation of substantial proposals. Concepts, funding and Member State interest are converging. Two concepts are nearing maturity: an international fuel bank to be managed by the IAEA, and a Russian proposal to guarantee supply under IAEA auspices. The concepts are both sound and complementary. We also have funding. Over 30 States plus the Nuclear Threat Initiative have committed $150 million to the international fuel bank, which Kazakhstan is considering hosting. The Russian Federation has offered to produce and stockpile the low enriched uranium for its concept. Finally, as more and more countries look to nuclear power, more and more are expressing interest in having fuel banks to back up the commercial market, so long as the fuel banks do not deny any rights — which they will not. President Obama is a proponent of fuel banks. As a senator, he supported a $50 million contribution to the international fuel bank. As President, he called on all of us to establish fuel banks as part of an effort to help countries gain access to nuclear power while strengthening the world's non-proliferation regime. A strong non-proliferation regime is central to the President's vision — set forth in Prague earlier this month — of a world free of nuclear weapons but taking advantage of nuclear power to support economic growth and development, energy security and our collective fight against climate change.

OPENING REMARKS

Chen Qiufa
Chairman, China Atomic Energy Authority

Distinguished Vice Premier Zhang Dejiang,
Distinguished Director General Dr. ElBaradei,
Distinguished Secretary-General Mr. Gurría,
Ladies and gentlemen, good morning.

Entrusted by the President of this conference, I am privileged to be the host of the opening ceremony of the International Ministerial Conference on Nuclear Energy in the 21st Century. At the outset, please allow me, on behalf of the conference, to extend a warm welcome to all distinguished guests, leaders, guests from the nuclear industry and media friends.

In today's opening ceremony, we have with us on the podium:

- Mr. Zhang Dejiang, Vice Premier of the State Council of China;
- Dr. Mohamed ElBaradei, Director General of the International Atomic Energy Agency;
- Mr. Angel Gurría, Secretary-General of the OECD;
- Mr. Luis E. Echávarri, Director General of the OECD/NEA;
- Mr. Yury Sokolov, Deputy Director General of the IAEA;
- Mr. Zhang Guobao, Vice Minister of NDRC and Administrator of the National Energy Administration;
- Mr. Xiao Yaqing, Deputy Secretary General of the State Council;
- Mr. Li Ganjie, Vice Minister of Environment Protection and Administrator of the National Nuclear Safety Administration.

Let's give our sincere thanks for their presence at the conference with a round of warm applause.

The conference is a grand event in the international nuclear field, and has attracted wide attention and the strong support of a number of countries and international organizations. Four hundred and forty-two representatives and 365 observers from 68 countries and 8 organizations are attending this conference.

As the host, the Chinese Government attached great importance to the conference. Today, Vice Premier Zhang Dejiang attends the meeting and will deliver a speech.

OPENING STATEMENT

Zhang Dejiang
Vice Premier of the State Council of China

Distinguished Director General Dr. ElBaradei,
Distinguished Secretary-General Mr. Gurría,
Distinguished ministers and high level representatives,
Ladies and gentlemen,

The International Ministerial Conference on Nuclear Energy in the 21st Century, organized by the International Atomic Energy Agency and hosted by the Chinese Government, opens in Beijing today. I would like to express warm congratulations on behalf of the Chinese Government on the opening of the conference and to extend a heartfelt welcome to all participants.

Ladies and gentlemen,

Nuclear science and technology is one of the greatest scientific and technological achievements of humankind in the 20th century. Nuclear science and technology is widely applied in various sectors, with over 50 years of development, such as energy, industry, agriculture, health and environmental protection, and is playing an important role in the prospering economy, and in improving peoples' livelihoods and promoting sustainable development. With global economic development and rising energy consumption, supply of traditional energy sources is becoming more stretched, and climate change is becoming an increasingly severe challenge. It is a common task of the international community to develop and utilize clean and renewable energy sources and properly address growing contradictions among economic development, energy development and environmental protection. Given its advantage as a clean, safe energy source that could be applied at a large scale, more and more countries are placing importance on nuclear energy. Accelerating the peaceful use of nuclear energy is the common wish and inevitable choice of many countries.

China started the development of nuclear energy in the early 1950s, and with the efforts of over half a century, China has established a relatively complete nuclear industry system. The installed capacity of nuclear power has reached 9 100 MW(e), and nuclear power generation accounts for 2 per cent of the national total electricity generated. Nuclear energy is playing an incremental role in China's economic development. However, nuclear energy

utilization is rather insufficient in China, its development level is behind countries which are advanced in nuclear energy use such as the United States of America and France, and the rate of nuclear power generation in the total electricity generated still falls behind the world average level. China's energy supply mix features a dominance of coal and a low proportion of clean energy. To achieve sustainable energy and socioeconomic development, China has formulated the energy development strategy of actively promoting energy conservation and optimizing the energy structure. Accelerating nuclear power development and enhancing the ratio of clean energy such as nuclear power in the aggregate energy supply is the priority of China's energy development strategy. Currently, the peaceful use of nuclear energy has entered a stage of rapid development. A batch of new nuclear power projects are starting construction in coastal areas, preparation for other new projects is going on in an orderly manner, and demonstration projects of the introduction of third generation nuclear power technology are moving ahead smoothly. Scientific and research engineering programmes such as China's experimental fast reactor, high temperature gas cooled reactor and thermal nuclear fusion device are making positive progress. The nuclear fuel cycle industry continues its development, and the ability to ensure supply of nuclear fuel is being enhanced.

China has always attached great importance to nuclear safety in its promotion of nuclear energy utilization, and it has established a fairly complete nuclear safety legal, regulatory and emergency management system that is in line with international best practices. China has issued a series of instruments such as nuclear safety regulations, rules, guidelines and standards. Independent, strict and efficient nuclear safety supervision and management and scientific management of nuclear facility operators have been put in place to ensure safe and secure operation of nuclear facilities. All these efforts have led to a sound nuclear safety record and have boosted public confidence in nuclear energy.

Ladies and gentlemen,

As a responsible and peace loving country, China consistently advocates the complete prohibition and thorough destruction of nuclear weapons, and is sternly against any form of proliferation of nuclear weapons and engages in active international cooperation in non-proliferation. Through the years, in addition to its efforts in nuclear energy development, the Chinese Government has been actively participating in international non-proliferation cooperation. China has joined all the major international non-proliferation mechanisms and established a complete domestic nuclear safeguards, nuclear material

management and nuclear export control system, making notable contributions to maintaining and promoting global and regional peace and stability, and ensuring the peaceful use of nuclear energy.

Ladies and gentlemen,

Since its establishment, the IAEA has faithfully performed its missions entrusted by the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the IAEA Statute, and made unremitting efforts and a remarkable contribution to promote worldwide development of the peaceful use of nuclear energy and prevention of proliferation of nuclear weapons. The Chinese Government would like to express appreciation in this regard.

The Chinese Government highly values the IAEA's role in the peaceful use of nuclear energy and non-proliferation, and actively participates in deliberations of relevant issues within the IAEA's framework, and earnestly undertakes its international obligations. At the same time, China has strengthened cooperation with the IAEA and conducted fruitful cooperation in nuclear technology, nuclear safety and nuclear safeguards, and enhanced the overall capability of China's nuclear energy development. The Chinese Government will, as always, support the IAEA and would like to continue to enhance and expand cooperation in various fields.

Ladies and gentlemen,

The current global financial crisis has severely hit world economic development and has resulted in new challenges for international nuclear energy development. It is the right time to hold this conference, which is a rare opportunity for the international nuclear community to exchange experiences in nuclear energy development, explore future strategies and deliberate on plans for sustainable nuclear energy development. I hope that the delegates of all parties can centre on issues of common concern, conduct in-depth communication, increase understanding, narrow differences and reach consensus. I believe that with the joint efforts of the international community, this conference will reach expected goals and make a significant contribution for promoting world nuclear energy development.

In conclusion, I wish the conference a complete success, and good health and a pleasant stay in Beijing to all.

OPENING STATEMENT

Mohamed ElBaradei
Director General, IAEA

In the four years since the last Ministerial Conference on Nuclear Energy, both global energy demand and interest in nuclear power have continued to grow. Most of the 30 countries already using nuclear energy plan to expand their output. More than 60 countries — mostly in the developing world — have informed the IAEA that they might be interested in launching nuclear power programmes. Of these, 12 countries are actively considering nuclear power.

The biggest change since the March 2005 Paris conference — one which none of us could have foreseen then — has been the global economic crisis. There is much discussion about what effect this unprecedented crisis will have on plans for nuclear energy. I have no doubt that this will play an important part in your deliberations in the next three days. It seems likely that the crisis could delay the implementation or expansion of nuclear power programmes in some countries for a limited period. But it is clear that, in the medium and long term, global demand for energy will continue to increase significantly as countries everywhere seek to improve living standards. Although nuclear power is not a panacea for all the world's energy problems, it will continue to play an important role in the global energy mix. The OECD Nuclear Energy Agency's high projection is for global nuclear power capacity to grow by around 66 per cent by 2030.

I will begin my remarks by reviewing the current state of play in the nuclear energy sector. I will update you on what the IAEA is doing to help Member States, especially so-called 'newcomers' to nuclear energy. And I will conclude with some observations about the future of the IAEA, highlighting issues which I believe governments, the nuclear industry, regulators and users of nuclear power need to consider carefully.

CURRENT STATE OF THE NUCLEAR ENERGY SECTOR

The year 2008 was somewhat paradoxical for nuclear power. It was the first year since 1955 in which not a single new power reactor came on-line, but it also saw construction start on no fewer than ten new reactors. This was the highest number since 1985, the year before the Chernobyl accident. There are now 436 nuclear power reactors in operation in 30 countries. Growth targets have been raised significantly here in China, in India and in the Russian

Federation. Asia remains the focus of growth in nuclear power. Of the ten construction starts in 2008, eight were in this region — and six of them were in China. In the United States of America, the Nuclear Regulatory Commission has received combined licence applications for 26 new reactors. In Europe, Italy plans to restart its nuclear power programme, while the Swedish Government has proposed dropping plans to phase out nuclear power and building replacement reactors. Other European countries also have expansion plans.

Growing global demand for energy throughout the 21st century will reflect continued population growth, the drive by developing countries to connect the 1.6 billion people who have no access to electricity and the 2.4 billion who have no access to modern energy systems. We have to understand that there is no development without energy, and if we need to improve the lives of one third of humanity who live on less than $2 per day, we need to increase our supply of energy and electricity. In many countries, therefore, there is a need for major investment in new electricity production plants, both to increase capacity to cope with the constant development of new technologies for industry and consumer use and to replace old, uneconomic and environmentally damaging power plants. And in this context there are a number of key drivers that are fuelling increased interest in nuclear energy — in particular, energy security and the environmental benefits.

Back in the 1970s, concerns about supply security, triggered by the oil price shocks, were a major cause of nuclear expansion in countries such as France and Japan. Today, there are concerns about dwindling reserves of fossil fuels, and some countries worry that their supplies of oil and gas are vulnerable to disruption. The sometimes dramatic fluctuations in the prices of oil and gas are a major concern. Many countries are also looking to renewables as a means of ensuring diversity of energy supply.

Environmental concerns are a second key driver. Nuclear power emits almost no greenhouse gases, and it is therefore seen by many as part of the solution to the problems of global warming and climate change. The entry into force of the Kyoto Protocol and the European carbon trading scheme means there is now a real financial benefit to avoiding greenhouse gases. This increases the attractiveness of low carbon electricity generation such as nuclear power and renewables.

The attraction of nuclear energy is supported by the improved performance of the nuclear energy industry since the 1980s. The world has now accumulated more than 13 000 reactor-years of experience. Improvements in safety have been matched by improvements in efficiency. Nuclear plants are more economical to run, availability and productivity have increased, and there is less downtime for maintenance. The long term stability of the cost of electricity generated by nuclear power is also an important attraction.

POTENTIAL RISKS

Overall, safety is much better than it was 10 years ago, but we still have vulnerabilities in safety, as well as in security — even in countries with significant nuclear programmes. In some countries we see a troubling combination of old reactors, operators which are poorly managed or underfunded, and weak regulators. This needs to be addressed. It is in all our interests to ensure that the highest safety standards are upheld everywhere. A strong focus on safety and security should be seen as an enabler of the further development of nuclear energy rather than as a hindrance. New ideas and innovative thinking to address challenges to nuclear safety and security should be encouraged.

As far as non-proliferation risks are concerned, countries that have mastered uranium enrichment and plutonium separation can be viewed as nuclear weapons *capable* States, meaning they could develop nuclear weapons within a short time span if they walked out of the NPT or launched clandestine programmes. This is too narrow a margin of security, in my opinion. These countries may have no intention of ever making nuclear weapons, but that can change quickly if their perception of the risks to their national security changes. And security perceptions, as we know, can change very rapidly.

For some years, therefore, I have been advocating the establishment of multinational mechanisms to ensure access for all countries to nuclear fuel and reactor technology, as envisaged in the IAEA Statute. Important progress has recently been made on a number of proposals, including the establishment of a fuel bank to be managed by the Agency, and a Russian proposal to guarantee supplies of low enriched uranium to the Agency. I hope to present proposals on this to our Board of Governors in June. I remain convinced that, ultimately, a multinational approach to the entire fuel cycle — including the back end — has great potential to facilitate the expanded safe and secure use of nuclear energy for peaceful purposes, while reducing the risk of proliferation. I hope that the new environment created with the declaration by Presidents Medvedev and Obama to move through concrete steps along with other weapon States to establish a world free from nuclear weapons should create a new and positive atmosphere in this regard.

ROLE OF THE IAEA

Every country has the right to make use of nuclear power, as well as the responsibility to do so in accordance with the highest standards of safety, security and non-proliferation. The IAEA's statutory objective is "to accelerate

and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world." That means helping interested Member States to exercise their right to use nuclear power and to meet their responsibility. Our advice has the advantage of being comprehensive and impartial.

Requests from Member States for the Agency's assistance with nuclear power projects have grown significantly. We help them to analyse their energy system to see under what conditions, if any, nuclear power might make sense. Sometimes, our advice is that a country should not resort to nuclear power at this stage and that other energy sources might be more appropriate.

Before countries decide to proceed with the introduction of nuclear power, we impress upon them the fact that they will need to plan properly, to build the human resources and infrastructure, to establish independent and effective regulators and to adhere to international safety, security and non-proliferation instruments. The IAEA has developed milestones to help countries work systematically towards the introduction of nuclear power. We provide guidance, organize workshops and give specific assistance if requested. We offer advice on drafting nuclear legislation, and we train regulators and operators. We have developed a methodology that countries can use to perform a self-assessment of whether they are ready to introduce nuclear power, and we offer a service to provide an integrated nuclear infrastructure review (INIR) for any interested country as it moves towards nuclear power.

We stress that the primary responsibility for all aspects of a nuclear power programme — and in particular for safety, security and safeguards — lies with the countries concerned. This cannot be outsourced. By launching a nuclear power programme, countries take on a long term commitment to deal responsibly with nuclear material for possibly hundreds of years. It is vital that they develop sufficient national expertise so they can take full responsibility for all aspects of running a nuclear plant in the long term.

We also make the companies that supply the equipment and expertise aware of *their* responsibility. Suppliers of nuclear technology owe a duty of care to the recipients and to the world at large. This is because failures of either safety or security can have consequences stretching well beyond national borders, as the Chernobyl accident demonstrated. Cooperation between the suppliers and users of nuclear technology must be continuous, stretching well beyond the handover of a plant to an operator. Public attitudes towards nuclear energy have become more positive in the past decade, due not least to improvements in safety and growing concern about climate change. But the nuclear industry needs to remain open and transparent in order to generate and maintain public trust.

Although in many countries high level radioactive waste has been safely stored for many decades, the management of spent fuel and disposal of high level radioactive waste remain key challenges for the nuclear power industry. Experts agree that the geological disposal of high level radioactive waste is safe and technologically feasible. Finland and Sweden have made the most progress in this area. However, public opinion will remain sceptical at least until the first deep geological repositories are operational in a decade or so.

STRENGTHENING THE IAEA'S ROLE

I have been concerned for some time about the erosion of the IAEA's ability to perform effectively the tasks entrusted to us by Member States because of years of zero growth budgets. Fortunately, there are now reasons for hope on that front. An independent Commission of Eminent Persons, which I appointed to make recommendations on the future of the Agency, proposed last year that our budget should be doubled by 2020. Recently, the new US administration of President Obama has proposed that our budget be doubled within four years. Our latest budget submission proposes a substantial increase in resources in order to meet the growing demand from Member States for Agency services in all areas of our work.

Of course, money is not the whole problem. As well as adequate, stable and predictable resources, the Agency needs sufficient legal authority in nuclear verification, safety and security if it is to do its job properly. I hope that before long all Member States will have implemented the Additional Protocol to comprehensive safeguards agreements so the Agency can credibly verify that no undeclared nuclear activities are taking place. I also hope that all Member States will join the safety and security conventions and adhere to all Agency standards.

The Commission of Eminent Persons made many practical suggestions for strengthening the Agency and improving our services to Member States. I would like to single out two that I believe may be of particular relevance to your discussions here in Beijing. The first is that global nuclear security standards should be made *binding* rather than voluntary as at present, so that the risk of nuclear terrorism — the most dangerous threat we face — can be addressed more effectively. The second is that the IAEA should lead an international effort to establish a global nuclear safety network, also based on binding agreements. Countries should submit to mandatory international nuclear safety peer reviews. Having seen peer review in action through voluntary Agency mechanisms such as our Integrated Regulatory Review

Service (IRRS), I firmly believe that this is the way ahead — experts and practitioners sharing experience and best practices for the benefit of all.

In conclusion, I would like to thank the Government of China and the China Atomic Energy Authority for hosting this important International Ministerial Conference on Nuclear Energy in the 21st Century, and for their generosity and support. I wish you every success in your discussions.

OPENING STATEMENT

Angel Gurría
Secretary-General, OECD

Minister Li Yizhong,
Doctor ElBaradei,
Ladies and gentlemen,

It is a great honour to open this International Ministerial Conference on Nuclear Energy. It is also a privilege for the OECD Nuclear Energy Agency to co-sponsor this conference. I wish to thank both our hosts, the International Atomic Energy Agency and the Government of China, represented by the Ministry of Industry and Information Technology and the China Atomic Energy Authority, for convening us today to advance on our common goal: to secure clean and peaceful nuclear power for the 21st century.

The global crisis has exposed not only the paramount challenges of today's global economy and the remarkable level of interdependence among our nations. It has also confronted us with our duty to define the kind of global economy we need for tomorrow. It is our responsibility to devise sound policies for a stronger, cleaner and fairer global economy. Clean and affordable energy, including access to safe and secure nuclear power, should be a central element of our efforts. This is essential not only for a sustainable economy, but also for the future of our planet.

The crisis has prompted us to act immediately and in concert. Take the example of our hosts, the Government of China. In the face of the economic slowdown, they responded rapidly and in a comprehensive fashion. Importantly, they increased government spending, and stimulated domestic demand, and are looking into effective ways to enhance social policies. The turmoil showed that China and all of us need to be more involved in international economic cooperation. We are profoundly affected by the policies implemented by each of our countries. There is no better example than energy to illustrate our interdependence. Holding this meeting in Beijing shows the importance China places on international cooperation and recognizes the role China could play in designing clean and safe energy solutions for the future.

For me, coming to Beijing is also an opportunity to stress the high significance of the OECD partnership with China. Our organization is now more open and plural, welcoming new members and having launched an 'enhanced engagement' process with the most important emerging economies.

Forging a more structured and stronger partnership with China is fundamental in such a process. It is based on our mutual interest to develop global solutions to global challenges, such as nuclear energy in the 21st century.

Thus, I urge you to look into three important issues, which we should address in the years to come, namely, security, financing and development of nuclear energy.

NUCLEAR POWER: ENERGY SECURITY AND SUSTAINABILITY

Sustainable growth cannot be fully restored without secure access to energy and electricity. However, the way we have produced and used energy so far is not sustainable. Carbon releases resulting from fossil fuel combustion need to be reduced drastically in order to avoid global warming. Local and regional air pollution induced by burning coal and using petroleum has reached unprecedented levels in many countries. The depletion rate of natural resources, such as oil and gas, needs to be controlled for the sake of future generations. At the same time, access to and the price of electricity for the most vulnerable of the world need to be kept at a level compatible with the overall reduction of poverty and the achievement of the Millennium Development Goals.

Our obligation to future generations is to address these challenges of energy security and sustainability today. Therefore, we need to advance on many fronts: policy design and implementation, effective regulation, full recognition of the negative impact of carbon emissions, and ensuring the security of supply. Clearly, the development and commercial deployment of low carbon or carbon free energy sources are essential prerequisites for the achievement of sustainable energy policies.

Nuclear energy should be a part of such a better future, but only if we can reconcile its development with social and environmental concerns. Cleaner, carbon free sources will also help to respond to growing energy demand. Projections suggest that by 2030 energy demand in the world will increase by 45 per cent and electricity consumption by 75 per cent. Nuclear energy has the potential to meet a significant part of future demand, while reducing tensions on hydrocarbon markets and alleviating the risk of global climate change.

However, the management of radioactive waste is an important concern for governments and society at large. The volume of waste is small but its radiotoxicity is high. Progress towards the construction, commissioning and operation of repositories for all types of radioactive waste should fully address this concern, and in a manner that enhances public confidence.

In the nuclear domain, the role of governments goes beyond setting national energy goals. Governments should work together with private stakeholders to enhance the effectiveness of regulatory regimes and to ensure that the nuclear industry keeps safety and environmental protection as its highest priority. International organizations such as the OECD/NEA and the IAEA are supporting national and multilateral efforts in this direction, such as the Multinational Design Evaluation Programme (MDEP).

Another crucial challenge that governments have to address is finance.

FINANCING ENERGY DEVELOPMENT: THE ROLE OF NUCLEAR POWER

Today, compared with other sources of baseload electricity, notably coal and gas, nuclear generated electricity is very competitive in most countries. Since the cost of uranium amounts to only about 5 per cent of the cost of nuclear generated electricity, the latter is very stable, and this long term stability is an important asset for electricity intensive industries. In their efforts to mitigate the economic and social consequences of the present economic crisis, governments may rely on nuclear energy to enhance the competitiveness of domestic industries and underpin economic growth.

Financing nuclear plants and fuel cycle facilities is, however, an issue. The current generation of reactors is very capital intensive and takes a long time to build. This involves risks that may be difficult for private investors to accept. The current crisis is adding to the challenge of financing the nuclear power industry, as well as wind and solar projects.

However, the financing of carbon free energy facilities will bring along opportunities to create new businesses, new industries and millions of new jobs. Governments can facilitate investments in the sector by ensuring a stable regulatory regime and avoiding undue licensing delays. Furthermore, specific measures, such as loan guarantees, public–private partnerships and other innovative means to finance nuclear facilities and to mitigate risks for developers of new technology, should also be explored.

Currently identified uranium resources are sufficient to fuel nuclear power plants for many decades, while production capacities are distributed in a broad range of countries. In addition, strategic stocks could be accumulated easily and at a low cost. Looking beyond a few decades, advanced nuclear systems capable of breeding fissile nuclear fuel could become commercially available. Fast neutron reactors under development can reuse fissile and fertile materials retrieved from spent fuel of all reactors. They could multiply by 50 or

more the lifetime of uranium resources and eventually bring nuclear energy into the family of renewable sources.

Ensuring adequate financing for the development of such innovative technologies should be a priority as a matter of energy security. Our ideas and achievements addressing this issue should be shared with emerging economies. Let's not forget that today just three countries — France, Japan and the United States of America — have 57 per cent of the world's nuclear generating capacity[1], and that nearly 74 per cent of the increase in global primary energy needs between 2005 and 2030 will happen in developing countries[2].

THE WAY FORWARD: A CHALLENGING AGENDA FOR GOVERNMENTS

In the long term, there will be no single 'solution' to providing abundant, clean and affordable energy. Expanding nuclear energy, as a part of the energy 'mix' for the future, requires collective action by governments, researchers and the private sector. This is not only a challenge, but also an opportunity to revive the economy. Our success will depend on our capacity to address technical challenges, to invest in nuclear science and R&D, and to find new ways to work, plan and design in a more cooperative manner.

We will have to provide not only adequate infrastructure but, most importantly, human resources. Highly trained scientists, engineers and skilled craftspeople are in short supply. The Steering Committee of the NEA alerted governments to the importance of qualified manpower for the success of nuclear energy programmes.

While the industry is actively involved in nuclear R&D, governments should continue supporting research and long term projects. Innovative nuclear systems responding to the requirements of the 21st century are often conceived and designed within international frameworks. The Generation IV International Forum (GIF), for which the NEA is serving as Technical Secretariat, and the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) led by the IAEA are examples of such international endeavours. Our host, China, takes part in both projects and has

[1] OECD NUCLEAR ENERGY AGENCY, *Nuclear Energy Outlook 2008*, OECD/NEA, Paris (2008) p. 18.

[2] INTERNATIONAL ENERGY AGENCY, *World Energy Outlook 2007*, OECD/IEA, Paris (2007) p. 42.

comprehensive R&D programmes, in particular on high temperature reactors and fast neutron systems.

Ladies and gentlemen,

The current global trends in the energy sector are unsustainable as they prepare a dirty, insecure and expensive future. We must work together towards a system of energy supply with much lower carbon intensity. There is no 'silver bullet', and it is essential to keep all low carbon energy options open and to avoid idolizing or demonizing any technology.

In this context, it seems crucial to reconsider the role of nuclear energy and to drop its exclusion from the flexibility mechanisms of the Kyoto Protocol. Indeed, nuclear power can provide clean energy in a safe and cost effective manner. We have two main challenges in this respect: to increase public confidence that high level radioactive waste will be safely managed in the long term, and to ensure more political and regulatory stability in order to reduce business risks and facilitate decision making by investors. Governments have a major role to play in these two areas.

Nuclear energy can play an important role in the energy mix for the 21st century. Joining forces to allow nations safe and secure access to nuclear power is critical to rise to the challenge of energy security. Intergovernmental organizations such as the OECD are providing a framework for effective international cooperation. Today I would like to state clearly the commitment of the OECD Nuclear Energy Agency to continue supporting collective action for safe, emissions free, low cost nuclear power.

I am confident that the conference will be a major milestone on the road map for safe and effective nuclear energy programmes in the 21st century. I thank you for your attention and wish you fruitful debates.

OPENING STATEMENT

Chen Qiufa
Chairman, China Atomic Energy Authority

Ladies and gentlemen,

The China Atomic Energy Authority is the authority responsible for China's nuclear industry development and the representative organization of the Chinese Government for participating in IAEA related activities. As the Chairman of the CAEA, I would like to use this opportunity to share my views on nuclear energy development.

As an important part of modern high level technology, nuclear energy, as a proven, safe and clean source of energy, plays an outstanding role in the economic and social development of humanity. The development and application of nuclear energy, involving basic nuclear research, engineering design, equipment manufacturing, nuclear fuel supply, nuclear safety regulation, nuclear waste treatment and disposal, nuclear non-proliferation, public acceptance and so on, is fairly complicated systematic engineering. Looking back on China's more than 50 year history of nuclear energy, and looking to the promising prospect of nuclear energy development in the new century, I believe the following six development rules should be prioritized, so as to achieve sustainable and healthy development of nuclear energy for the benefits of society.

MAKE OVERALL PLANS

The development of nuclear energy should proceed from the strategic overall picture, including national economic development, social progress and environmental protection, obtaining a common understanding of the social, making long term development plans, and carrying them out consistently. At the beginning of reform and opening-up, when China had just begun its nuclear power development, the Three Mile Island nuclear power plant accident and the Chernobyl accident happened, which plunged the world nuclear industry into stagnation. The Chinese Government made the decision to continue to develop nuclear energy for economic development, which laid the foundation for China's nuclear energy industry. In recent years, the Chinese Government has made the strategic decision of actively promoting nuclear energy

development, and the Eleventh Five-year Plan of Nuclear Industry and Mid- and Long-Term Nuclear Power Development Plan have been made successively. The China Atomic Energy Authority, along with relevant ministries, will earnestly carry out the decisions of the State Council, and make overall plans to advance the sustainable development of the nuclear industry.

IMPOSE STRICT REGULATIONS

China attaches great importance to nuclear safety, and has acceded to the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management. China has established a relatively complete nuclear safety regulation system and supervision management system. The nuclear safety regulatory authority conducts stringent, effective and independent regulation through the nuclear safety licensing system, while the nuclear operation institutions strictly abide by the regulations, improve the quality security system and build a nuclear safety culture to ensure the safe operation of nuclear facilities. To respond to an emergency such as a nuclear accident, China has established the National Nuclear Emergency Response Coordination Committee comprising 18 ministries and organizations, and has drawn up national nuclear emergency counterplans. To resolve radioactive waste properly, China is intensifying research efforts on critical technologies such as the decommissioning of nuclear facilities, spent fuel reprocessing, radioactive waste treatment and disposal, and separation and transmutation, and is laying down the strategy of regional near surface disposal of low and intermediate level radioactive waste, and deep geological disposal of high level and transuranium radioactive waste, to reduce the volume of radioactive waste and ensure the permanent safety of the environment. At present, disposal of low and intermediate level radioactive waste is at the industrial scale, and studies and related projects on deep geological disposal of high level radioactive waste are making positive progress, because of the effective measures on the issues of nuclear safety and radioactive waste.

CONSOLIDATE THE FOUNDATIONS

China highly values the development of fundamental nuclear research capabilities. With input from the Government and the industry for decades, a nuclear scientific research system, including basic study, application study and engineering study, and a batch of advanced large scale nuclear scientific

research bases have been established, and a great number of fundamental and engineering studies have been conducted in the field of reactors, accelerators and fusion, with distinguished achievements.

Now, a 10 MW high temperature gas cooled reactor has been constructed; the CEFR (China Experimental Fast Reactor) is going well; and the research of China Circumfluencor-II and EAST has also had some breakthroughs. The 'three step' approach of nuclear power development, from thermal reactors to fast neutron breeding reactors and then to controlled fusion reactors, is now developing steadily.

PUT IN PLACE EFFECTIVE CONTROLS

With several decades of development, China has mastered the crucial techniques such as uranium prospecting and mining, uranium purification and conversion, uranium concentration and fuel element fabrication, with production capability to some scale. China will actively participate in the discussions on establishing a multilateral nuclear fuel supply mechanism with a constructive attitude, and will make due contribution to nuclear energy development in the world. China strictly fulfils the international non-proliferation obligations, and has established a nuclear material accounting and control system and nuclear export control system in line with international practice, by means of legislating related regulations and establishing dedicated institutions, to ensure the effective control of nuclear material and technology.

FOCUS ON HUMAN RESOURCE DEVELOPMENT

To deal with the challenge of a lack of nuclear experts, by the means of Government support and collaboration between universities and the industry, China has established a nuclear human resource development system featuring university education as the mainstay, complemented by on-the-job training in enterprises. In recent years, the CAEA has implemented the 2006–2010 Nuclear Science and Technology Expertise Development Plan, and expanded nuclear study programmes in colleges and universities. In addition, enterprises also provide on-the-job education and occupational training to improve the quality of their workforce. With years of efforts, China has built a team of high quality professionals in nuclear research, engineering design, and construction and operation, and has laid down a solid basis for the new stage of rapid development of nuclear energy.

STRENGTHEN INTERNATIONAL COOPERATION

China places emphasis on the unique role of international cooperation for nuclear energy development, and carries out full scale cooperation on multilateral and bilateral fronts under the principle of playing a major role while cooperating with other countries.

In the multilateral arena, China has conducted fruitful cooperation with the IAEA in nuclear technology, nuclear safety, non-proliferation and human resources, to name just a few. China also actively participates in other major international cooperation programmes such as OIF, ITER and GNEP, contributing to the joint efforts in research on next generation nuclear technology. In the bilateral area, China has signed agreements on peaceful use of nuclear energy with more than 20 countries and organizations, such as France, Egypt, Pakistan, the Russian Federation, the United States of America and the European Union, conducting mutually beneficial and substantial bilateral cooperation. With the precondition of ensuring the peaceful use of nuclear energy, China has also provided support in terms of equipment, technology and expert service to other developing countries seeking nuclear energy development. It is fair to say that China's over 20 years of international nuclear cooperation have contributed to the nuclear energy development of its own and the world.

Ladies and gentlemen,

Against the background of a global renaissance of nuclear energy and rapid development of China's nuclear industry, the CAEA is honored to host this conference. To make full use of this opportunity and to promote exchanges and collaboration with the international nuclear community, the CAEA has organized a large delegation comprising participants from governmental organizations, the nuclear industry, research institutes and industrial associations to attend this conference. In the following days, the Chinese delegation will be active in all sessions, to exchange opinions about nuclear development issues of common interest to delegations of all countries, and to discuss nuclear energy development strategy in the 21st century. I am convinced that, with the efforts of all participants, this conference will realize the expected goals and make contributions to global nuclear energy development.

Now, I declare the conclusion of the opening ceremony of the International Ministerial Conference on Nuclear Energy in the 21st Century. After the distinguished guests leave the podium, the national presentations will begin.

面向 21 世纪核能部长级国际大会
2009 年 4 月 20 日至 22 日 · 北京

大 会 主 席 声 明

2009年4月20日至22日，“面向21世纪核能部长级国际大会”在北京举行，61 个国家和 7 个国际组织的部长、高级官员和专家总计 808 人出席会议。大会由国际原子能机构主办，中国政府委托中国国家原子能机构承办，经合组织核能机构与中国核能行业协会协办。会议的目的是分析核能现状，讨论核技术发展，展望核能未来，并为正在考虑利用核电改善能源结构的国家提供有益的论坛。

为期三天的会议讨论了涉及核能发展的一系列问题，包括能源资源与环境、核能技术进展、基础结构建设、燃料保障供应、乏燃料和废物管理等。会议代表通过专题报告、讨论和磋商等各种形式，就核能的未来充分交换了意见。会议凝聚了共识，达到了预期的目的。

会议认识到，核电发展的积极势头正在显现，许多国家包括发达国家和发展中国家，做出了发展核能的决策。国际原子能机构总干事在发言中指出，目前已有 60 多个国家，其中大多数是发展中国家，向机构表示有意发展核电。在尊重各国有权依据其国际义务制订本国能源政策的同时，绝大多数会议代表认为，核能作为一种成熟、清洁、安全和有竞争力的技术，在 **21** 世纪及未来，将对人类可持续发展做出更大的贡献。会议就以下问题达成了广泛共识：

— 核电有助于保障全球能源安全，应对气候变化，减少空气污染；

— 核电是一种基荷电力来源，能够为 21 世纪能源的可持续发展发挥重要作用；

— 核能能够为全球社会经济发展做出有益贡献。

大会对核电发展面临的机遇表示欢迎，为抓住这一机遇，会议代表指出：

— 应加强国际防扩散努力，各国应履行各自防扩散义务，加强出口控制，与国际原子能机构深入合作以确保履行其保障义务。应继续加强上述领域的国际合作。

— 世界范围的在运核电站保持了出色的安全记录。核电站的持续安全运行对于提高人们的信心十分重要。所有国家包括已经发展或将要发展核电的国家都应高度重视核安全问题。此外，各国应参照国际原子能机构的导则，采取适当有效的实物保护措施。为此，应当鼓励就核安全和核保安开展国际合作与交流。

— 应采取措施，在保持国际核燃料市场正常运作的情况下，确保核燃料的可靠供应。国际社会应当深入讨论，并从技术、法律、政治、经济等方面全面分析，在国际原子能机构框架下建立多边核燃料保障供应机制的建议。国际原子能机构总干事希望向六月理事会提出此类建议。

— 乏燃料安全管理和放射性废物处置，对核电的可持续发展极为重要。对一些国家来说，乏燃料安全管理还包括后处理和再循环。各国对各自乏燃料和放射性废物的管理负有责任。会议代表鼓励在上述领域开展国际合作。各国应采取适当措施，确保充足的资金，用于核装置整个寿期内包括退役阶段的安全管理，以及乏燃料和放射性废物的安全管理。

— 计划发展核电的国家，应当建立必要的基础结构。包括发展中国家在内的一些国家可以向已经具备基础结构和技术能力的国家寻求援助和支持。应当向发展中国家提供支持，以帮助其建立必要的基础结构，并满足其特殊需求。具体的援助可以包括以下方面：建立法律和监管框架；开展培训，增进对各种核技术的了解；促进和支持新核电站融资等。

— 应继续加强国际合作，推动先进核技术的研究和开发。在进一步加强核电站安全、核保安和抗扩散的同时，技术开发方还应根据发展中国家和发达国家的不同需求，对核电的经济竞争性给予应有的重视。

— 经合组织秘书长和其他会议代表表示，核能应在后京都议定书灵活机制方面发挥更大的作用。

综上所述，自 2005 年巴黎会议以来，核工业取得了长足发展，有意建造核电站的国家数量增加。国际原子能机构在协助各国和平利用核能方面发挥着不可或缺的作用。大会鼓励国际原子能机构继续与成员国和经合组织核能机构等国际组织开展国际合

作。为此，会议代表期待四年后再次举行部长级大会，并认为这是朝着正确方向迈出的重要一步，将强化有关国家对核能和平利用的支持和保证。

CONCLUDING STATEMENT BY THE PRESIDENT OF THE CONFERENCE

Li Yizhong
Minister of Industry and Information Technology of China

The International Ministerial Conference on Nuclear Energy in the 21st Century was held in Beijing, China, from 20 to 22 April 2009, and was attended by ministers, high ranking officials and experts from 61 Member States and 7 international organizations, with a total of 808 participants and observers. This conference was organized by the IAEA, hosted by the Chinese Government through the China Atomic Energy Authority (CAEA), and co-sponsored by the OECD Nuclear Energy Agency and the China Nuclear Energy Association (CNEA). Its aim was to review the status and the prospects of nuclear energy, including the evolution of technology, and to offer a forum for many countries considering the potential benefits of adding nuclear power to the energy mix.

A wide range of issues has been covered during the three day conference, including energy resources and the environment, technology available now and in the future, infrastructure development, reliable fuel supply, spent fuel and waste management. The participants exchanged views on the future role of nuclear energy, in presentations, discussions and consultations. There was a broad convergence of views among participants. The goal of the conference has been achieved.

The conference recognized the positive momentum towards nuclear power and the decisions by many developed and developing States to pursue the use of nuclear energy. The Director General of the IAEA reported that more than 60 countries — mostly in the developing world — have informed the IAEA that they might be interested in launching nuclear power programmes. While respecting the right of each State to define its national energy policy in accordance with its international obligations, the vast majority of participants affirmed that *nuclear energy, as a proven, clean, safe, competitive technology, will make an increasing contribution to the sustainable development of humankind throughout the 21st century and beyond.* It was widely recognized that:

— Nuclear power contributes to global energy security while addressing climate change and avoiding air pollution.

— Nuclear power is a baseload source of electricity that can make a major contribution to meeting energy needs in a sustainable manner in the 21st century.
— Nuclear energy can make a valuable contribution to worldwide socioeconomic development.

Welcoming the opportunity of further development of nuclear power, participants present at this conference expressed their views on the following aspects:

(a) International non-proliferation efforts should be strengthened, and States must comply with their respective non-proliferation obligations, strengthen their export controls and enhance their cooperation with the IAEA to ensure the implementation of their respective IAEA safeguards obligations. International cooperation in these areas should be reinforced.
(b) The operating nuclear power plants in the world have maintained an excellent safety record. The continuing safe operation of the current fleet of nuclear power reactors is essential for continued confidence in the use of nuclear technology. All States having or developing a nuclear power programme should give high priority to ensuring safety. In addition, States should develop and maintain appropriate effective physical protection measures, with due regard to IAEA guidance. To this end, international cooperation and communication on nuclear safety and security should be encouraged.
(c) Consideration should be given to measures that will help to ensure reliable access to nuclear fuel supply, while maintaining the normal operation of the international nuclear fuel market. The international community should conduct in-depth discussions and thorough analysis of the technical, legal, political and economic aspects of proposals to establish multilateral nuclear fuel cycle mechanisms for reliable access to nuclear fuel cycle services under the auspices of the IAEA. The Director General of the IAEA expressed his hope to bring proposals to the June Board of Governors meeting.
(d) The safe management of spent fuel, which for some countries includes reprocessing and recycling, as well as the disposal of radioactive waste are of great importance for the sustainable development of nuclear power. Each State remains responsible for the management of its spent fuel and radioactive waste. The participants encourage international cooperation in these fields. Each State should take appropriate steps to ensure that adequate financial resources are available to support the safety of nuclear

installations throughout their life, including during the decommissioning phase, and the safety of the management of spent fuel and radioactive waste.

(e) Countries developing nuclear power programmes are responsible for the development of the necessary infrastructure. Some countries, including developing countries, may seek assistance and support from countries with existing infrastructures and capability. Support should be given to the developing countries to help them to address their particular needs and responsibilities in the development of necessary infrastructures. Specific support could include, inter alia, helping with how to establish laws and regulatory frameworks, supporting training and the development of the understanding of nuclear technology and the technical options, and facilitating and supporting financing of new nuclear power plants.

(f) International cooperation should be continually strengthened to carry forward research and development of advanced nuclear technologies. While further enhancing the safety, security and proliferation resistance of nuclear power plants, technology developers should pay due attention to the economic competitiveness of nuclear power in accordance with the needs of both developing and developed countries.

(g) The Secretary-General of the OECD and other participants expressed the view that nuclear energy should have an important role to play in post-Kyoto flexibility mechanisms.

To conclude, the progress made by the nuclear industry since the 2005 Paris Conference has been significant, as indicated by the number of countries expressing interest in new nuclear plants. The IAEA plays an essential role in assisting States to develop the use of nuclear energy for peaceful purposes. The IAEA was encouraged to continue its international cooperation with Member States and international organizations such as the OECD/NEA. In this regard, participants are looking forward to a further conference at the ministerial level in another four years, which would be a valuable step in the direction of developing the support and assurance by all countries involved in the peaceful uses of nuclear energy.

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Dr. Anil Kakodkar
Chairman, Atomic Energy Commission, INDIA

H.E. Mr. Qin Sun
Vice Minister, Chairman, China Nuclear Energy Administration, CHINA

H.E. Dr. Hassan Younes
Minister of Electricity and Energy, EGYPT

H.E. Dr. Byong-man Ahn
Minister of Education, Science and Technology, REPUBLIC OF KOREA

Mr. Adiwarjoyo
on behalf of the Minister of Energy and Mineral Resources, INDONESIA

Dr. A.M. Agapov
on behalf of the Minister and Director of the State Atomic Energy Corporation 'Rosatom', RUSSIAN FEDERATION

H.E. Dr. Khaled Toukan
Chairman, Jordan Atomic Energy Commission, JORDAN

H.E. Ambassador G. Schulte
on behalf of H.E. Mr. S. Chu, Secretary of Energy,
UNITED STATES OF AMERICA

H.E. Dr. Mohammed bin Ibrahim Al-Sawaiyel
Minister and President of King Abdulaziz City for Science and Technology, SAUDI ARABIA

H.E. Dr. Mohammed bin Ibrahim Al-Sawaiyel
Minister and President of King Abdulaziz City for Science and Technology, SAUDI ARABIA
(English version)

H.E. Mr. Mauri Pekkarinen
Minister of Economic Affairs, FINLAND

H.E. Mr. Yeafesh Osman
State Minister of Science and Information and Communication Technology, BANGLADESH

Dr. Mohammed Saeidi
on behalf of the Vice President of the ISLAMIC REPUBLIC OF IRAN

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Deputy Minister of Fuel and Energy, UKRAINE

H.E. Ms. Natalya Shumkova
Deputy Minister of Fuel and Energy, UKRAINE
(English version)

H.E. Mr. Wannarat Channukul
Minister of Energy, THAILAND

Dr. F.E. Osiasai
on behalf of H.E. Dr. Alhassan Baso Zaku, Minister of Science and Technology, NIGERIA

Monsignor Michael W. Banach
on behalf of H.E. Archbishop Dominique Mamberti, Secretary for the Holy See's Relations with States, HOLY SEE

H.E. Mr. Angelo T. Reyes
Secretary, Department of Energy, PHILIPPINES

Mr. Ansar Parvez
on behalf of the Minister and Chairman of the Planning Commission of the Government of Pakistan, PAKISTAN

Mr. Moubarak Abdelkader El Mikki
on behalf of H.E. Mr. Chakib Khelil, Minister of Energy and Mines, ALGERIA

Mr. Moubarak Abdelkader El Mikki
on behalf of H.E. Mr. Chakib Khelil, Minister of Energy and Mines, ALGERIA
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Mr. Rokas Bernotas
on behalf of H.E. Mr. A. Sekmokas, Minister of Energy, LITHUANIA

Ms. Soad Shilli
on behalf of H.E. Dr. Ali Gashut, Secretary, Atomic Energy Establishment, LIBYAN ARAB JAMAHIRIYA

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H.E. Ms. Madeleine Tchuinte
Minister of Scientific Research and Innovation, CAMEROON

H.E. Ms. Madeleine Tchuinte
Minister of Scientific Research and Innovation, CAMEROON
(English version)

Mr. Mohamad Eltayeb
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H.E. Ambassador William Ehrman
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H.E. Mr. Daniel Omar Cameron
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Mr. Gu Zhongmao
China Institute of Atomic Energy, CHINA

Assurances of fuel services versus proliferation risks
Mr. B. Pellaud
SWITZERLAND

Internationalization of nuclear fuel supply and SNF management as a factor of strengthening non-proliferation regime
Mr. V.P. Kuchinov
Advisor to the Director General, State Atomic Energy Corporation 'Rosatom', RUSSIAN FEDERATION

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Mr. V.P. Kuchinov
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(English version)

Swedish nuclear fuel and waste management experience
Ms. S. Laârouchi Engström
Vice President, Swedish Nuclear Fuel and Waste Management Company (SKB), SWEDEN

FINAL DISCUSSION SESSION

PARTICIPATION

Ministerial Speaking List

Technical Sessions: Speakers

Final List of Participants

The International Ministerial Conference on Nuclear Energy in the 21st Century provided an opportunity to review the status and prospects of nuclear power, and to discuss the actions necessary to carry forward the positive momentum that nuclear power has experienced in recent years. It also offered a forum for countries considering the potential benefits of introducing nuclear power into their national energy mix to further assess the viability of the nuclear power option. Conference participants discussed developments and emerging issues relevant to the role of nuclear power in providing clear and sustainable energy for national and regional development. The technical sessions were devoted to energy resources and the environment; available technology and long term perspectives; infrastructure development and safety and legal issues; and reliable fuel supply, spent fuel, waste management and strengthening of non-proliferation.

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