Overview

For well over fifty years the International Atomic Energy Agency has been dedicated to the achievement of the vision "Atoms for Peace", serving as the focal point for worldwide cooperation in the peaceful uses of nuclear technology, for promoting global nuclear safety and security, and — through its verification activities — for providing assurances that international undertakings to use nuclear facilities and materials for peaceful purposes only are being honoured. What follows is a survey of worldwide nuclear related developments in 2010 and how they affected the work of the Agency.

The accident at the Fukushima Daiichi Nuclear Power Plant, caused by the extraordinary natural disasters of the earthquake and tsunamis that struck Japan on 11 March 2011, continues to be assessed. As this report focuses on developments in 2010, the accident and its implications are not dealt with here, but will be addressed in future reports of the Agency.

Nuclear Technology

Nuclear Power, Nuclear Fuel Cycle and Sustainable Development

Nuclear Power: Status and Trends

The need for sustained economic development to reduce poverty and hunger clearly necessitates increases in the supply of energy and electricity. Nuclear power is a significant contributor to world electricity, and its role as a major source of energy supply and as a mechanism to mitigate climate change has been undergoing a steady re-evaluation. More than 60 countries have expressed an interest in exploring nuclear power, many of which are likely to bring their first reactors on-line by 2030, according to Agency projections.

Construction started on 15 new nuclear power reactors, the largest number of new construction starts since 1985. Five new reactors were connected to the grid, and one reactor was retired, resulting in a net increase of global nuclear generating capacity to 375 gigawatts of electric power (GW(e)). At the end of the year there were 441 reactors in operation and 66 under construction.[1]

[1] For more detailed information on nuclear power reactors in operation and under construction around the world in 2010, see Table A9 in the Annex.

Projected Growth for Nuclear Power

Current expansion and near and long term growth prospects remained centred in Asia. Twelve of the 15 construction starts were in Asia, as were two thirds of the reactors under construction at the end of the year. Four of the five new reactors connected to the grid were in Asia.

Expectations for future growth remained high in 2010. The Agency raised its low projection for global nuclear capacity in 2030 by 7% over the 2009 projection; the high projection declined very slightly. The upward revision in the low projection reflected the progress made by governments, utilities and vendors in implementing their announced plans. The relatively stable high projection means that, globally, aspirations about more ambitious possibilities for nuclear expansion were essentially unchanged in 2010.

"The need for sustained economic development to reduce poverty and hunger clearly necessitates increases in the supply of energy and electricity."

In 2010, the Agency extended its projections to 2050 for the first time. In the low projection, growth slows after 2030. In the high projection, global nuclear capacity in 2050 is four times greater than today.

The Agency also participated in the preparation of the 2010 edition of *Projected Costs of Generating Electricity*, published by the OECD/IEA and OECD/NEA, which showed that at low interest rates, capital intensive, low carbon technologies such as nuclear energy can provide baseload electricity at costs competitive with those of coal fired plants and natural gas fired combined cycle plants. But at high interest rates, fossil fuelled electricity generation costs less than nuclear power in many locations.

Support to Operating Nuclear Power Plants

There is now a more global and competitive energy market than when most existing plants were constructed, as well as more demanding regulatory,

stakeholder and environmental requirements. Of the 441 nuclear power reactors in operation at the end of 2010, 358 had been operating for more than 20 years. Many Member States therefore continued to give high priority to operating their reactors for longer than the 30–40 years originally envisaged.

During the Agency's 2009–2011 technical cooperation cycle, 15 Member States have been participating in technical cooperation projects to strengthen their capabilities to plan and manage for long term operation and improved performance. This is a doubling compared with the participation of seven Member States during the 2007–2008 cycle.

Expansion of Nuclear Power Programmes

Most of the growth in nuclear power capacity will occur in the 29 countries that already have operating nuclear power programmes. After a slowdown in new construction in the 1990s, these countries have recently shown increased interest in building new plants. Currently, 24 countries are planning to expand their existing nuclear programmes and, at the end of 2010, 65 reactors were under construction in countries with operating reactors. At the same time, the Agency received an increasing number of requests for assistance with future expansions of nuclear power programmes. Agency assistance continued to help in developing the necessary nuclear power infrastructure.

"The Agency supports national energy assessments for all interested Member States, not only for those interested in nuclear power."

Energy Assessment Services

The Agency supports national energy assessments for all interested Member States, not only for those interested in nuclear power. Sometimes it conducts assessments directly for Member States. In other cases, by transferring assessment tools to and training experts in Member States, it helps build their capacity to conduct their own assessments. Demand continued to increase in 2010 for Agency assistance in capacity building for energy system analysis and planning, and for conducting national and regional studies on future energy strategies and the role for nuclear power. The Agency's analytical tools developed for this purpose are now being used in more than 120 Member States. During 2010, over 650 energy analysts from 68 countries were trained in the use of these tools. Following successful initial experience with e-training, about 20% of the training was conducted through distance learning courses.

Launching Nuclear Power Programmes

Interest in starting nuclear power programmes remained high. At the end of 2009, Turkey and the United Arab Emirates announced that they had ordered their first nuclear power plants. Additional countries have indicated that they have made a decision to move forward with a nuclear power programme and have been actively preparing the necessary infrastructure. As countries make progress, their plans for nuclear power are becoming more concrete and detailed.

Of the 60 countries that received Agency assistance in this area through national and regional technical cooperation projects in 2010, approximately one third were studying the nuclear power option in preparation for a decision, while roughly half had expressed interest in understanding the issues but had not taken steps toward a decision.

Member States continued to follow the Agency's 'milestones approach' as guidance.[2] Having a clear national policy and government support — the first of the 19 'milestones issues' — is particularly important for successful planning. Member States also requested Agency assistance in the areas of human resource development, stakeholder involvement, financial risk management and waste strategy development.

Assurance of Supply

In December 2010, the Board of Governors authorized the Director General to take steps towards the establishment of a low enriched uranium (LEU) bank. The LEU bank will be owned and controlled by the Agency, as a supply of last resort for nuclear power generation while avoiding any disturbance of the existing commercial fuel

[2] *Milestones in the Development of a National Infrastructure for Nuclear Power*, IAEA Nuclear Energy Series No. NG-G-3.1 (2007).

market, and will be funded exclusively through voluntary contributions. Pledges and contributions in excess of $150 000 000 have been provided by the European Union, Kuwait, Norway, the United Arab Emirates, the United States of America and the Nuclear Threat Initiative, and Kazakhstan has offered to provide a location for an Agency LEU bank and bear the relevant storage costs. Should a Member State's LEU supply be disrupted due to exceptional circumstances, and the supply cannot be restored by the commercial market, State to State arrangements or any other such means, the Member State may call upon the Agency's LEU bank to secure LEU for fuel supplies. Work on this fuel bank is continuing.

An agreement approved by the Board in November 2009, which was signed by the Agency with the Russian Federation in March 2010, established an LEU reserve for supply to Member States. In December 2010, the fuel reserve was fully stocked to its planned capacity of 120 tonnes of LEU by the Russian State Atomic Energy Corporation and placed under Agency safeguards at the Angarsk nuclear facility in Siberia.

Uranium Resources

In 2010, the OECD/NEA and the Agency published the latest edition of the 'Red Book', *Uranium 2009: Resources, Production and Demand*, which estimated identified conventional uranium resources recoverable at a cost of less than $130/kg uranium (kg U) at 5.4 million tonnes of uranium (Mt U). An additional 0.9 Mt U were estimated to be recoverable at costs between $130/kg U and $260/kg U. For reference, the spot price for uranium fluctuated between $105/kg U and $115/kg U for the first half of 2010 before rising to a two year high above $160/kg U by year end.

At the 2009 rate of consumption, the projected lifetime of the 5.4 Mt U mentioned above is around 90 years. This compares favourably with reserves of 30–50 years for other commodities (for example, copper, zinc, oil and natural gas). However, to ensure that uranium in the ground is available as 'yellowcake in the can' to fuel the projected expansion of nuclear power, new mines will need to be developed and existing mines will need to be expanded in a timely manner. Expenditures on exploration and mine development are reported in the Red Book only through 2008. They totalled $1.641 billion in 2008, an increase of 133% over the 2006 figures reported in the Red Book's previous edition.

Uranium production increased by 16% in 2009 compared with 2008. In Kazakhstan, production increased by more than 70%, making it by far the world's top uranium producer in 2009, up from fifth place in 2003 and second place in 2008.

Innovation

The 21st century promises the most open, competitive, globalized markets in human history and the most rapid pace of technological change ever. If a technology is to survive and flourish, continual innovation is essential. While the Agency does not develop technology directly, it promotes the exchange of technical information among interested Member States, using Technical Working Groups, coordinated research projects (CRPs), international conferences and the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) to foster international cooperation. In 2010, the Agency released an updated version of its Advanced Reactors Information System (ARIS) containing comprehensive information on all advanced reactor designs and concepts.

"… the Agency … promotes the exchange of technical information among interested Member States, using Technical Working Groups, coordinated research projects …, international conferences and … [INPRO] to foster international cooperation."

The Agency continued its cooperation with other international programmes on advanced technology, in particular the Generation IV International Forum (GIF). In June, the Agency and GIF held a workshop on the operational and safety aspects of sodium cooled fast reactors (SFRs) to exchange information on safety related fast reactor operational experience, national safety approaches for the next generation of SFRs, and ongoing and planned R&D.

To help countries analyse the long term sustainability of nuclear power programmes, INPRO completed a report entitled *Nuclear Energy Development in the 21st Century: Global Scenarios and Regional Trends* in 2010 and continued to help INPRO members build corresponding national long range strategies. The INPRO Dialogue Forum

regularly brings technology holders and technology users together to help ensure that innovations and R&D strategies meet the needs of both.

Research Reactors

Over 20 Member States are considering building new research reactors. To assist these States, the Eastern European Research Reactor Initiative (EERRI), supported by the Agency, organized the second Research Reactor Group Fellowship Training Course. The six week course made use of different research reactors in the EERRI and included theoretical classes, technical visits and hands-on experiments on various aspects of research reactors. The Agency also assisted North Carolina State University (NCSU) in the USA and the Jordan University of Science and Technology (JUST) in implementing the first international 'remote reactor' programme. Signals from the NCSU's PULSTAR research reactor were sent to JUST, where the displays at PULSTAR were replicated in the classroom. Real-time interaction with instructors in the USA was carried out through videoconferencing.

In November–December 2010, the Agency completed the repatriation of spent fuel from the Vinča Institute in Serbia to the Russian Federation as well as the removal of all high enriched uranium (HEU) from Serbia. The repatriation, which followed six years of preparatory work by several hundred experts and cost more than $50 million, was the largest technical cooperation project in the Agency's history. A total of 2.5 tonnes of spent research reactor fuel, including 13.2 kg of HEU, was repatriated. Also in 2010, under the Russian Research Reactor Fuel Return programme, 109.4 kg of fresh HEU fuel was shipped out of Belarus, the Czech Republic and Ukraine. The Agency also assisted in the repatriation of 362.7 kg of spent HEU fuel from Belarus, Poland and Ukraine.

"… the repatriation of spent fuel from the Vinča Institute in Serbia to the Russian Federation … was the largest technical cooperation project in the Agency's history."

Hospitals all over the world use radioisotopes in medicine, mainly for diagnosis. Shortages in the supply of one of the most frequently used radioisotopes, molybdenum-99 (Mo-99), continued to affect patient services for almost eight months into 2010 until the NRU reactor in Canada and the High Flux Reactor in the Netherlands returned to production. A session on 'Multilateral and Regional Approaches to Securing and Supplementing Mo-99 Supplies' at the Agency's General Conference highlighted both current international initiatives to secure adequate Mo-99 supplies and the scope for further international cooperation. During the year, the Agency participated in the review of two reports by the OECD/NEA 'High-level Group on the Security of Supply of Medical Radioisotopes'. One dealt with the economic aspects of Mo-99 production, and the other assessed alternative production technologies.

Applications of Nuclear Technology

Trends and developments in 2010

In 2010, the Agency continued its work in applying nuclear and isotopic techniques in the areas of food and agriculture, human health, water resources, the environment and industry in order to help reach some of the key targets of the Millennium Development Goals (MDGs). The trend in leveraging partnerships with Member States focused on utilizing, wherever possible, their skills, knowledge and facilities. In particular, the Agency continued to expand its Collaborating Centre scheme (involving research institutions in Member States), which grew in 2010 from 14 to 20. Cooperation with universities and research institutions in 2010 resulted in the completion of 19 CRPs. In addition to networking, the trend of expanding its educational and facilitating role yielded tangible results to the Agency in 2010, such as the development of on-line curriculums in the area of human health and training videos in isotope hydrology.

Human Health

As part of its mandate, the Agency seeks to enhance the capabilities of Member States to prevent, diagnose and treat health problems through the application of a range of nuclear techniques. In its efforts to assist in reducing the shortage of medical specialists in the developing world, particularly for cancer treatment, the Agency developed educational materials and syllabuses and launched the on-line 'Human Health Campus'

at *http://humanhealth.iaea.org*. The web site provides insights into the different aspects of modern clinical practice and serves as a resource and platform for hosting and disseminating learning materials.

Ionizing radiation is used in medicine to investigate medical conditions, diagnose illnesses and administer treatment to patients. If improperly used or administered, radiation can harm the patient, the radiation worker and the public. That is why the accurate measurement of radiation dose, known as dosimetry, is vital to health care and the safe use of nuclear technologies in medicine. In November 2010, the Agency hosted an international symposium on 'Standards, Applications and Quality Assurance in Medical Radiation Dosimetry' to foster the exchange of information and highlight recent developments in this field. Twelve international and professional organizations cooperated in the organization of the conference, which featured 372 participants from 66 Member States.

Programme of Action for Cancer Therapy

In 2010, the Agency continued to strengthen its partnerships with health and cancer control organizations through the WHO/IAEA Joint Programme on Cancer Control. As part of its capacity building and awareness initiatives in 2010, the Agency invited 72 policy makers from the African and the Asia–Pacific regions to attend coordination and planning meetings on cancer control. Building upon the Joint Programme, the Agency and WHO also organized the first joint seminar intended for Member States with PACT Model Demonstration Sites (PMDSs). And the Agency's integrated missions of PACT (imPACT) continued to be in high demand by Member States, with 16 imPACT reviews conducted in 2010.

The Agency's support to Member States through PACT relies largely upon external financial resources. In 2010, contributions to PACT from France, the Republic of Korea, Monaco, New Zealand, Spain, the USA, the OPEC Fund for International Development and F. Hoffmann-La Roche Ltd exceeded $5.7 million. Additionally, funding from the USA was received through the Peaceful Uses Initiative (PUI) to cover 25 imPACT reviews and PMDS follow-up missions.

Management of Water Resources

Ten years after adopting the MDG of "reducing in half the number of people without access to safe drinking water", the United Nations discussed progress in the *2010 Millennium Development Goals Report* and in the Dushanbe Declaration, which was an outcome of the 'Water for Life' conference held in Dushanbe, Tajikistan, in June 2010. Both documents noted that significant progress has been made and it is expected that 86% of the population in developing regions will have access to safe water by 2015. However, progress has been uneven, and some large regions currently have less than 60% access. In addition, there is an increasing concern that improvements in water quality have not kept up with enhanced water access.

Consistent with the above mentioned assessments, the Agency initiated a project in 2010 to enable Member States to have a sound scientific basis for the use and sharing of their water resources. The IWAVE (IAEA Water Availability Enhancement) project aims at facilitating the comprehensive gathering and use of scientific information to fully assess the availability and quality of water resources.

"… the Agency's integrated missions of PACT (imPACT) continued to be in high demand by Member States, with 16 imPACT reviews conducted in 2010."

In addition, the Agency strengthened Member State capabilities to use isotope techniques for water resources management by producing training tools and videos, conducting training courses for analytical and data analysis methods, and expanding its global isotope monitoring networks, and by initiating a thematic series of isotope hydrology atlases. In 2010, the first atlas in this series was published for Morocco.

Radioisotopes and Radiation Technology

Radioisotope products are major tools for nuclear applications in diverse fields. The continuing evolution of new applications requires the development and production of new products, mostly radiopharmaceuticals. Agency activities in 2010 focused on promoting innovation in Member States. For example, a CRP completed in 2010 resulted in the development of two novel

technetium-99m tracers. Such substances are used as radioactive tracers in medical diagnoses and treatments. The work included the characterization of the biological properties of the tracers in the pre-clinical phase, as well as the production of kits for their easy preparation. The goal is to accelerate further evaluation and lead to their clinical use in breast cancer patients.

Radiation induced grafting is a powerful technique for the preparation of advanced materials based on easily available and low cost synthetic and natural polymers. The Agency concluded a CRP in 2010 which resulted in the development of methodologies for the preparation of radiation grafted membranes to remove pollutants (e.g. heavy metal ions, toxic compounds) from wastewater. In expanding the utilization of Member State capabilities, the Institute of Nuclear Chemistry and Technology (INCT) in Poland was designated as a new IAEA Collaborating Centre for Radiation Processing and Industrial Dosimetry. The INCT will help implement industrial dosimetry intercomparison exercises that are vital for the effective and efficient application of radiation processing technology.

Food and Agriculture

In 2010, the world's growing population continued to be faced with inadequate food supplies, partly caused by the changing environment and further exacerbated by the global financial crisis. Science, including nuclear and isotopic techniques, provides solutions for making sustainable agriculture techniques accessible to people everywhere. For example, the early application of rapid and sensitive nuclear and nuclear related diagnostic tests to control transboundary animal diseases was one of the Agency's key priorities in the area of food and agriculture in 2010. It contributed to the control and eradication of rinderpest, a devastating disease of cattle. The Agency has provided $20 million over the years to support the eradication of rinderpest, with the return on investment in Africa alone of $1 billion per year in livestock production. Building on this, FAO and the World Organisation for Animal Health are expected in 2011 to officially declare the global eradication of rinderpest, the first time that this has been achieved for an animal disease.

"The Agency has provided $20 million over the years to support the eradication of rinderpest, with the return on investment in Africa alone of $1 billion per year in livestock production."

Insect pests can seriously affect food security and the commercial value of agricultural products. Sterile insect techniques offer an alternative way of suppressing and/or eradicating insects such as fruit flies, tsetse flies, moths and others. In 2010, an integrated pest management system against cotton and sugarcane major pests, based on the use of biological control agents through the application of radiation technology, was developed for Pakistan. Cotton and sugarcane are the principal crops in Pakistan, and insect pests are a major constraint, resulting in yield losses in spite of huge quantities of insecticides being sprayed every year. As part of a pilot project, biocontrol agents based on the use of radiation are being applied to more than 600 hectares of a cotton field. As a result of this project, the technology was transferred to the sugarcane industry to produce natural enemies of sugarcane borers to manage these pests in an environment friendly way. In 2010, seven sugar mills were producing biological control agents and applying them successfully over 25 000 hectares.

Environment

The Agency provides reference materials to Member States to improve quality, accreditation and measurement procedures for the analysis of environmental samples. An intensive five day IRCA (International Register of Certificated Auditors) certified 'ISO/IEC 17025 Lead Auditor Training' session was held in Monaco at the end of 2010 to prepare for the accreditation of the Agency's Environment Laboratories.

Nuclear Safety and Security

Nuclear Safety: Status and Trends

The international nuclear community maintained a high level of safety performance in 2010. Nuclear power plant safety performance remained high, and indicated an improved trend in the number of emergency shutdowns as well as in the level

of energy available during these shutdowns. In addition, more States explored or expanded their interests in nuclear power programmes, and more faced the challenge of establishing the required regulatory infrastructure, regulatory supervision and safety management over nuclear installations and the use of ionizing radiation.

Building Capacity in Member States

As the global demand for energy intensifies and the need to counteract climate change becomes more urgent, many countries have committed themselves to exploring the possibility of embarking on nuclear power programmes or expanding existing ones. However, not all States have adequate competences, especially with regard to the required legal and regulatory frameworks necessary for nuclear safety and security. In June 2010, the Regulatory Cooperation Forum (RCF) was formed to assist Member States in this effort. The RCF is a regulator to regulator body that optimizes regulatory support from Member States with advanced nuclear power programmes to newcomer Member States.

New and Expanding Nuclear Power Programmes

During 2010, the Agency assisted Member States in developing their governmental and regulatory framework, especially those States interested in developing new, or expanding existing, nuclear power programmes. For instance, the Agency developed a Safety Guide on establishing safety infrastructure. It also carried out a number of missions, inter alia, in the Islamic Republic of Iran, Jordan, Thailand, the United Arab Emirates and Vietnam, particularly for strengthening safety infrastructure. These missions provided guidance on the progressive application of the Agency's safety standards for the different steps in the development of nuclear power programmes. In addition, the Agency conducted several regional and national workshops and training events on regulatory issues for newcomers in the areas of licensing process, regulatory oversight for the construction of nuclear power plants and stakeholder involvement including the public.

Enhancement of Research Reactor Safety

In 2010, the Agency continued its efforts aimed at encouraging Member States to apply the Code of Conduct on the Safety of Research Reactors by organizing meetings and training activities. In 2010, four regional meetings on the application of the Code were organized in Africa, Asia, Europe and Latin America. These meetings focused on safety issues of common interest, including regulatory supervision, ageing management, operational radiation protection, safety of experiments, emergency planning and preparedness, and decommissioning planning.

"During 2010, the Agency assisted Member States in developing their governmental and regulatory framework, especially those States interested in developing new, or expanding existing, nuclear power programmes."

The Agency's Incident Reporting System for Research Reactors and Research Reactor Information Network seek to improve the safety of research reactors through the exchange of safety related information on unusual events. In addition to continuing efforts to encourage the sharing of knowledge, operating experience and good safety practices, the Agency facilitated the creation of a Regional Advisory Safety Committee in Africa, and achieved significant progress in creating such committees for other regions.

Incident and Emergency Preparedness

Nuclear emergencies and radiation related events, when they occur, affect workers, the public, property and the environment. Not all Member States are adequately prepared to respond to radiation events, and any expansion in the use of nuclear energy needs to go hand in hand with enhancement of national, regional and international emergency preparedness and response capabilities. Moreover, increased concern over the malicious use of nuclear or radioactive materials stressed the need to broaden those capabilities. In light of these facts, in 2010 Agency activities were geared to enhancing technical guidelines, providing technical assistance, building capacity in Member States, fostering the sharing of information, and improving international and the Agency's arrangements and capabilities. In specific terms,

the Agency organized 38 training events on various aspects of emergency preparedness and response. Six Emergency Preparedness and Review (EPREV) missions were carried out in Azerbaijan, Belarus, Philippines, Qatar, Romania and Thailand, and 13 additional missions were implemented to assist in the development and strengthening of national emergency preparedness and response systems.

Spent Fuel and Radioactive Waste Management

For nuclear power, the disposal of high level waste (HLW) remains the one step in the civilian nuclear fuel cycle where there is still no industrial scale facility in operation. However, Finland, France and Sweden have made substantial progress and expect to bring repositories into full operation around 2020. Industrial scale facilities do exist for the storage of spent fuel and for the disposal of intermediate and low level waste. The Agency's role is to ensure that information on the technology and experience accumulated in the area of waste management and disposal is available to the public at large, to countries considering or introducing nuclear power, and to those involved with waste in all nuclear power programmes.

"… the European Commission … proposal for a Council Directive on the management of spent fuel and radioactive waste. … is based largely on the Agency's Fundamental Safety Principles …"

With respect to HLW disposal, the access tunnel at the Olkiluoto site in Finland was excavated to its final disposal depth of 434 metres by the end of 2010. The tunnel will be used first for rock characterization to ensure the suitability of the site and then for disposal. The construction licence application is scheduled for 2012. In Canada, the Nuclear Waste Management Organization began a process in May 2010 to select a site for a deep geological repository. In the USA, a 'Blue Ribbon Commission on America's Nuclear Future' was established following the US Government's 2009 decision not to proceed with the Yucca Mountain repository. The Commission will make recommendations on long term solutions for spent fuel and high level waste. Its first report is scheduled for June 2011. As part of its assistance to Member States in developing geological disposal programmes, the Agency organized training courses in 2010 in Japan and the USA, including a visit to the Waste Isolation Pilot Plant in Nevada.

For low and intermediate level waste (LILW), disposal facilities are currently operating in 23 countries. In 2010, Slovenia confirmed the site for a new LILW repository near the country's existing nuclear power plant. And the first radioactive waste arrived at the Wolsong repository in the Republic of Korea, where it is currently stored in a storage facility on the repository site. The Agency provided training and information on LILW disposal at courses and workshops in Argentina, Germany, India, Malaysia and Spain.

Long Term Management of Radioactive Waste

In November 2010, the European Commission presented a proposal for a Council Directive on the management of spent fuel and radioactive waste. This proposal is based largely on the Agency's Fundamental Safety Principles and the obligations embodied in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The proposed Directive requires that Member States shall, at least every ten years, carry out self-assessments of their national framework, including assessments of the competent regulatory authority and national programme, and its implementation compared with international peer reviews of their national framework, authority and/or programme.

Decommissioning

Worldwide statistics on the decommissioning of nuclear power plants did not change significantly in 2010. At the end of the year, 124 power reactors were shut down. Of these, 15 reactors were fully dismantled, 52 were in the process of being dismantled or planning for short term dismantling, 48 were being kept in safe enclosure mode, 3 were entombed, and 6 did not yet have specified decommissioning strategies. The Agency's International Decommissioning Network facilitated the exchange of information and experience through workshops and hands-on training in Austria, Belgium, Germany, Hungary, Ukraine and the USA.

In addition to radioactive waste associated with nuclear power, sealed radioactive sources that have

been used in medical, industrial and other non-power applications must be properly packaged, managed and disposed of. The Agency helps Member States improve the management of these sources and repatriate them to their countries of origin. In 2010, the mobile hot cell, a technology developed by the Nuclear Energy Corporation of South Africa under contract to the Agency, was deployed in Uruguay to extract 14 components with high activity sources from the devices in which they were housed, and package them into transport containers for repatriation.

Safety in Medical Uses of Ionizing Radiation

The extent of medical radiation exposure has increased considerably in recent years, and the doses involved are quite large compared with occupational exposures. In some countries, the population dose from medical exposures has rivalled that from natural background radiation, and globally accounted for more than 98% of the contribution from all artificial sources. In general, access to radiation in medicine increased for the global population; however, about 25% of the world's population in developed countries received around 75% of the medical procedures utilizing ionizing radiation.

The safe and appropriate use of new medical radiation technology was examined at the Scientific Forum held in conjunction with the 54th session of the Agency's General Conference in Vienna in September. The Forum drew attention to the challenges in ensuring safety when establishing a radiotherapy programme, especially in settings where there were constraints on capacity and infrastructure. Scientists and regulators discussed evidence based and cost–benefit issues when introducing new technology, as well as governmental commitment when addressing education and training, and safety culture in medicine.

Fostering the Safe Management of Sources

In 2010, the Agency organized two important international meetings where States were able to share their experience and challenges in the 'cradle to grave' management of sources at the international level and to address the issue of sustainable management of disused sealed sources. Both the open-ended meeting on the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources and the International Workshop on Sustainable Management of Disused Sealed Radioactive Sources provided recommendations for future international cooperation programmes.

Denials and Delays of Shipments

The safety record for the transport of radioactive material remained excellent in 2010. However, denials and delays of shipment of radioactive materials continued to occur, with the most apparent increase in denials of shipment resulting from national variations in regulations. The International Steering Committee on Denials of Shipment of Radioactive Material continued to coordinate efforts to find solutions related to denials of shipment.

Nuclear Law

Member States have long recognized that coherent and comprehensive national legal frameworks are essential for ensuring the safe, secure and peaceful uses of nuclear energy and related nuclear applications. Since the establishment of the Agency, a number of legally binding and non-binding international legal instruments have been adopted under its auspices in the fields of nuclear safety, nuclear security, safeguards and civil liability for nuclear damage.

"The safe and appropriate use of new medical radiation technology was examined at the Scientific Forum held in conjunction with the 54th session of the Agency's General Conference in Vienna in September."

The continued increase in the number and complexity of these instruments presents a significant challenge for Member States. This is particularly the case for States that have expressed an interest in pursuing civil nuclear power programmes and that hence need to bring their respective national legislation in line with these instruments.

With the aim of assisting States required to draft corresponding national implementing legislation,

especially those that have expressed an interest in pursuing civil nuclear power programmes, the Agency established a comprehensive approach to nuclear law that brings different fields of nuclear law together in one piece of national legislation. This approach is being applied widely in the Agency's legislative assistance programme, under which more than 100 Member States have received bilateral legislative assistance, essentially by means of written comments and advice on drafting national nuclear legislation. Also under this programme, training has been provided to over 300 individuals through workshops, courses, short term scientific visits as well as longer term fellowships, allowing individuals to gain further practical experience in nuclear law.

"… the Agency established a comprehensive approach to nuclear law that brings different fields of nuclear law together in one piece of national legislation."

Following up on the publication in 2003 of a reference book providing a theoretical overview of nuclear law — the *Handbook on Nuclear Law* — the Agency published a companion volume in 2010 — *Handbook on Nuclear Law: Implementing Legislation* — setting out concrete model texts of legislative provisions needed for drafting comprehensive national nuclear legislation.

INLEX

The International Expert Group on Nuclear Liability (INLEX), established by the Director General in 2003, continues to serve as the Agency's main forum for dealing with questions related to nuclear liability. INLEX aims at contributing to a better understanding of, and adherence to, international nuclear liability instruments. In 2010, at its tenth meeting, INLEX reported on the status of ratification of the international nuclear liability conventions, and the European Commission legal study on the harmonization of the civil nuclear liability system within the European Union. The Group also exchanged preliminary views on a draft Explanatory Text on the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention. As part of its regular outreach activities, INLEX held a regional workshop on civil liability for countries in Eastern Europe and Central Asia in Moscow from 5 to 7 July 2010. During the workshop, presentations were made on various aspects of the international nuclear liability regime, including the insurance of nuclear risks, and extensive discussions took place on the need for a uniform international nuclear liability regime and on how such a regime might be best reflected in corresponding national laws.

Training in Nuclear Safety and Security

Several Member States have some form of education and training programme in nuclear safety and security; this is fundamental to sustain nuclear safety. To address the challenge of establishing a national strategy for building competence in nuclear safety and security, the Agency issued its updated *Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011–2020.* In this regard, Agency regional training centres for education and training in radiation safety have been established and their activities periodically monitored through Education and Training Appraisal (EduTA) missions. In 2010, there was increasing interest in EduTA missions, with six missions to Algeria, Brazil, Egypt, Ghana, Morocco and South Africa.

Nuclear Security

The Agency's nuclear security activities contributed to efforts by States to mitigate the risk of nuclear or other radioactive material being used in malicious acts through the establishment of appropriate and effective national systems for nuclear security. During 2010, the Agency published guidance, conducted advisory missions, organized training events and provided technical assistance in completing security upgrades to 11 facilities, coordinating the repatriation of HEU and donating to States more than 800 radiation detection instruments.

In April 2010, the Director General attended the Nuclear Security Summit, held in Washington, D.C. At the Summit, he informed participants about the work being carried out by the Agency in the nuclear security area, and "the essential role of the IAEA in the international nuclear security framework" was recognized by the participants in the Summit communiqué.

Technical Cooperation

The Agency's technical cooperation programme is the primary mechanism to support Member States in the peaceful and safe use of nuclear technology for development. Due to the specialized technical nature of its contribution within the wider development context, and in view of ever more complex global challenges that must be tackled in coordination with other relevant actors, the management of the programme emphasizes the importance of partnerships at all levels, from counterparts up to other international organizations. Participation in the United Nations Development Assistance Framework process, as well as linkages with other international and regional development agendas, is highlighted as a means to leverage project impact and achieve synergies with UN system organizations.

Technical cooperation projects are developed and managed jointly by Member States and the Secretariat, based on the principle of shared responsibility. In 2010, technical cooperation projects were under way in 129 countries and territories.[3]

The Agency's Technical Cooperation Programme in 2010

In 2010, nuclear safety accounted for 18.4% of disbursements. It was followed by human health at 17.9%, with food and agriculture, at 14%, in third place. By the end of the year, implementation of the Technical Cooperation Fund (TCF) stood at 73.9%, with implementation of all funds at 76.6%. Considerable efforts were expended throughout the year on pre-planning work for the 2012–2013 technical cooperation cycle. Updated guidance was issued to Member States, and emphasis was placed on the preparation of cohesive country programmes, reflected in Country Programme Notes (CPNs) that align with national Country Programme Frameworks (CPFs).

For many African Member States, meeting basic human needs remained the top priority on the agenda for national development plans and international cooperation programmes in 2010. Activities in the region concentrated on supporting Member States in developing technical, managerial and institutional capacities in nuclear science and technology. A second focus was the sustainable application of nuclear techniques in key areas of national and regional significance to achieve increased food security, improved nutrition and health services, better management of groundwater resources, improved energy development planning including the feasibility of the nuclear power option, quality control in industrial development and a cleaner and safer environment.

In Asia and the Pacific, the focus was on strengthening human and institutional capacity for nuclear safety and for applications of nuclear technology in health, agriculture and industry, and supporting infrastructure building for Member States embarking on nuclear power.

"In all regions, cooperative arrangements, including regional agreements, have become key strategic mechanisms to expand cooperation with other partners at the regional and international levels."

In Europe, projects to support the development of nuclear power and the use of radiation in health care, as well as to maintain appropriate levels of safety and security in all aspects of the peaceful use of nuclear technology were an important area of activity.

In Latin America, in addition to ongoing projects in the areas of radiotherapy, nuclear medicine, plant breeding, pest control and water management, strategic alliances and partnerships continued to be important means to address the development needs of Member States. Emphasis was placed on disseminating the achievements of the projects carried out in connection with the ARCAL Regional Agreement over the last 25 years.

In all regions, cooperative arrangements, including regional agreements, have become key strategic mechanisms to expand cooperation with other partners at the regional and international levels. During the General Conference, consultations were held among the regions to identify synergies and initiatives for enhancing communication and cooperation between them, especially through regional agreements.

[3] More detailed information on the Agency's technical cooperation programme can be found in the *Technical Cooperation Report for 2010: Report by the Director General* (GC(55)/INF/2).

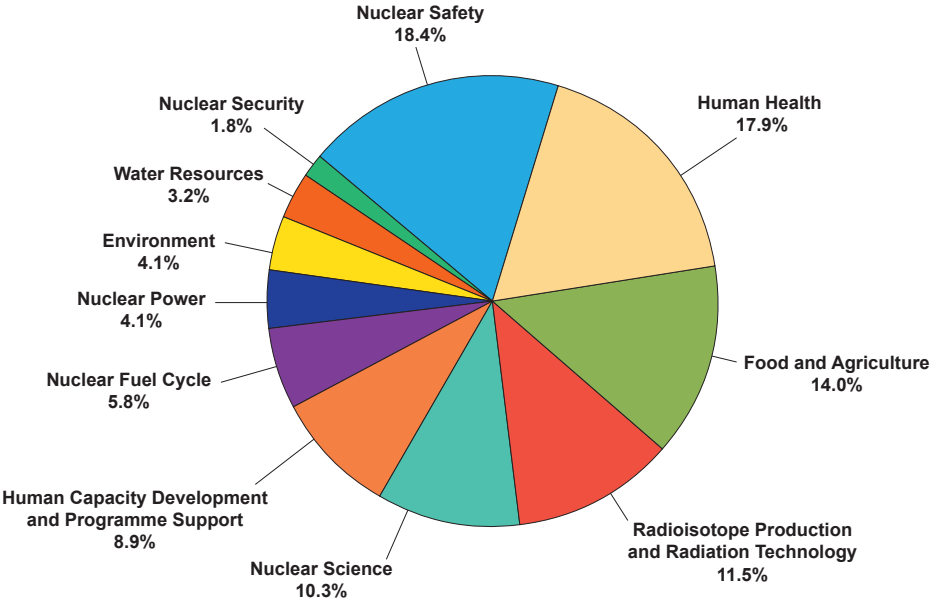

FIG. 1. Distribution of technical cooperation disbursements in 2010 by Agency programme (percentages in the chart may not add up to 100 due to rounding).

Financial Resources

The technical cooperation programme is funded by contributions to the TCF, as well as through extrabudgetary contributions, government cost sharing and contributions in kind. Overall, new resources reached a total of $127.6 million in 2010, with $79.7 million for the TCF (including previous year payments to the TCF, assessed programme costs, national participation costs[4] (NPCs) and miscellaneous income), $45.6 million in extrabudgetary resources, and $2.2 million representing in-kind contributions. These resources were applied directly to technical cooperation projects.

"Resources were sufficient to carry out the core technical cooperation programme as planned for 2010."

In 2010, the technical cooperation programme benefited from generous funding through the PUI. Eleven 'footnote-a/' projects[5] in the area of nuclear power infrastructure were being implemented with over $1.9 million in funds. Over 80 Member States were participating in various PUI funded activities under these projects, and a number of other footnote-a/ projects in non-power applications will also be funded by up to $478 000 through the PUI. The European Commission also made available up to €1.1 million for the period 2010–2012, with €507 000 received in 2010. Projects funded under this contribution concentrate on nuclear safety.

The rate of attainment[6] for the TCF stood at 92.3% on pledges and at 87.9% on payments at the end of the year, while payment of NPCs totalled $0.8 million. Resources were sufficient to carry out the core technical cooperation programme as planned for 2010.

Disbursements

In 2010, the sum of $114.3 million was disbursed to 129 countries or territories, of which 29 were

[4] *National participation costs*: Member States receiving technical assistance are assessed a charge of 5% of their national programme, including national projects and fellows and scientific visitors funded under regional or interregional activities. At least half of the assessed amount for the programme must be paid before contractual arrangements for the projects may be made.

[5] *Footnote-a/*: Projects that are awaiting funding or are partially funded by the TCF.

[6] The rate of attainment is the percentage that results from dividing the total voluntary contributions pledged and paid to the TCF for a particular year by the TCF target for the same year. As payments can be made after the year in question, the rate of attainment can increase over time.

least developed countries, reflecting the Agency's ongoing effort to address the development needs of the world's poorest States (Fig. 1).

Safeguards and Verification

The Agency's verification programme remains at the core of multilateral efforts to curb the proliferation of nuclear weapons. Through the application of safeguards, the Agency aims to assure the international community that nuclear material and facilities are used only for peaceful purposes. As such, the Agency has an essential verification role under the Treaty on the Non-Proliferation of Nuclear Weapons, as well as other treaties such as those establishing nuclear-weapon-free zones.

Safeguards Conclusions for 2010

At the end of each year, based upon an evaluation of all information available to it for that year, the Agency draws a safeguards conclusion for each State with a safeguards agreement in force. In 2010, safeguards were applied for 175 States[7] with safeguards agreements in force with the Agency.[8]

For a 'broader conclusion' to be drawn that 'all nuclear material remained in peaceful activities', both a comprehensive safeguards agreement (CSA) and an additional protocol (AP) must be in force, and the Agency must have been able to conduct all necessary verification and evaluation activities. Of the 99 States that had both a CSA and an AP in force, the Agency concluded that all nuclear material remained in peaceful activities in 57 States[9]. For the remaining 42 States, the Agency was only able to conclude that declared nuclear material remained in peaceful nuclear activities, as it had not yet completed all the necessary evaluations under these States' respective APs.

For States that have a CSA in force but no AP, the Agency does not have sufficient tools to draw soundly based safeguards conclusions regarding the absence of undeclared nuclear material and activities. For the 68 such States, the Agency drew the safeguards conclusion that declared nuclear material remained in peaceful activities.

Safeguards were also implemented with regard to declared nuclear material in selected facilities in the five nuclear weapon States with voluntary offer agreements. For these five States, the Agency concluded that nuclear material to which safeguards were applied in selected facilities remained in peaceful activities or had been withdrawn as provided for in the agreements.

The Secretariat could not draw any safeguards conclusions for the 17 NPT non-nuclear-weapon States without safeguards agreements in force.

For the three States that had safeguards agreements in force based on INFCIRC/66/Rev.2, the Secretariat concluded that the nuclear material, facilities or other items to which safeguards were applied remained in peaceful activities.

During 2010, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement and relevant United Nations Security Council resolutions in the Islamic Republic of Iran (Iran). In 2010, while the Agency continued to verify the non-diversion of declared nuclear material at the nuclear facilities and locations outside facilities declared by Iran, the Agency was not able to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran was in peaceful activities. Contrary to the relevant resolutions of the Board of Governors and the Security Council, Iran did not: implement the provisions of its AP; implement the modified Code 3.1 of the subsidiary arrangements general part to its CSA; suspend its enrichment related activities; suspend its heavy water related activities; and clarify the remaining outstanding issues which give rise to concerns about possible military dimensions to its nuclear programme. In 2010, Iran announced that it had selected the sites for new enrichment

"Of the 99 States that had both a CSA and an AP in force, the Agency concluded that all nuclear material remained in peaceful activities in 57 States."

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[7] The 175 States do not include the Democratic People's Republic of Korea (DPRK), where the Agency did not implement safeguards and, therefore, could not draw any conclusions.

[8] The status with regard to the conclusion of safeguards agreements, additional protocols and small quantities protocols is given in Table A6 in the Annex.

[9] And Taiwan, China.

facilities and that construction of one of these facilities would start in 2011.

In 2010, the Director General submitted four reports to the Board of Governors on the implementation of the NPT safeguards agreement in the Syrian Arab Republic (Syria). The Agency continued its verification activities in relation to the allegations that an installation destroyed by Israel at Dair Alzour in Syria in September 2007 had been a nuclear reactor under construction. Syria has yet to provide a credible explanation for the origin and presence of anthropogenic natural uranium particles found at the Dair Alzour site.[10] Syria has not cooperated with the Agency since 2008 in connection with the unresolved issues related to the Dair Alzour site and the three other locations to which it is allegedly functionally related. In 2009, the Agency found anthropogenic natural uranium particles at the Miniature Neutron Source Reactor (MNSR) near Damascus. A plan of action was agreed between Syria and the Agency, the aim of which is to resolve the inconsistencies between Syria's declarations and the Agency's findings.

Other Verification Activities

Since December 2002, the Agency has not implemented safeguards in the Democratic People's Republic of Korea (DPRK) and, therefore, cannot draw any safeguards conclusion regarding the DPRK. Since 15 April 2009, the Agency has not implemented any measures under the ad hoc monitoring and verification arrangement agreed between the Agency and the DPRK and foreseen in the Initial Actions agreed at the Six-Party Talks. Although not implementing any verification in the field, the Agency continued to monitor the DPRK's nuclear activities by using open source information, satellite imagery and trade information. In this regard, the Agency learned with great regret of the report on the uranium enrichment facility at Yongbyong. The Agency also continued to further consolidate its knowledge of the DPRK's nuclear programme with the objective of maintaining operational readiness to resume safeguards implementation in the State, to implement ad hoc monitoring and verification arrangements and to resolve any issues that may have arisen due to the long absence of Agency safeguards. In 2010, the Agency continued to regard the DPRK nuclear issue and that country's nuclear tests as a serious threat to the international nuclear non-proliferation regime and regional and international peace and stability.

"… in 2010, the Agency also continued its work on the conceptual framework for safeguards, aimed at further improving the State evaluation process and ensuring that States have a high level of confidence in the Agency's assurances."

Conclusion of Safeguards Agreements and Additional Protocols

The Secretariat continued to implement its Plan of Action to Promote the Conclusion of Safeguards Agreements and Additional Protocols, which was updated in September 2010. Outreach events in 2010 included: a briefing on Agency safeguards held in New York in May at the 2010 Review Conference of the Parties to the NPT; and an interregional seminar on the Agency's safeguards system for Portuguese speaking States with limited nuclear material and activities, conducted in Lisbon, in June.

In 2010, CSAs entered into force for five States and APs for ten States. One State acceded to the safeguards agreement between the non-nuclear-weapon States of Euratom, Euratom and the Agency, as well as the AP thereto. Small quantities protocols were amended to reflect the revised text with three States.

Strengthening Safeguards

In August, the Agency completed *The Long-Term Strategic Plan (2012–2023)*, which addresses the conceptual framework for safeguards, legal authority, technical capabilities and human and financial resources for Agency verification.

The drawing of soundly based safeguards conclusions is of utmost importance to the Agency. Therefore, in 2010, the Agency also continued its work on the conceptual framework for safeguards, aimed at further improving the State evaluation process and ensuring that States have a high level

[10] 'Anthropogenic' refers to nuclear material that has been produced as a result of chemical processing.

of confidence in the Agency's assurances. The Agency continued to further develop the State level concept for the planning, implementation and evaluation of safeguards activities for all States with CSAs in force. Key to this approach is the strengthening of collaborative analysis, involving multi-disciplinary teams throughout the entire safeguards process.

The Secretariat continued to work with State authorities responsible for implementing systems of accounting for and control of nuclear material on safeguards implementation issues, such as the quality of operator systems for the measurement of nuclear material, the timeliness and accuracy of State reports and declarations, and support for the Agency's verification activities, including through training and advisory missions.

Further enhancements were made to the capabilities of the safeguards analytical services through a project entitled 'Enhancing Capabilities of the Safeguards Analytical Services (ECAS)': the architectural design for a Nuclear Material Laboratory to analyse nuclear material samples was completed; and construction of an extension to the Clean Laboratory at Seibersdorf began in April.

In November, the Agency held its 11th Symposium on International Safeguards in Vienna. Some 670 participants from 64 States and 17 international organizations attended the event, the theme of which was 'Preparing for Future Verification Challenges'.

Conclusion

The role that the Agency has played in helping to achieve global development objectives continues to conform to the objective stated in Article II of its Statute, namely to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". In this context, several principles central to the Agency's mission were reinforced during 2010, the most important of which were the following:

- Important benefits for achieving sustainable development and for improving the quality of life can derive from the peaceful application of nuclear energy and nuclear techniques. The Agency thus has an important role in assisting developing countries to improve their scientific and technological capabilities in the nuclear area.
- Both national measures and international cooperation are essential for nuclear, radiation, waste and transport safety, and the Agency has a key role in the promotion of a global safety culture.
- Agency safeguards are a basic component of the non-proliferation regime and create an environment conducive to nuclear disarmament and nuclear cooperation.

Responding to the challenges of the future requires collaborative efforts by Member States, international organizations and civil society. It also requires flexibility — the ability to adapt to changing circumstances to achieve common goals. For the Agency, this cooperation is the key to harnessing nuclear energy in the service of peace and development for humanity.