IAEA AT WORK

2014 Edition

IAEA

atoms for peace

CONTENTS

FOREWORD

The IAEA's mission is to prevent the spread of nuclear weapons and to help all countries benefit from the peaceful, safe and secure use of nuclear science and technology.

Since the IAEA was founded in 1957, its work has constantly evolved to meet the changing needs of its Member States. It works to improve human and animal health. It helps farmers to grow more abundant and robust crops. It helps to make clean water more available and to combat environmental pollution. It helps countries that wish to use nuclear power to do so safely and securely. Through all of these activities, the IAEA helps Member States to use nuclear technologies to meet the basic needs of their people.

Nuclear power is the best-known peaceful application of nuclear energy. Use of nuclear power looks set to grow steadily in the next 20 years. The Fukushima Daiichi accident in 2011 led to a renewed focus on safety. After that accident, IAEA Member States agreed on the IAEA Action Plan on Nuclear Safety which they, and the IAEA, are now implementing.

The IAEA also serves as the global platform for strengthening nuclear security. Its work focuses on helping to minimize the risk of nuclear and other radioactive material falling into the hands of terrorists, or of nuclear facilities being subjected to malicious acts.

The IAEA is the only organization within the UN system with expertise in nuclear technologies, which are made available to developing countries through its extensive technical cooperation programme. Its unique specialist laboratories help transfer knowledge and expertise to its Member States in areas such as human health, food, water and the environment.

Its work in nuclear non-proliferation is generally the best known area of its activities. IAEA inspectors conduct about 2000 inspection missions annually to over 1200 sites in 78 States to verify that nuclear material is not being diverted from peaceful purposes. This is an important contribution to international peace and security.

I hope this brochure will provide a useful overview of the IAEA's activities.

Yukiya Amano
IAEA Director General

162 MEMBER STATES

AFGHANISTAN, ISLAMIC REPUBLIC OF
ALBANIA
ALGERIA
ANGOLA
ARGENTINA
ARMENIA
AUSTRALIA
AUSTRIA
AZERBAIJAN
BAHAMAS
BAHRAIN
BANGLADESH
BELARUS
BELGIUM
BELIZE
BENIN
BOLIVIA
BOSNIA AND HERZEGOVINA
BOTSWANA
BRAZIL
BRUNEI DARUSSALAM
BULGARIA
BURKINA FASO
BURUNDI
CAMBODIA
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHAD
CHILE
CHINA
COLOMBIA
CONGO
COSTA RICA
CÔTE D'IVOIRE
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
DEMOCRATIC REPUBLIC OF THE CONGO
DENMARK
DOMINICA
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ERITREA
ESTONIA
ETHIOPIA
FIJI
FINLAND
FRANCE
GABON
GEORGIA
GERMANY
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN, ISLAMIC REPUBLIC OF
IRAQ
IRELAND
ISRAEL
ITALY
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
KYRGYZSTAN
LAO PEOPLE'S DEMOCRATIC REPUBLIC
LATVIA
LEBANON
LESOTHO
LIBERIA
LIBYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MADAGASCAR
MALAWI
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA, ISLAMIC REPUBLIC OF
MAURITIUS
MEXICO
MONACO
MONGOLIA
MONTENEGRO
MOROCCO
MOZAMBIQUE
MYANMAR
NAMIBIA
NEPAL
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
OMAN
PAKISTAN
PALAU
PANAMA
PAPUA NEW GUINEA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
REPUBLIC OF SAN MARINO
ROMANIA
RUSSIAN FEDERATION
RWANDA
SAUDI ARABIA
SENEGAL
SERBIA
SEYCHELLES
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
TAJIKISTAN
THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
TOGO
TRINIDAD AND TOBAGO
TUNISIA
TURKEY
UGANDA
UKRAINE
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VENEZUELA, BOLIVARIAN REPUBLIC OF
VIET NAM
YEMEN
ZAMBIA
ZIMBABWE

IAEA MISSION

THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

- Is an independent intergovernmental, science and technology-based organization, in the United Nations family, that serves as the global focal point for nuclear cooperation;
- Assists its Member States, in the context of social and economic goals, in planning for and using nuclear science and technology for various peaceful purposes, and facilitates the transfer of such technology and knowledge in a sustainable manner to developing Member States;
- Develops nuclear safety standards and, based on these standards, promotes the achievement and maintenance of high levels of safety in applications of nuclear energy, as well as the protection of human health and the environment against ionizing radiation;
- Verifies through its inspection system that States comply with their commitments, under the Treaty on the Non-Proliferation of Nuclear Weapons and other non-proliferation agreements, to use nuclear material and facilities only for peaceful purposes.

INTRODUCTION

NUCLEAR TECHNOLOGY FOR A SUSTAINABLE FUTURE

Nuclear technology is used everywhere in our daily lives: supporting health from diagnosis to cure or palliation, improving crops and strengthening agriculture, monitoring and protecting the environment, identifying and protecting water resources, in energy planning and nuclear power, in research, data collection and analysis. The IAEA helps its Member States safely employ this technology to ensure peace, health and prosperity throughout the world.

Food and Agriculture

The sustainable production of food will remain a pre-eminent challenge in the decades to come. Based upon current practice and consumption, agricultural production will have to increase by about 70% by 2050 to meet this demand. Nuclear technologies are used in developing countries to increase production sustainably by breeding improved crops, enhancing livestock reproduction and nutrition, as well as controlling animal and plant pests and diseases. Post-harvest losses and wastage in the supply chain can be reduced and food safety increased with the application of nuclear technologies. Soil can be evaluated with nuclear techniques to conserve soil resources and improve soil productivity and water management.

Health and Nutrition

In the area of health, nuclear techniques are used to diagnose and treat cancer, cardiovascular and other non-communicable diseases, which are increasing rapidly in developing countries — in fact they will account for almost 70% of all deaths by 2030. Nuclear techniques also help develop and monitor efficient and sustainable interventions to combat malnutrition in all its forms.

Water

Population growth, accelerating economic development, and changing lifestyles demand ever more resources. Increased access to sufficient, safe water is made possible through isotope techniques that map water resources more affordably and more quickly than any other means, and thus improve water managers' ability to sustain this crucial resource. In addition, isotopes of water in rain, monitored by the IAEA since 1961, are used for understanding climate change impacts, including validation of global climate models.

Environment

Nuclear techniques also provide researchers with tools to study the planet's past and predict its future. They are used to monitor pollution trends and assess their impacts, while also improving global understanding of the effects of climate change in both terrestrial and oceanic systems.

Energy Planning and Nuclear Power

Access to affordable energy directly improves human welfare; current projections foresee electricity demand increasing by 60 to 100% between today and 2030. Low carbon sources of energy, such as nuclear energy, minimize the greenhouse gases emitted in energy generation and mitigate the negative impact of climatic disruption on development. The IAEA helps countries using or introducing nuclear power to do so safely,

securely, economically and sustainably. Its assistance and reviews in the area of safety standards increase safety for the benefit of human health and the environment. The IAEA also verifies that nuclear energy is only used for peaceful purposes, directly contributing to international peace and security.

Industrial Applications and Radiation Technology

A range of safe, tested nuclear techniques can be used to measure pollution levels, identify and measure the properties of different materials, sterilize and disinfect, and change chemical, physical and biological properties. Radiation can be used for both the analysis and processing of a range of materials.

Safety and Security

One of the IAEA's key objectives is to help countries to upgrade their nuclear safety infrastructure and to prepare for and respond to nuclear and radiological emergencies. Work is based on international conventions, standards and guidance, and aims to protect people and the environment from harmful exposure to radiation. Assistance in radiation protection and radiation safety is provided to Member States through dedicated projects covering strengthening regulatory infrastructure, occupational exposure control, medical exposure control, protection of the public and the environment from radiation practices, nuclear and radiological emergencies, education and training, and transport safety.

Activities in the nuclear security area cover nuclear and radioactive materials, as well as nuclear installations. IAEA projects support the implementation of relevant legal instruments with the ultimate goal of establishing sustainable nuclear security infrastructures and strengthening aspects of nuclear security such as prevention capabilities at facilities housing nuclear and other radioactive material, and detection and response capabilities at borders and other checkpoints.

Safeguards

The primary role of the Department of Safeguards is to deter the proliferation of nuclear weapons. It does so in two ways: by providing credible assurances that States are honouring their international obligations, thus helping to build international confidence, and by being able to detect early any misuse of nuclear material or technology, thereby alerting the world to potential proliferation.

To do so, the Department applies various technical measures referred to as 'safeguards' to verify the correctness and the completeness of the declarations made by States about their nuclear material and activities. IAEA safeguards are an essential component of the international security system.

OVERVIEW OF THE IAEA POLICY-MAKING ORGANS

IAEA programmes and budgets are set through decisions of its policy-making bodies: the General Conference of all Member States and the 35-member Board of Governors.

IAEA GENERAL CONFERENCE

The General Conference is the plenary policy-making body of the IAEA. It is composed of representatives of all Member States of the IAEA. The General Conference meets annually, typically in September, to consider and approve the IAEA's programme and budget and to decide on other matters brought before it by the Board of Governors, the Director General, or Member States.

President, Vice-Presidents and Chairman of the Committee of the Whole

Temporary President: at the beginning of each session of the General Conference, the delegate from whose delegation the President of the previous session was elected or, in the absence of that delegate, the Director General presides until the General Conference has elected a President for the session.

Election of President, Vice-Presidents and Chairman of the Committee of the Whole: the General Conference elects a President and the President, having due regard to equitable geographical representation, proposes to the General Conference for election, the names of eight Vice-Presidents and the name of a Chairman of the Committee of the Whole. The President, the Vice-Presidents and the Chairman of the Committee of the Whole hold office until the close of the session at which they are elected.

Acting President: if the President is absent during a meeting or any part thereof, he appoints one of the Vice-Presidents to take his place, who, while acting as President, has the same powers and duties as the President.

Replacement of the President: if the President is unable to perform his functions, a new President is elected for the unexpired term of office of the President.

IAEA BOARD OF GOVERNORS

The IAEA Board of Governors is composed of 35 Member States, as designated and elected by the General Conference. The Board of Governors generally meets five times per year — in March and June, twice in September (before and after the General Conference) and in December. At its meetings, the Board examines and makes recommendations to the General Conference on the IAEA's accounts, programme, and budget and considers applications for membership. It also approves safeguards agreements and the publication of the IAEA's safety standards and has the responsibility for appointing the Director General of the IAEA with the approval of the General Conference.

Representation of Members

Governors: each Member of the Board of Governors designates one person as its Governor. Each Governor may be accompanied by alternates, experts and advisers. The Governor and all such alternates, experts and advisers constitute the Member State's delegation to the Board.

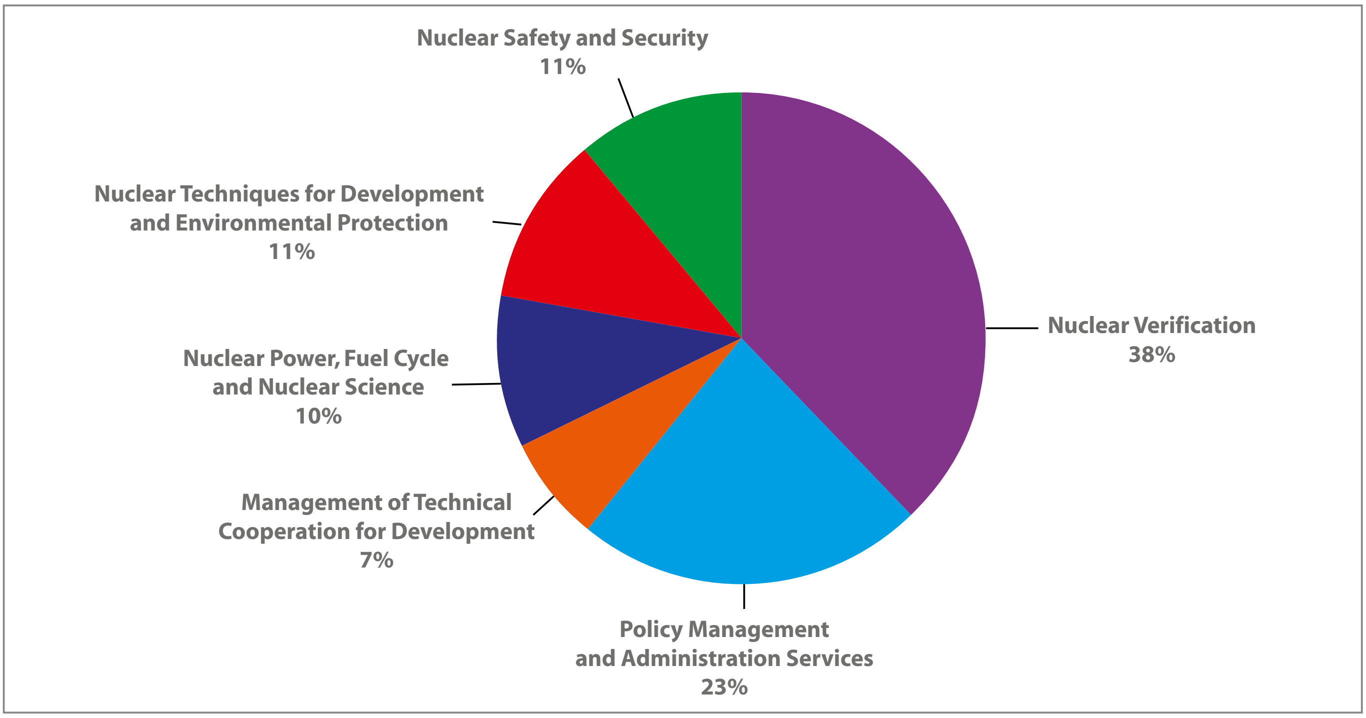
Officers of the Board

Chairman and Vice-Chairmen: the Chairman and two Vice-Chairmen are elected from among the accredited Governors and may at all times participate in the discussions of the Board as Governors and may also vote in that capacity. The Chairman or, in his absence or disability, the Vice-Chairman acting as Chairman, presides at all meetings of the Board. As presiding officer, he declares the opening and closing of each meeting of the Board, directs the discussions, ensures observance of the Rules of Procedure, accords the right to speak, puts questions and announces decisions. He rules on points of order and, subject to the Rules, has control of the proceedings of the Board and over the maintenance of order at its meetings.

Programme and Budget

The formulation of the 2014–2015 programme and budget was guided by the goals of maximizing efficiency, reflecting changing priorities, striking an appropriate balance among the IAEA's activities and, at the same time, taking into account the current financial challenges faced by most Member States and constantly increasing demands for the IAEA's services. A two stage budget preparation process using a new methodology was initiated that also considered the guidance given to the Secretariat by Member States and the priorities identified in the Medium Term Strategy 2012–2017.

Fig. 1: The Operational Regular Budget for 2014 amounts to €341.6 million



OVERVIEW OF THE IAEA SECRETARIAT

The IAEA Secretariat — the international body of staff tasked with running the IAEA — is made up of a team of 2300 multidisciplinary professional and support staff from more than 100 countries. They come from scientific, technical, managerial and professional disciplines.

Most of these men and women work at the IAEA's headquarters in Vienna, Austria. Others work at the regional offices in Toronto and Tokyo, at liaison offices in New York and Geneva and at research laboratories in Seibersdorf, Austria and Monaco.

Six major IAEA Departments set the organizational framework:

❶ Department of Technical Cooperation

❷ Department of Nuclear Sciences and Applications

❸ Department of Nuclear Energy

❹ Department of Nuclear Safety and Security

❺ Department of Safeguards

❻ Department of Management

DEPARTMENT OF TECHNICAL COOPERATION

THE IAEA'S TECHNICAL COOPERATION PROGRAMME

The IAEA's TC programme is a one house initiative that is responsible for delivering IAEA services in the peaceful application of nuclear science and technology to Member States. The Department of Technical Cooperation is responsible for overall programme coordination and management, while the technical Departments provide the essential scientific expertise and knowledge.

The mandate of the IAEA's TC programme is set out in the IAEA Statute: to support "the contribution of atomic energy to peace, health and prosperity throughout the world". We do this by helping our Member States to safely and securely apply nuclear technology in pursuit of sustainable socio-economic development. All IAEA Member States can participate in the IAEA's TC programme, but in practice, our technical cooperation activities tend to focus on the needs and priorities of less developed countries.

The IAEA's TC programme is the main mechanism through which the IAEA delivers support to its Member States. It focuses on improving human health, supporting agriculture and food security, advancing water resource management, addressing environmental challenges, helping with energy planning and sustainable energy development (including the use of nuclear power for electricity), and promoting safety and security. The IAEA's TC programme is unique in the United Nations system, as it combines specialized technical and development competencies.

TC activities are programmed according to the needs of four geographical regions — Africa, Asia and the Pacific, Europe (including parts of central Asia) and Latin America — and take into consideration

"Over the last five decades, the IAEA has trained over 29 000 people through fellowships and scientific visits, designed to promote the use of nuclear technology across a range of topics. These include supporting agriculture, improving health and healthcare infrastructure, advancing water resource management, addressing environmental challenges, planning for future energy needs, and supporting the introduction of nuclear power. Every year, around 125 Member States take part in the IAEA's technical cooperation (TC) programme.

The programme also contributes to the achievement of many of the Millennium Development Goals: combating poverty and hunger; promoting gender equality and empowering women; reducing child mortality; improving maternal health; combating disease; ensuring environmental sustainability; and promoting partnerships between science and development authorities."

Kwaku Aning
Deputy Director General and Head of the Department of Technical Cooperation

existing capacities and different operational conditions. The programme builds on the capacities of Member States in the same region by facilitating cooperation between them. For example, technically advanced countries in a region can provide expertise for projects in less advanced countries.

Funding the IAEA's TC Programme

The IAEA's TC programme is funded by voluntary contributions to the Technical Cooperation Fund (TCF), as well as by extrabudgetary contributions, government cost-sharing and contributions in kind.

The target for voluntary contributions to the TCF for 2014 is €69.2 million. There are currently some 800 active technical cooperation projects. This increased in January 2014 as the new 2014–2015 programme cycle begins (with some 500 new projects).

The IAEA's TC Programme: Delivering Results for Peace and Development

Through the IAEA's TC programme, the IAEA helps Member States to build, strengthen and maintain capacities for the safe, peaceful and secure use of nuclear technology in support of national development priorities. The IAEA's TC programme is developed and managed jointly by the Member States and the IAEA's Secretariat.

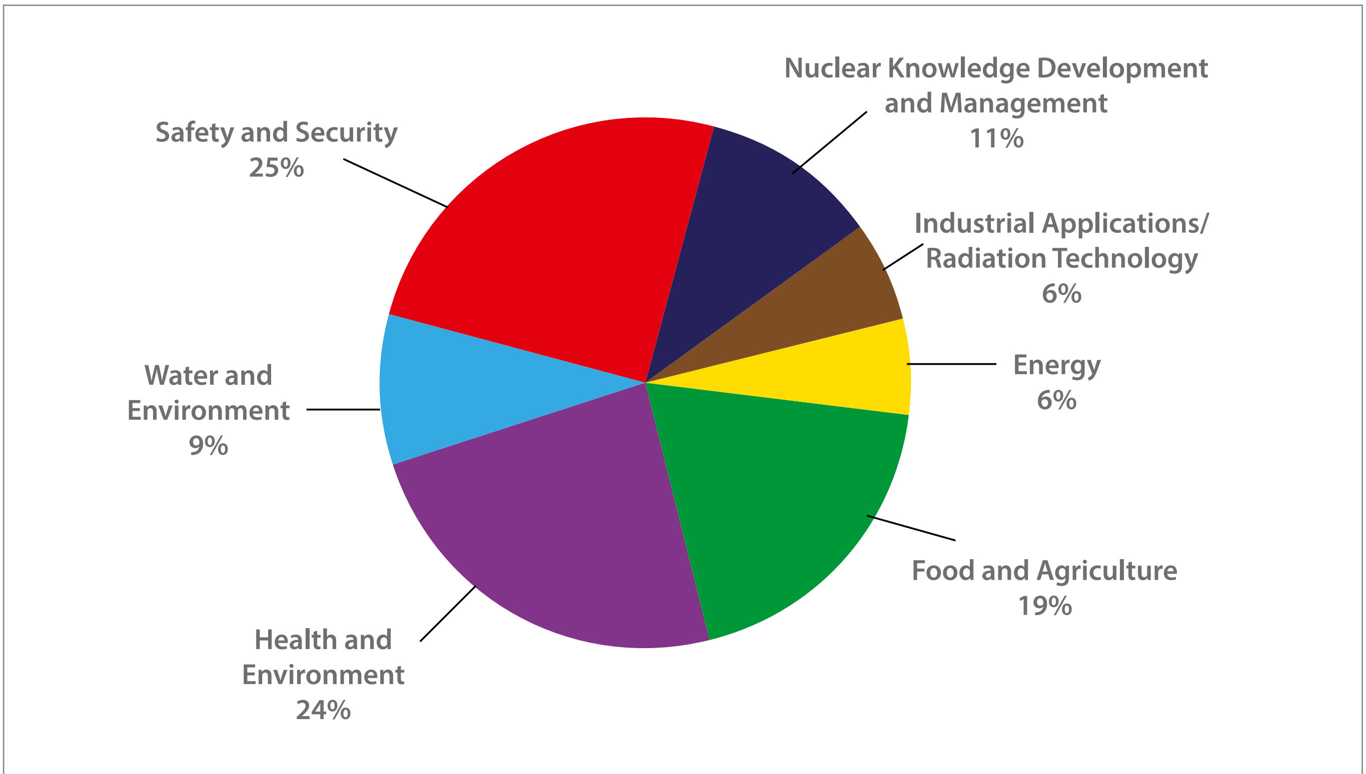
TC projects respond to Member States' development priorities and support the implementation of national development programmes by providing expertise in fields where nuclear techniques offer advantages over other approaches, or where nuclear techniques can usefully supplement conventional means — for example, where the IAEA can add value to services from other development partners. The programme offers support through human resource capacity building activities and equipment procurement, and emphasizes cooperation between Member States, as well as enablement, self-reliance, mutual responsibility and ownership.

The IAEA's TC programme delivery mechanisms include fellowships and scientific visits, expert missions and meetings, and training courses focusing on the safe and effective application of nuclear technology. Workshops, meetings and symposia organized under the IAEA's TC programme not only enhance technology transfer and cooperation, but also support the creation of networks and encourage cooperation at all levels.

Training fellowships prepare local personnel to apply nuclear techniques in the national sector. Fellows are sent abroad for comprehensive training in a suitable institution for periods ranging from a few months to several years.

Scientific visits are designed for senior personnel, and aim to broaden the scientific or managerial qualifications of specialists in developing countries. Scientific visits may be as long as two weeks.

Fig. 2: Allocation of Resources for the core IAEA's TC programmes 2014–2015



The Millennium Development Goals

Expert assistance delivers on-the-spot, training in the country by a recognized expert. Expert missions may be of a few weeks' duration or may last a whole year.

Training courses and workshops in various industry sectors help build local expertise and strengthen networking by bringing together researches and technicians from across the developing world.

Conferences, symposia and seminars are designed to support the exchange of ideas between experts and specialists from various countries.

Equipment and materials provided by the IAEA are used to establish or enhance national development activities in Member States. When complex equipment is supplied to a country, the project usually includes the visit of an expert to train the staff in the operational and technical aspects of the instrument.

Partnerships

The IAEA's TC programme works in close partnership with Member States, United Nations agencies and other international organizations and civil society in order to maximize the contribution of nuclear science and technology to the achievement of development priorities.

Such partnerships help ensure project results and strengthen the competence and capabilities of counterparts. This enables good science and strong technical and regulatory institutions that can accelerate national development.

The IAEA's TC programme helps Member States to improve agriculture and food security with the support of the long-running and highly effective Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, which focuses on the integration of nuclear technologies and related biotechnologies with conventional techniques.

IAEA Technical Cooperation and the International Development Context

In 2000, the Millennium Development Goals (MDGs) were established as a UN initiative to harmonize national development around common priority objectives, the achievement of which would be measurable and accountable over time. All 189 United Nations Member States at the time (there are 193 currently) and 29 international organizations committed themselves to help achieve these Goals by 2015.

The IAEA is contributing actively to the ongoing debate on successor sustainable development goals (SDGs) encouraging Member States to strengthen the role of science, technology and innovation in sustainable development. That necessitates national technology development strategies and competent scientific, technical and regulatory institutions.

IAEA PACT: TAKING ACTION TO FIGHT CANCER IN DEVELOPING COUNTRIES

Cancer is an increasingly important factor in the global burden of disease. According to the World Health Organization (WHO), more than half of all cancers and deaths due to the disease in 2012 occurred in less developed regions of the world — and these figures are expected to increase in the coming decade.* In response to the developing world's growing cancer crisis and recognition that providing technology and training is not enough to address a country's cancer burden, the IAEA

established the Programme of Action for Cancer Therapy (PACT) in 2004.

In 2009, the IAEA established the Joint Programme on Cancer Control with the WHO to strengthen the development and implementation of comprehensive national cancer control programmes (NCCPs) in low- and middle-income countries. Components of NCCPs include cancer registration, prevention, early detection, diagnosis and treatment (including radiation medicine), and palliative care.

PACT enables developing countries to introduce, expand and improve comprehensive strategic national plans for cancer control by utilizing PACT coordination competencies, global partnerships and the IAEA's TC programme.

Three key PACT services to Member States include the imPACT review, PACT Model Demonstration Sites and the Virtual University for Cancer Control.

imPACT reviews involve an evaluation of a country's readiness to implement cancer control programmes, an assessment of the national cancer burden and recommendations on developing the country's cancer control capacity. The recommendations can then be used to produce or augment an NCCP to support national and international stakeholders in the development and implementation of effective measures that respond to the cancer control needs of the country.

PACT Model Demonstration Sites (PMDSs) are pilot projects that aim to provide evidence-based strategies and the benefits of strategic partnerships to efficiently fight cancer in developing countries. Currently, eight IAEA Member States are participating, namely Albania, Ghana, Mongolia, Nicaragua, Sri Lanka, United Republic of Tanzania, Vietnam and Yemen. PACT works together with international and national organizations to develop sustainable cancer control projects at the PMDSs as well as with donors to fund them.

To address an acute workforce shortage of cancer professionals in Africa, PACT launched the Virtual University for Cancer Control and Regional Training Network (VUCCnet), a pilot project in the sub-Saharan Africa region. Begun in 2010, the project is focusing initially on four Member States: Ghana, Uganda, United Republic of Tanzania and Zambia. In further developing cancer education and training in the pilot countries, South Africa and Egypt are operating as mentors.

At the start of 2014, the PACT Programme Office was moved to the Department of Technical Cooperation. The new, expanded Division of Programme of Action for Cancer Therapy will enhance fundraising efforts and will develop new products and services for Member States.

---

*GLOBOCAN 2012, International Agency for Research on Cancer.




DEPARTMENT OF NUCLEAR SCIENCES AND APPLICATIONS

NUCLEAR TECHNIQUES FOR DEVELOPMENT AND ENVIRONMENTAL PROTECTION

A most diverse Department, the Department of Nuclear Sciences and Applications cuts across a number of important socio-economic sectors, from health, food and agriculture to the environment, water resources and industry. In each thematic area, the IAEA's scientists work together with experts in Member States to help meet their development needs through nuclear science, technology and innovation. The IAEA provides Member States with scientific advice, education and training, technical documents, access to key nuclear data, as well as meetings, conferences and symposia. The Department works with Member States to advance nuclear science and technology, and improve awareness about its wide range of applications.

The services are delivered through various mechanisms, such as technical cooperation projects and coordinated research activities. To further research and development (R&D) and capacity building, the Department works together with scientific institutions such as laboratories, universities and research facilities around the world through its Collaborating Centre scheme, as well as networks, such as Analytical Laboratories for the Monitoring of Environmental Radioactivity (ALMERA). Cooperation with important partners such as the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the International Centre for Theoretical Physics (ICTP) is paramount in order to expand capabilities in the nuclear field.

A unique feature in the United Nations system, the Department operates a group of 12 nuclear applications laboratories in Vienna, Seibersdorf and Monaco. The laboratories provide Member States with applied R&D, training and capacity building, technical and

"In order to respond to Member States' growing demands, ageing infrastructure and constrained capacities, a new project, titled the Renovation of the Nuclear Applications Laboratories in Seibersdorf (ReNuAL project) was launched during the last General Conference.

The overarching goal of the ReNuAL project is to have fit-for-purpose laboratories that can address the evolving range and complexity of Member States' growing demands for technological development. Specific elements of the project include: upgrading the infrastructure and improving the efficiency and effectiveness of laboratory operations and services; acquiring new equipment either to replace ageing or obsolete hardware or to be able to respond to emerging issues and/or changes in technology.

The project will greatly benefit from the advocacy and fundraising support by the "Friends of ReNuAL" group, which was called by General Conference resolution GC(57)/RES/12. All Member States are encouraged to join this initiative. The resolution also recognized the need for vigorous resource mobilization and a concrete strategic plan, which should be available to Member States sometime in the first half of 2014."

Daud Mohamad
Deputy Director General and Head of the Department of Nuclear Sciences and Applications

analytical services, reference materials, quality control and quality assurance services. They also set international standards in the respective areas.

SERVING HUMANITY — ADAPTING SCIENCE FOR DEVELOPMENT

The Nuclear Applications (NA) Laboratories support and implement programmatic activities in response to Member States' needs in the areas of water resources, food and agriculture, human health, environmental monitoring and assessment, and the use of nuclear analytical instruments. Their services include:

- Applied/adaptive research and development linked to coordinated research projects (CRPs) and TC projects, two of the IAEA's main delivery mechanisms in transferring nuclear technologies to Member States. Currently over 50 CRPs are directly supported by the NA laboratories in Seibersdorf.
- Capacity building, including education and training, are crucial components of the technology, skills and knowledge transfer that takes place at the NA laboratories (train-the-trainer workshops, courses and seminars) and in Member States or at regional laboratories.
- Technical and analytical support is provided through evaluation, standardization and selection of appropriate equipment and processes for each specific project or need, as well as through dosimetry calibrations, auditing services, and provision of reference materials.

There are 12 NA Laboratories at the IAEA, comprising one facility in Vienna, three in Monaco and eight in Seibersdorf:

The Animal Production and Health Laboratory (Seibersdorf), part of the Joint FAO/IAEA Division's food and agriculture programme, supports Member States in the use of radioisotopes and related technologies to map superior genes for increased animal productivity, and develops and transfers molecular and immunoassay methods for diagnosis and control of transboundary animal diseases, including diseases transmissible to humans (zoonoses).

The Dosimetry Laboratory (Seibersdorf), part of the IAEA's human health programme, oversees the quality assurance aspects of the use of radiation in medicine in Member States. It provides dosimetry calibrations for national standards laboratories and conducts audits of radiation doses provided in radiotherapy and for radiation protection.

The Food and Environmental Protection Laboratory (Seibersdorf), part of the Joint FAO/IAEA Division's food and agriculture programme, uses nuclear technologies to trace and authenticate food products and to detect and monitor contaminants in foods and the environment. It develops and promotes analytical methods to improve Member States' laboratory practices in food safety and quality in order to safeguard health and facilitate international trade.

The Insect Pest Control Laboratory (Seibersdorf), part of the Joint FAO/IAEA Division's food and agriculture programme, develops environmentally friendly methods for area-wide control of key insect pests, such as different species of fruit flies and moths, as well as disease-transmitting species of mosquitoes and tsetse flies.

The Isotope Hydrology Laboratory (Vienna), part of the water resources programme, houses state-of-the-art equipment for measuring isotopes of oxygen, hydrogen, carbon and noble gases (helium, neon, krypton and others) in water samples as part of training and analytical services provided to Member States. A major focus of the Isotope Hydrology Laboratory (IHL) is to help Member States build their own laboratories and to ensure the quality of their isotope measurements. Recently, the IHL helped develop a new technique for oxygen and hydrogen isotope analysis, which has been provided to more than 50 Member States through TC projects over the last five years. An easier method for tritium analysis is now being tested.

The Marine Environmental Studies Laboratory (Monaco) covers isotopic and elemental analysis of trace elements, long lived radionuclides, organic contaminants and lipid biomarkers. It supports capacity building in Member States to enhance their capabilities for marine environmental surveys. The laboratory is the pillar of the quality assurance programme for the determination of non-nuclear contaminants in the marine environment. Investigations related to biogeochemical cycling of mercury, methyl mercury and persistent organic pollutants are particularly emphasized.

The Nuclear Science and Instrumentation Laboratory (Seibersdorf), part of the IAEA's nuclear science programme, works with laboratories in Member States to enhance their use of nuclear instrumentation and analytical techniques, for example in promoting the use of various types of accelerator for materials testing and historical artefact preservation.

The Plant Breeding and Genetics Laboratory (Seibersdorf), part of the Joint FAO/IAEA Division's food and agriculture programme, focuses on nuclear technologies in plant mutation breeding to increase food security and biodiversity for desired traits in crop plants and hence to accelerate the development of new varieties with higher yield, better yield stability, improved food and feed qualities, improved resistance to pests and diseases and tolerance to environmental stresses such as drought and salinity.

The Radioecology Laboratory (Monaco) focuses on the study of the behaviour and fate of nuclear and non-nuclear contaminants in seafood and food webs using radiotracer techniques; on the impact of ocean acidification on marine organisms of ecological and commercial interest and on ecosystem services; on the management of harmful algal blooms (HABs) in coastal environments; and on the tracking of carbon export from the upper ocean using natural radiotracers.

The Radiometrics Laboratory (Monaco) is an internationally recognized centre for the study of the oceans using radionuclides and isotopes as environmental tracers, in collaboration with leading research centres and environmental agencies of Member States around the world. It develops analytical methods and supports Member States in their quality assurance of marine monitoring activities by enabling interlaboratory comparisons, by producing reference materials of marine origin and by assisting national agencies in their marine monitoring activities.

The Soil and Water Management and Crop Nutrition Laboratory (Seibersdorf), part of the Joint FAO/IAEA Division's food and agriculture programme, uses isotope and nuclear techniques to measure and monitor soil, water and nutrients in cropping and integrated cropping-livestock production systems. This is a basis for developing strategies and best farming management practices that ensure judicious and efficient use of resources for sustainable agriculture and that minimize environmental degradation and greenhouse gas emissions.

The Terrestrial Environment Laboratory (Seibersdorf), part of the IAEA's environment programme, helps Member States to better understand and protect the terrestrial environment. The laboratory develops environmental assessment strategies and ensures the quality of analytical results by recommending analytical methods, producing and providing reference materials and organizing proficiency tests.

SUSTAINABLE ENVIRONMENTAL MANAGEMENT

Key to the long term sustainability of national development is the health of the natural environment. A healthy environment provides unpriced, essential 'ecosystem services' such as the capture of carbon dioxide, the recycling of nutrients, the provision of clean air and water, and recreational opportunities. However, development can be quickly undermined by careless pollution, the loss of biodiversity and global transformations, such as climate change. In this context, the IAEA's Environment Laboratories in Monaco and Seibersdorf help Member States apply nuclear techniques for the protection of terrestrial, atmospheric and aquatic environments, including fragile coastal zones and the world's oceans.

For over five decades the IAEA's Environment Laboratories have provided essential scientific and analytical support for landmark studies of radioactive pollutant levels in seas across the globe. Worldwide radioactivity baseline studies of the oceans and seas have been undertaken and the IAEA Environment Laboratories work closely with Member States to monitor contemporary impacts from radionuclides in the environment, such as those associated with the 2011 Fukushima Daiichi nuclear accident, and to assist Member States in their monitoring activities in coastal and marine areas.

Coordination is provided to the international ALMERA network , which includes over 140 laboratories in 81 Member States for environmental monitoring and emergency preparedness.

The IAEA Environment Laboratories also work with Member States and regional organizations to improve their capacity to use nuclear and isotope techniques to monitor and assess marine pollutants, such as toxic heavy metals and pesticides or oil. Similarly, the IAEA works with Member States to improve understanding of key marine and carbon cycling processes. One core goal of the IAEA's laboratories is to improve the quality of these measurements by performing proficiency tests, interlaboratory comparisons and producing reference materials of high quality.

The IAEA contributes to basic climate science by using nuclear techniques to learn more about past climates. The isotopic 'natural archives' preserved in marine sediments, ice cores, and corals and polar ice offer valuable data on climatic conditions on Earth over several millennia. The IAEA Environment Laboratories also study ocean acidification and the other effects of climate change on oceans and marine ecosystems. Ocean acidification occurs as oceans absorb the rising quantities of carbon dioxide in the atmosphere.

Carbon dioxide forms carbonic acid, creating more acidic seawater, which can threaten marine ecosystems, especially corals and other marine organisms with shells. The Ocean Acidification International Coordination Centre (OA-ICC), based at the IAEA's laboratories in Monaco, coordinates international efforts to study and respond to the growing threat of ocean acidification.

The work of the IAEA Environment Laboratories is complemented by work on environmental issues by other NA laboratories to build capacity in Member States in the use of radiation technology for a cleaner environment. For example, radiation technology is used effectively to treat industrial textile dye waste water using an electron beam and for the sanitization of sewage sludge for agricultural applications and thus helps to conserve water resources and improve soil conditions.

Most of the world's energy (88%) is produced by the combustion of fossil fuels such as oil, natural gas and coal. This process forms toxic pollutants such as sulphur oxides and nitrogen oxides, which travel across borders and cause widespread damage through the formation of acid rain. Many countries are introducing stricter emission control regulations to mitigate the problem. Conventional technology for removal of these pollutants from flue gases employs a two stage process with wet chemical methods and needs an expensive catalyst for the process. Electron beam treatment of flue gas is emerging as a new technology, the only one that simultaneously facilitates the conversion of sulphur oxides and nitrogen oxides into useful by-products such as fertilizers by irradiating water-saturated flue gas in the presence of ammonia with an electron beam accelerator.

In 2013, the IAEA Scientific Forum focused on many of these issues. Entitled 'The Blue Planet: Nuclear Applications for a Sustainable Marine Environment', the forum brought together scientists, experts and policymakers from different fields to initiate dialogue on the protection and preservation of the ecological balance that is vital for the survival of the coastal regions and marine environment.

IAEA AND FAO WORK TOWARDS GLOBAL FOOD SECURITY

Food for the Future: Meeting the Challenges with Nuclear Applications

While more than 800 million people suffer from hunger, the world population is expected to rise by a further two billion people by 2050. The challenges to ensure global and sustainable food security have never been greater: fresh water is dwindling, arable land is shrinking, transboundary diseases are increasing, resources are overexploited, and harsh and more erratic climatic conditions cut food outputs and threaten whole ecosystems.

"All of us have a responsibility to do everything we can to reduce hunger. The IAEA is in the unique position of being able to make nuclear technology available to developing countries. We help them grow more food, fight animal and plant pests and diseases, and ensure the safety of food products", says IAEA Director General Yukiya Amano.

The FAO and the IAEA have been partners in promoting nuclear technologies to improve crop and livestock productivity, and the safety and quality of food since 1964. The Joint FAO/IAEA Division combines the mandates, expertise and resources of both organizations to broaden cooperation between their member countries in the peaceful application of nuclear science and technology in food and agriculture. Its experts and laboratories serve the needs of the Member States through its five subprogrammes and associated laboratory activities.

In the area of soil and water management and crop nutrition, isotope and nuclear methods are used to measure and monitor nutrients and water in the soil–crop and soil–crop–livestock systems as the basis for developing strategies and best fit soil–water–nutrient practices. This will help to minimize greenhouse gas emissions and ensure the optimum conservation of natural resources and sustainable agriculture with high resilience and adaptability to climate change and variability.

In the area of plant breeding and genetics, radiation techniques are used to create variability in the desired traits of food and industrial crops and to accelerate the breeding of varieties that have higher yields and improved resistance to disease and tolerance to environmental stresses such as drought and salinity.

In the area of animal production and health, isotopes are used to develop diets and feeding strategies that improve productivity and reproductive efficiency; to develop immunoassays and molecular techniques; and to establish pathogen inactivation techniques using irradiation to help authorities in Member States to detect animal diseases (including zoonoses) at an early stage so they can protect animals by vaccination and monitor the effectiveness of disease control and eradication programmes.

In the area of insect pest control, sterile insect techniques offer environmentally friendly means of suppressing, containing and, in some cases, even eradicating major insect pests such as different species of fruit flies and moths and disease-transmitting tsetse flies and mosquitoes.

In the area of food safety and control, irradiation provides a safe and environmentally friendly method for controlling at the post-harvest level foodborne diseases and insect pests. Analytical nuclear technologies are used to trace and authenticate food products and combat 'food fraud'. Nuclear and related technologies are also used to detect, monitor and track the fate of contaminants in foods and the environment to ensure that agrochemicals and veterinary medicines can be used efficiently to produce high quality food and maintain food safety.

The FAO/IAEA Agriculture and Biotechnology Laboratories in Seibersdorf, Vienna also conducts applied research and development, and provides technical services and laboratory training to develop, transfer and adapt technologies for local needs and specific environments (for details see page 14 on the NA Laboratories). The Joint FAO/IAEA Division's commitment to member countries is adding value through research coordination and technical support to Member States. The Joint FAO/IAEA Division has identified five avenues for adding value to its research and development: research coordination, capacity building, technology transfer, laboratory support, and information harmonization and dissemination

The Joint FAO/IAEA Division transfers the knowledge and information developed through its research and development activities to support its overall goal of mobilizing the peaceful applications of nuclear science and technology in order to improve global food security, reduce poverty and support the sustainable use of natural resources. The Joint FAO/IAEA Division's staff of scientists and technical experts help identify, develop and adapt cutting edge nuclear technology that can add value to global agricultural research, and then transfer it to the fields of the world's farmers where it can help improve yields, while ensuring food safety for consumers and protecting the environment.

COORDINATED RESEARCH ACTIVITIES

The IAEA works with its Member States and multiple partners worldwide to support the safe, secure and peaceful application of nuclear technologies, using two related mechanisms: coordinated research activities (CRAs) and TC projects. Activities under these mechanisms foster collaboration between Member States and forge human and institutional capacity in countries so that they can safely utilize nuclear technologies to address key development challenges. CRAs can lead to TC projects and, in some cases, TC projects can trigger the establishment of CRAs.

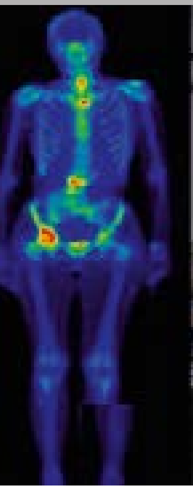
The IAEA brings together research institutions across the globe to collaborate in CRAs covering areas such as applications of isotopes and radiation in agriculture, human health, industry, hydrology and terrestrial and marine environment, nuclear energy and economic studies, and nuclear safety/security.

The CRAs encourage both the acquisition and dissemination of new knowledge and technology generated through the use of nuclear technologies and isotope techniques, as well as the adaptation of these technologies in IAEA Member States. Results of the CRAs are disseminated to Member States and the international scientific community through publications and via the IAEA TC projects, under which CRA findings are often applied practically.

The CRAs are implemented primarily via coordinated research projects (CRPs) and their related Research Coordination Meetings (RCMs). Each CRP typically brings together 10–15 research institutions from a range of countries at different stages of socio-economic development, which work together. Research is conducted in the participating institutions, with the IAEA coordinating the work and organizing periodic RCMs, with CRPs designed to contribute to building professional relationships and networks, which thrive beyond the lifetime of the CRP.

CRAs at a Glance

- 120 active CRPs
- 1600 research institutions involved through research, technical and doctoral contracts or research agreements
- 70 Research Coordination Meetings organized per year
- €7 million budget per year



Research institutes can participate by visiting the CRA website, cra.iaea.org, to search relevant CRPs that are open for submission of proposals, as well as to submit a Proposal for Research Contract or Agreement directly to the IAEA's Research Contracts Administration Section, using the forms template on the CRA website.

From Research to Action

While not all CRPs lead to TC projects, the two are complementary. CRPs offer Member States the ability to develop cutting edge technologies and to undertake research in nuclear techniques through collaboration between their respective research institutions and IAEA experts. By advancing national knowledge and expertise in a particular field, Member States are better equipped to carry out TC projects.

CRP findings, once tested and proven, can be applied practically through TC projects. This moves scientific research and development out of the laboratory and into the field, allowing the IAEA to help Member States implement new methodologies expediently, and ensuring that countries and their populations benefit promptly from the application of new scientific discoveries.

RADIOISOTOPES, RADIOPHARMACEUTICALS AND RADIATION TECHNOLOGY

Contributing to Better Health Care, a Cleaner Environment and More Efficient Industrial Processes

Radioisotopes and radiation technology are extremely useful in medicine, industry, agriculture and the environment. To take full advantage of their benefits, the necessary infrastructure as well as qualified personnel, are absolutely essential. The IAEA works to ensure that radioisotopes and radiation technology are available to developing countries; to strengthen quality assurance practices and regulatory compliance; and to facilitate human resources development.

This includes providing advice, assistance and capacity building support for:

❶ Development, production and quality assurance of reactor and accelerator based medical isotopes and radiopharmaceuticals for both the diagnosis and treatment of diseases, especially cancer.

- Diagnostic radiopharmaceuticals used in conjunction with modern medical imaging devices such as gamma camera and positron emission tomography (PET)–computed tomography (CT) scanners, which are able to diagnose specific pathological conditions such as cancer, cardiac disorders and neurological conditions much earlier. The early diagnosis and subsequent monitoring offers improved therapy and survival chances for the patient.

- Therapeutic radiopharmaceuticals are smart molecules that selectively target cancerous cells subjecting them to a lethal dose of radioactivity, thus generating a therapeutic effect that leads to the destruction of the cancerous tissue.

❷ Establishment of irradiation facilities and utilization of gamma radiation, electron beam and X-ray technology for varied applications, including tackling of pollutants, wastewater treatment, sterilization of medical products, preservation of cultural heritage objects and archives, and synthesis and characterization of advanced materials.

- Radiation processing technology, where materials are exposed to ionizing radiation, is an additive-free treatment process that can change the physical, chemical and biological properties of a material without generating radioactivity or any pollutants. The use of radiation in developing and studying polymer composites and nanostructured materials is an emerging and innovative area.

- Ionizing radiation is a powerful tool for the deactivation of microbes either to address threats to public health and safety that might be posed by deliberate or inadvertent contamination, or to treat wastewaters for reuse in industrial, agricultural and horticultural sectors. Radiation treatment of volatile organic compounds and hazardous chemical agents can also be highly effective in neutralizing harmful pollutants.

❸ Application of radiation and isotopes in industrial process management.

- Radiation techniques are uniquely effective for visualizing multiphase flow in complex industrial and environmental processes, and can assist Member States in enhancing quality assurance systems and the safety of industrial processes in strategic industries.

- Radiotracers are materials labelled with radioisotopes. They have been widely used throughout industry to optimize processes, solve problems and improve productivity in terms of yield, quality, energy utilization, and pollution control.

NUCLEAR SCIENCE — THE CORE OF IT ALL

Measurements and Data

Nuclear science investigates the realm of the atomic nucleus, its structure and reactions, through measurements, theory and simulations. Measurements typically involve a particle beam that is used to probe a target and instrumentation that detects the reaction products and the outgoing radiation. The resulting data are collected in databases and compared to theoretical calculations and simulations; they provide the basis for all nuclear technology.

The technologies developed to carry out nuclear science experiments also directly translate into technological applications. This includes accelerators for the provision of particle beams, detectors for radiation and particles, data acquisition systems, digital electronics and computer technology.

There are currently about 30 000 accelerators at work in the world today, 99% of which are used for applications in industry (about 20 000) and medicine (about 10 000). All the products that are processed, treated and inspected using beams from particle accelerators have a combined estimated value of $500 billion per year. Accelerators are important tools for economic development.

Radiation detectors have become irreplaceable tools in medical diagnostics, but are also crucial for environmental monitoring and of course for radiation safety and security. They are used to inspect cargo crossing borders and are part of the detector packages on space probes exploring the solar system.

Activities on accelerator applications especially on material testing with a view to future fission and fusion power stations are carried out by the IAEA, through CRPs, technical meetings and conferences such as the biennial Accelerator Applications Conference. The Nuclear Science and Instrumentation Laboratory (NSIL) carries out R&D projects in mobile gamma spectrometry, environmental mapping and X-ray fluorescence, provides technical support for IAEA missions and offers training in a variety of topics from digital electronics to instrumentation for cultural heritage applications. NSIL also operates beam lines at the Elettra synchrotron in Trieste, Italy, and at the Ruđer Bošković Institute in Zagreb, Croatia, which provide training and research opportunities for research groups from Member States.

Nuclear and atomic data are fundamental for nuclear science and technology. Applications such as fission, fusion, medical and analytical applications rely on these data. The importance of data activities has been recognized from the beginning of the IAEA and the Nuclear Data Section has been providing this core service, unique among all UN organizations, for 50 years. The IAEA coordinates the International Network of Nuclear Reaction Data Centres (NRDC), which links 14 national data centres, and organizes CRPs and technical meetings for the worldwide collection, evaluation, compilation and dissemination of nuclear data.

The IAEA employs cutting edge IT technology to serve Member States better in their data needs. Software tools have been developed for users to access data easily, to visualize them and to bring together experimental and evaluated data. Regularly updated data and applications such as LiveChart, plotting of Experimental Nuclear Reaction Database (EXFOR) and Evaluated Nuclear Structure Data Files (ENSDF) are available on the web (www-nds.iaea.org) and are extensively used. The data and website have been moved to 'cloud' servers for more cost-effective and reliable services. The first Android app, Isotope Browser, launched in July 2013, has been downloaded more than 3500 times at the start of 2014. This app provides summary nuclide properties for researchers worldwide, even where the Internet is not available.

DEPARTMENT OF NUCLEAR ENERGY

"Nuclear power is the best known peaceful application of nuclear energy and is an important option for many countries. Our latest projections show a steady rise in the number of nuclear power plants in the world in the next 20 years. The Fukushima Daiichi nuclear accident once more highlighted that safety must come first. We are committed to supporting Member States in expanding existing and developing new nuclear power programmes in a safe, secure, economical and sustainable manner. From energy planning to innovative nuclear technologies, from nuclear knowledge management to radioactive waste disposal, the Department of Nuclear Energy offers a wide spectrum of expertise and services."

Alexander Bychkov
Deputy Director General and Head of the Department of Nuclear Energy

FOSTERING SUSTAINABLE NUCLEAR ENERGY FOR THE FUTURE

The Department of Nuclear Energy fosters the efficient and safe use of nuclear power in the IAEA's Member States by supporting existing and new nuclear programmes and facilitating improvements in the performance of nuclear power plants, the nuclear fuel cycle, and the management of nuclear wastes, by catalysing innovation in nuclear power and fuel cycle technologies, by building indigenous capability in energy planning, analysis, and nuclear information and knowledge, and by advancing science and industry through the improved operation of research reactors.

The Department has the principal responsibility for the IAEA's Major Programme 1, "Nuclear Power, Fuel Cycle and Nuclear Science", and is also responsible for the technological aspects of radioactive waste and decommissioning as part of Major Programme 3, "Nuclear Safety and Security".

From peer reviews to databanks on nuclear power plant operating experience, from publishing standards and technical guidance to distance learning, the IAEA assists Member States on all aspects of the peaceful applications of nuclear energy.

Planning the Energy Future

Poverty eradication and sustainable development require clean affordable energy services. Expanding energy access requires planning. The IAEA helps developing countries build their energy planning capabilities by developing and transfering planning models and data, training local experts, and helping to establish local expertise to chart national paths to sustainable development, with or without nuclear energy.

Deploying New Nuclear Power Plants

Launching a nuclear power programme is a commitment of at least 100 years that requires careful planning, preparation and investment in time and resources. The IAEA's guidelines and milestones help countries work in a systematic way towards the introduction of nuclear power and increase transparency, both within a country introducing nuclear power and between it and other States.

Nuclear Power Plants

IAEA activities target improvements in quality management, maintenance, online monitoring, instrumentation and control, modernization programmes, outage management, corrosion control, structural integrity, staff training and knowledge management. The IAEA provides guidance on cost effectively scheduling replacements, improvements, upgrades, licence renewals and decommissioning.

The Fuel Cycle: Front End

The IAEA disseminates authoritative data on uranium and thorium resources, exploration, mining and production. It disseminates best practices in uranium exploration and promotes best environmental practices in uranium mining, production and mine remediation. It provides an important forum for the exchange of information, research, practical experience and best practices on all aspects of nuclear fuel.

The Fuel Cycle: Back End

The nuclear industry has half a century's successful experience with spent fuel storage. The IAEA helps Member States extend storage capacity by providing on-site evaluations, guidance and information. It builds capacity in geological disposal, conducts peer reviews and directly aids countries in disposing of used radiation sources from medical and industrial applications. It provides guidance, information, best practices and planning assistance for decommissioning nuclear facilities, site remediation, preparing radioactive waste and for final repository design, operation and closure.

Catalysing Innovation

Nuclear power requires continued innovation. The IAEA serves as a catalyst. It helps Member States resolve scientific and technological issues related to nuclear power and to non-electric nuclear reactor applications such as seawater desalination, and heat and hydrogen production. The IAEA coordinates research and promotes information exchange for current and future nuclear energy systems, including small and medium sized reactors that may be particularly suitable for developing countries and non-electric applications. The IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), with 38 members from developing and industrialized countries and the European Commission, facilitates joint international assessments of innovative nuclear energy systems.

Managing Nuclear Knowledge

The expansion of nuclear power requires continuous knowledge transfer and preservation. The IAEA assists knowledge transfer and helps link established centres of competence with centres of growth. It supports networks of educational institutions. Its International Nuclear Information System (INIS), with over three million bibliographic records, is the world's leading information system on the peaceful uses of nuclear science and technology.

Advancing Nuclear Research

As of November 2013, 67 research reactors in the world were producing radioisotopes for industrial, medical, agricultural and environmental applications. They help train new talent for the nuclear workforce, and foster development and innovation through testing new fuels and materials. The IAEA has developed norms of good practice for all aspects of the research reactor fuel cycle, thereby promoting regional and thematic cooperation. To reduce proliferation risks, the IAEA supports programmes to convert research reactors from highly enriched uranium (HEU) fuel to low enriched uranium (LEU), as well as programmes involving the return of HEU fuel to its country of origin.

ENERGY PLANNING: A STEP BY STEP APPROACH

Poverty eradication and sustainable development require clean affordable energy services. Expanding energy access requires planning. The IAEA helps build the capacities of interested Member States to analyse their national energy systems and evaluate future energy development strategies, regardless of whether or not they are interested in nuclear power. Such energy planning is also the first step in exploring the possibility of introducing nuclear power.

The IAEA also provides additional planning assistance to Member States interested in starting nuclear power programmes, expanding existing programmes, or starting uranium exploration and mining.

Capacity Building for Energy System Analysis and Planning

The IAEA helps interested Member States build their energy planning capabilities. It develops planning models and data and, largely through the IAEA's TC programme, transfers these to Member States, trains local experts, and helps establish local expertise to chart national paths to sustainable development. It is the only UN organization that does this at the national level.

At the request of Member States, the IAEA offers comprehensive training that is customized to reflect the country's current situation and development priorities, and aims to put the right tools into the hands of local experts. The IAEA has helped more than 120 Member

States acquire its energy models and trains approximately 600 local experts annually in their use.

The models and training cover energy demand, supply, environmental impacts, finance, system optimization and indicators for sustainable development. The models are technology neutral, i.e. there is no special focus on nuclear power. For many of the Member States that use the models, nuclear power is likely not to be a cost effective near-term option, and it is essential that the models help those countries, as well as others, to identify their effective energy strategies.

In addition, the IAEA generates annual projections of future nuclear power developments and contributes to international studies, negotiations and deliberations that set the global stage on which nuclear power competes. These include the studies and deliberations of, among others, the Intergovernmental Panel on Climate Change (IPCC), the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Commission on Sustainable Development (CSD). Partners include the UN and other international organizations such as the OECD's International Energy Agency (IEA) and the Nuclear Energy Agency (NEA).

HELPING STATES EXPAND THEIR OPTIONS

The need for electricity is rising at a time of heightened concerns worldwide over sufficient energy supplies, climate change, economic development and global security. A core IAEA function is to assist countries in the safe, secure, effective and sustainable use of nuclear energy. Advisory and technical services are provided for energy planning and production, infrastructure development and the nuclear fuel cycle.

As electricity demand rises, States are increasingly seeking technical advice and assistance to help them plan their energy futures. At the same time, countries that already have nuclear power plants (NPPs) are working together to share experience and improve their safe and effective operation. Collaboration is also valuable in the development of new and innovative nuclear power systems for possible introduction later in this century.

Nuclear power generation releases only small amounts of both carbon and conventional pollutants into the environment. Avoiding carbon emissions helps mitigate climate change. Since no other air pollutants are released, nuclear power generation contributes to cleaner air in urban areas. Nuclear electricity production does however generate radioactive waste, but this waste can be managed; the world has over half a century's knowledge and experience on how to safely deal with nuclear waste.

The economics of any particular project depend on the specific investment situation. Nuclear power is generally competitive and offers a low cost, reliable, long term source of electricity. As of 31 December 2013, 72 nuclear reactors were under construction around the world. Different types of reactors are in operation and are available commercially. The raw materials for nuclear power, uranium and thorium, are abundant. Identified uranium resources correspond to almost 80 years at the estimated 2012 rate of consumption. With the development of advanced reactors, much more energy could be produced from these resources.

Planning a New Nuclear Power Programme

According to the IAEA's 2013 projections, nuclear power generating capacity is expected to steadily rise until 2030. Although the Fukushima Daiichi nuclear accident slowed the growth of nuclear power, it did not reverse it. By 2030, the IAEA's projections indicate about 17% growth in

nuclear production capacity in the low projection and 94% growth in the high projection. However, the growth rate is slower than what was projected in 2011 and 2012.

More than 30 countries, mainly in the developing world, are considering, or planning to introduce, nuclear power. The IAEA has developed guidelines and milestones to help countries work in a systematic way towards the introduction of nuclear power. It also offers various services, available to interested Member States upon request, to assist countries that are considering launching a nuclear power programme, which requires careful planning, preparation and investment in time and resources.

These include advice on proper planning, building the required human resources and infrastructure, establishing legal and regulatory frameworks, and ensuring the highest standards of safety and security, without increasing proliferation risks.

The IAEA offers independent know-how on the construction, commissioning, startup and operation of nuclear reactors. Through the IAEA's TC programme, it provides targeted support to 'newcomer' countries in response to national development needs. The aim is that countries should be able to introduce nuclear power knowledgeably, profitably and safely.

ADVANCED AND INNOVATIVE DESIGNS

The 21st century promises the most competitive, globalized markets in human history. Future expansion of nuclear power will require continued design advances and technological innovation. The Agency seeks to stimulate innovation in nuclear power through activities in four areas:

- Technological progress along the main reactor lines: light water, heavy water, fast and gas cooled reactors;
- INPRO;
- Small and medium sized reactors;
- Non-electric applications such as hydrogen generation and desalination using nuclear energy.

The IAEA's work on advanced and innovative reactor designs includes publications, conferences, assessment studies and coordinated research projects.

In 2001, INPRO was launched to focus on key concepts of global nuclear energy sustainability. The INPRO methodology takes a holistic approach to assess innovative nuclear systems in seven areas: economics, infrastructure, waste management, proliferation resistance, physical protection, environment and safety. It assists its 39 members in understanding the challenges, developing options, and implementing solutions for global nuclear energy sustainability.

Most of the power reactors now operating or under construction in the world are large units, but approximately 45 innovative small and medium sized reactor (SMR) concepts have been, or are being, developed by national or international programmes. Innovative SMRs are under development for all principal reactor lines and for some non-conventional combinations.

Many Member States are also interested in the peaceful applications of nuclear reactors beyond electricity generation. Desalination of seawater using nuclear energy is a demonstrated option that could help meet growing demands for potable water.

Other interesting potential applications are district heating with heat and steam from nuclear reactors, industrial applications of nuclear heat and steam and hydrogen production from nuclear energy. Coupling nuclear reactors to industrial applications, i.e. nuclear cogeneration, has several practical advantages such as increased saving through the reuse of waste heat from the NPPs, increasing overall plant thermal efficiency, enhancing electrical grid flexibility, and reducing greenhouse gas emissions and the environmental impact.

BUILDING A COMPETENT WORKFORCE

Any nuclear power programme, whether new, expanding, stable or in a phase-out stage, requires a competent workforce. Sustainable capacity building is essential both for operating countries and newcomers to ensure adequate human resources for the lifetime of the programme, including decommissioning. Additional lessons on human performance issues are also being drawn from the March 2011 Fukushima Daiichi nuclear accident.

To assist its Member States in this area, the IAEA provides guidance and support services, including:

- A nuclear power human resources (HR) modelling tool and training programme to help newcomer Member States understand their workforce requirements;
- A capacity building concept paper and self-assessment methodology to help Member States assess their current capability and create an action plan for improvement;
- An e-learning programme, based on the 'Milestones' guidance, to help key decision makers understand their responsibilities;
- Human and organizational performance guidance services, including assistance on improving human performance and leadership in accidents;
- Guidance on the systematic approach to training (SAT), incorporating lessons learned over recent years and providing advice on the practical implementation of the SAT process.

In addition to these new services, the IAEA also:

- Develops guidelines, good practice publications, and conducts review missions, on various aspects of human resource management including the development of training facilities and training systems;
- Offers seminars, workshops and training courses for senior managers and HR professionals on topics such as workforce planning, HR development, SAT implementation and techniques for managing human performance.

Similar activities are also available in the fields of management systems, stakeholder involvement, strategic partnerships and the expansion of nuclear power programmes.

Managing Nuclear Knowledge

Succession planning and knowledge preservation are central issues to nuclear knowledge management. The IAEA assists Member States in preserving and enhancing nuclear knowledge by facilitating international and regional collaboration, promoting increased subject awareness, as well as providing guidance publications and developing methodologies.

For a continued safe, responsible and sustainable use of nuclear technology for power and non-power applications, the 'next generation' must be capable of applying, regulating and further developing nuclear technologies. Access to high quality nuclear education and practical training opportunities is crucial. There are growing concerns about an approaching shortage of next generation 'nuclear' personnel. Information exchange and experience through international coordination and collaboration can help reduce the risk of losing critical knowledge. The IAEA facilitates nuclear education and training, and provides a forum for such an exchange through regional educational networks such as the Asian Network for Education in Nuclear Technology (ANENT), Latin American Network for Education in Nuclear Technology (LANENT) and the AFRA Network for Education in Nuclear Science and Technology (AFRA-NEST), which covers the Africa region.

The IAEA also supports nuclear knowledge preservation by developing methodologies, guidelines, and publications. Upon request by Member States, the IAEA also conducts assistance missions to operating organizations, regulatory bodies, research, development and academic institutions to help Member States maintain and enhance nuclear competence and knowledge in the long term.

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

A STRONG, SUSTAINABLE, VISIBLE GLOBAL NUCLEAR SAFETY AND SECURITY FRAMEWORK

Safety and Security Coordination Section (SSCS)

The Safety and Security Coordination Section's mission is to ensure technical consistency and coordination between the IAEA's activities in the nuclear, radiation, transport and waste safety and nuclear security programmes.

Division of Nuclear Installation Safety (NSNI)

The Division of Nuclear Installation Safety works to achieve and maintain a high level of safety of nuclear installations worldwide under design, construction or operation by: establishing standards of safety for the protection of health, including standards for NPPs and other nuclear installations and facilities; and, providing for the application of these standards through, inter alia, support for the IAEA's TC programme, rendering services, providing education and training, promoting information exchange and assisting Member States embarking on a nuclear power programme to develop appropriate safety infrastructures.

Division of Radiation, Transport and Waste Safety (NSRW)

The Division of Radiation, Transport and Waste Safety develops and maintains standards for radiation protection, radioactive waste safety and safety in the transport of radioactive material that enable the beneficial uses of radiation to be exploited while ensuring appropriate protection of workers, the public and patients. It also assists Member States in the implementation of these standards and provides related services.

Incident and Emergency Centre (IEC)

The Incident and Emergency Centre (IEC) is the global focal point for preparedness and response to nuclear and radiological incidents and emergencies. The IEC develops the IAEA's emergency preparedness and response (EPR) related safety standards, guides and tools, assisting Member States in establishing or enhancing their EPR systems, providing appraisal services, and maintaining and strengthening the Secretariat's and inter-agency response preparedness. The IEC's role also includes notifying and sharing information about an emergency, assessing potential emergency consequences and

"I believe that nuclear power plants have already become safer as a result of the measures taken at local, national and international levels. Safety and security will continue to improve, but we must avoid complacency at all costs. Our job is to develop and make available standards, recommendations and guidance whose implementation will reduce the possibility of accidents and malicious acts taking place."

Denis Flory Deputy Director General and Head of the Department of Nuclear Safety and Security

forecasting possible emergency progression, providing advice and assistance on request, informing the media and the public and coordinating inter-agency response.

Division of Nuclear Security (NSNS)

The Division of Nuclear Security is responsible for planning, coordinating and implementing the IAEA's Nuclear Security Plan to assist upon request national efforts to prevent, detect and respond to acts of nuclear terrorism and threats thereof. It does so by offering training, providing technical advice, peer reviews and advisory services, delivering equipment and issuing nuclear security guidance, coordinated research and development on improving nuclear security.

IAEA ACTION PLAN ON NUCLEAR SAFETY

The purpose of the IAEA's Action Plan on Nuclear Safety is to define a programme of work to strengthen the global nuclear safety framework[1]. The success of this Action Plan in strengthening nuclear safety is dependent on its implementation through the full cooperation and participation of Member States and will require also the involvement of many other stakeholders[2].

Member States are therefore encouraged to work cooperatively to implement the Action Plan to maximize the benefit of the lessons learned from the Fukushima Daiichi nuclear accident and to produce concrete results as soon as possible.

Progress on the implementation of the Action Plan is regularly reported to the IAEA Board of Governors and also to the IAEA General Conference. Since the adoption of the Action Plan, significant progress has been made in several key areas. Strengthening nuclear safety in light of the Fukushima Daiichi nuclear accident is addressed through a number of measures in this Action Plan focusing on:

- Undertaking an assessment of the safety vulnerabilities of nuclear power plants in the light of lessons learned to date from the accident;
- Strengthening IAEA peer reviews in order to maximize the benefits to Member States;
- Strengthening emergency preparedness and response;
- Strengthening the effectiveness of national regulatory bodies;

[1]The Action Plan was unanimously endorsed by the IAEA's 55th General Conference held in September 2011.

[2]Stakeholders include, amongst others, governments, relevant international organizations and associations, regulatory bodies, operating organizations, nuclear industry, radioactive waste management organizations, technical support and safety organizations, research organizations, education and training institutions and other relevant bodies.

- Strengthening the effectiveness of operating organizations with respect to nuclear safety;
- Reviewing and strengthening IAEA safety standards and improving their implementation;
- Improving the effectiveness of the international legal framework;
- Facilitating the development of the infrastructure necessary for Member States embarking on a nuclear power programme;
- Strengthening and maintaining capacity building;
- Ensuring the ongoing protection of people and the environment from ionizing radiation following a nuclear emergency;
- Enhancing transparency and the effectiveness of communication and improving the dissemination of information; and
- Effectively utilizing research and development.

EMERGENCY PREPAREDNESS AND RESPONSE

Being well prepared is the basis for effective and efficient responses to incidents and emergencies. The IEC is the global focal point for preparedness and response to nuclear and radiological incidents and emergencies independent of whether they arise from an accident, natural disaster, negligence or a criminal act.

Member States' Preparedness

One of the main functions of the IEC is helping Member States to enhance their own level of preparedness, primarily through the implementation of a capacity building programme, which contributes to sustainable national capacities in emergency preparedness and response. The IEC continuously works to develop and refine standards, guidance, training programs and practical tools to assist Member States in applying those standards and guides and strengthen their preparedness. In addition, the IEC also conducts appraisal missions (Emergency Preparedness Review missions) to help Member States strengthen their national arrangements and capabilities for emergency response.

International Preparedness

The IEC coordinates and maintains the Joint Radiation Emergency Management Plan of the International Organizations (JPLAN), which describes the inter-agency framework for preparedness for and response to a nuclear or radiological emergency. The IEC is the main coordinating body for implementation of the JPLAN.

Event Reporting and Information Exchange

An important element of the IEC's activities involves event reporting and information sharing. For this purpose, the

IEC developed and maintains the Unified System for Information Exchange in Incidents and Emergencies (USIE) as a single unified website for national contact points under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (Assistance Convention) and for national officers under the International Nuclear and Radiological Event Scale (INES) whereby information on nuclear and radiological events is reliably and securely communicated.

Emergency Response

The immediate assessment of reported information and the prompt activation to respond, if required, are ensured by the IAEA's Incident and Emergency System. Its warning point serves as a 24/7 contact point for notification and requests for assistance and its on-call system ensures that the IEC's initial response to received messages concerning an actual or potential nuclear or radiological incident, or emergency, requests for assistance, or media reports is timely and efficient.

International Assistance

As part of the IAEA's strategy for supporting the practical implementation of the Assistance Convention and in order to coordinate international assistance, the IEC manages the Response and Assistance Network (RANET). This is a network of States capable and willing to provide, upon request, specialized assistance in case of a nuclear or radiological incident or emergency in a timely and effective manner and, when possible, on a regional basis.

NUCLEAR SAFETY PEER REVIEWS: COOPERATION AND COLLABORATION

Peer Review

Appraisals by teams of experts' help Member States share knowledge, experience and lessons learned. The IAEA organizes peer review teams of experts and observers — notably in radiation and nuclear safety through the Integrated Regulatory Review Service (IRRS), Design and Safety Assessment Review Service (DSARS), and the Operational Safety Review Teams (OSART)— to assess the application of safety standards covering areas such as:

- Governmental and regulatory infrastructures;
- Safety of research reactors;
- Operation, design and siting of nuclear power plants; and
- The safety of radiation technologies, radioactive waste management and the transport of radioactive materials.

Another key peer review service is the Emergency Preparedness Review (EPREV), which independently appraises preparedness for a radiation incident or emergency in Member States.

Peer reviews are also organized to assess against best practices and propose improvements in implementation of nuclear energy systems and waste management. The peer review process is also built into some international instruments including safety conventions and codes of conduct under IAEA auspices.

Cooperation and Collaboration

Collaborative efforts towards transparent, independent, technically competent and effective nuclear regulatory bodies are of worldwide benefit. International peer reviews of regulatory systems have proven highly valuable for collaboration, opening opportunities to share information on best practices and lessons learned.

The IAEA regularly collaborates in this area with various groups of nuclear safety regulators. They include the International Nuclear Regulators Association (INRA), the Western European Nuclear Regulators Association (WENRA), the Ibero American Forum of Radiation and Nuclear Safety Regulatory Agencies, the Forum of Nuclear Regulatory Bodies in Africa (FNRBA), Arab Network of

Nuclear Regulators (ANNuR) and the Asian Nuclear Safety Network (ANSN).

IAEA services take the form of technical and policy dialogue, legislative and regulatory assistance, training, networking and peer reviews. Areas they address include:

- **National Assessments**
  Improving national capabilities for self-assessment of the regulatory infrastructure is key. One interactive platform, the Radiation Safety Information Management System, enables online collaboration between the IAEA and States on topical work and planning. The Systematic Assessment of Regulatory Competence Needs (SARCoN) services help States to upgrade their training programmes for regulators.

- **Peer Reviews and Advisory Services**
  A central feature is the Integrated Regulatory Review Service (IRRS). The IRRS promotes the integration of regulatory requirements into national infrastructure and advances the effective independence of regulatory authorities.

- **Collaborative Reporting and Feedback**
  Technical and policy oriented meetings enable regulators to compare experiences, assess the overall status of nuclear safety and security worldwide, and identify challenges that require cooperative action. A web-based service permits worldwide collaboration.

- **Serving the Safety Convention**
  The IAEA serves as Secretariat to the Convention on Nuclear Safety and to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

INTERNATIONAL SEISMIC SAFETY CENTRE MAKES NUCLEAR POWER SAFER

The International Seismic Safety Centre (ISSC) is an extrabudgetary programme, supported by Member State institutions that collaborate on research projects to help enhance safety against external hazards at nuclear installations, including earthquakes and flooding.

The ISSC's work provides technical input for current and future IAEA safety standards, including site evaluation of nuclear installations, site surveys, external and internal hazards, (both natural hazards and those caused by humans). Within the ISSC's working groups, experts share and implement best practices at the national level.

One of the tools developed by the ISSC, the Nuclear ShakeCast System, provides users worldwide with real time alerts of seismic events near NPP sites. Nuclear ShakeCast compares the event's intensity against the NPP site's design basis, or capacity to withstand a given intensity of ground motion, and notifies the responsible parties at the IAEA of any potential damage. It also generates NPP damage assessment maps and other web-based products for IAEA communication purposes.

Another tool, TsunamiCast, combines state-of-the-art modelling and measuring technology to provide real time tsunami forecasts. It combines real time seismic and sea level data with numerical models to produce efficient tsunami forecasts of wave arrival times, heights and inundation.

The accuracy rate of the IAEA Tsunami Forecasting System is planned to be close to 80%. Prediction accuracy will depend on the availability of high resolution bathymetric data at NPP sites. The IAEA is working in cooperation with the United States National Oceanic and Atmospheric Administration to design and put TsunamiCast into operation.

The ISSC offers a set of workshops and training packages covering all aspects of site safety as reflected in the applicable IAEA Safety Requirements and Safety Guides.

Regional workshops, as well as specialized training or workshops are available for each type of hazard (e.g. seismic, tsunami, volcanic, meteorologic, hydrologic, human-induced and geotechnical hazards, as well as radiological dispersion and environmental impact assessment).

The selection and the evaluation of a site for an NPP are crucial parts of establishing a first NPP programme in a country and it can significantly affect the costs, public acceptance and safety of the installation during its complete life cycle.

Upon request from a Member State, the independent Site and External Events Design (SEED) review service, is designed to assist Member States with site selection, site assessment, and the design of structures, systems and components to withstand the site specific external and internal hazards.

PROTECTION OF PATIENTS: HELPING STATES PROTECT PEOPLE

Medicine

The extent of medical radiation exposure has considerably increased in recent times and the doses involved are equivalent to occupational exposures. In some countries, the population dose from medical exposures rivalled that from natural background radiation, and globally accounted for more than 98% of the contribution from all artificial sources. It has been estimated that the number of medical procedures using ionizing radiation grew from about

1.7 billion in 1980 to almost four billion in 2007. The global figure for the effective dose per capita from medical exposures was estimated by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to have increased from 0.3 mSv in 1993 to 0.4 mSv in 2000, to reach the current value of more than 0.6 mSv (2008).

Nuclear medicine is the medical specialty that uses unsealed sources of radiation (liquids and gases) for diagnosis and therapy. These unsealed sources are known as radiopharmaceuticals, drugs that emit radiation. On any given day, approximately 100 000 of these procedures are performed worldwide.

In addition, more than five million complete radiotherapy courses are given annually; these courses involve the use of either external radiation equipment or the internal placement of sealed radioactive sources.

Radiotherapy must be administered given at very high dose levels so that it can achieve its treatment objectives. Although this complex treatment modality has a low associated risk of injury or death from adverse effects ensuring safety in radiotherapy will continue to be of key concern.

Irradiation

Exposure to natural radiation sources and the exposure of patients in medical diagnosis and treatment represented over 95% of the worldwide collective dose from all sources of radiation. The remaining contribution came from artificial sources of radiation and occupational exposure that can arise from the use of radiation and radioactive sources in medicine, industry and research.

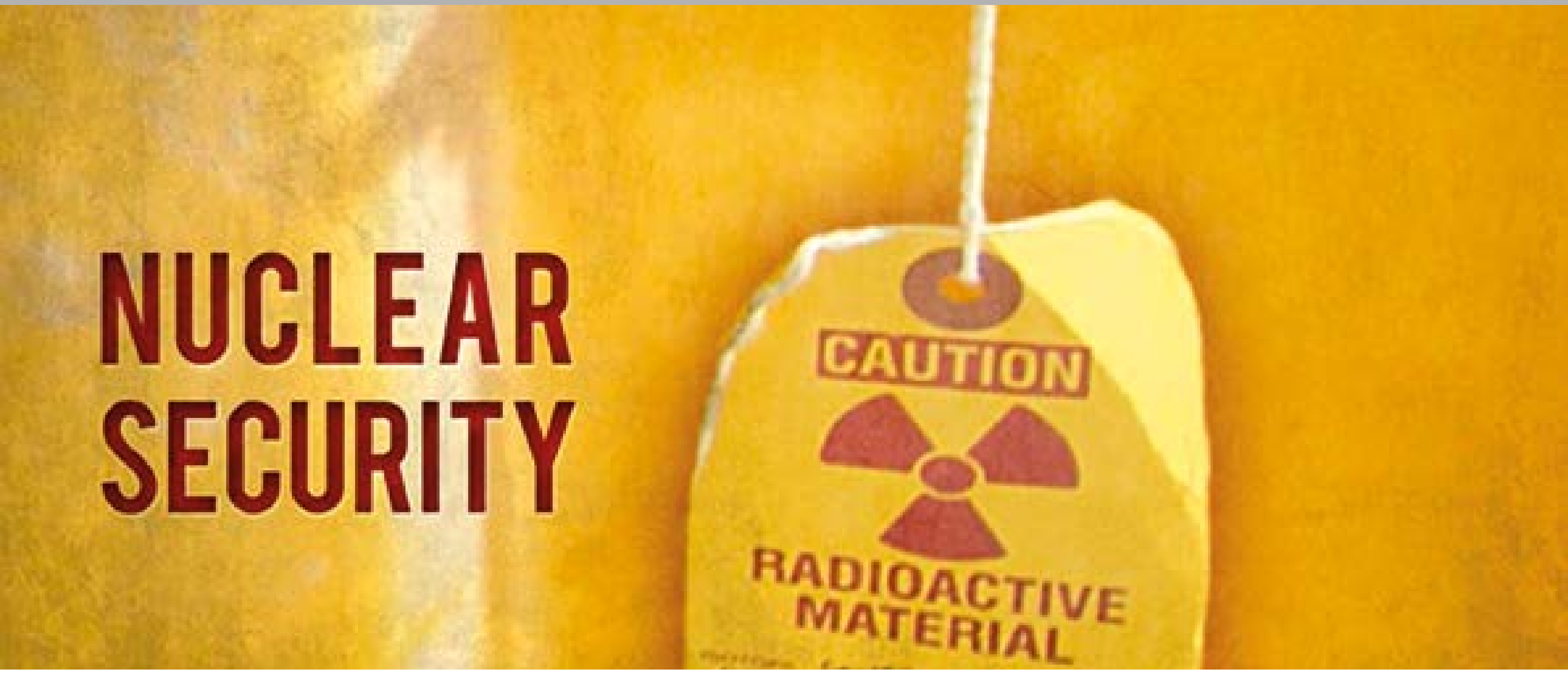
While the collective dose from these exposure pathways was not large compared to other contributions, the total number of individuals exposed was a small percentage of the population and these workers may have received higher radiation doses as part of their work than from other sources. This will continue to require constant vigilance through ongoing assessment and monitoring of doses received.

Medical workers comprised the largest proportion of workers exposed to artificial sources of radiation. New and emerging medical procedures tended to deliver higher radiation doses to patients than conventional technologies, and there was thus a corresponding potential for increased exposure of medical professionals. The worldwide expansion in the use of radiation in medical diagnosis and treatment has the potential to significantly increase the collective dose to workers from such applications.

IAEA NUCLEAR SECURITY PLAN 2014–2017

The risk that nuclear or other radioactive material could be used in criminal or intentional unauthorized acts remains a matter of concern internationally and continues to be regarded as a threat to international security. It is well recognized that the responsibility for nuclear security rests entirely with each State and that appropriate and effective national systems for nuclear security are vital in facilitating the peaceful use of nuclear energy and enhancing global efforts to combat malicious acts. The IAEA has provided, upon request, assistance to States and supported their national efforts to establish and improve nuclear security regimes since the early 1970s, when it began providing ad hoc training in physical protection.

The IAEA’s first comprehensive plan of action to protect against nuclear terrorism was approved in March 2002 by the Board of Governors. The fourth such Plan was approved in September 2013 to cover the years 2014–2017.



The Plan for 2014–2017 includes seven Programme Elements, including:

- **Needs Assessment, Information and Cybersecurity**
  Providing information to States to support the development of national nuclear security regimes and to identify potential problems through information exchange mechanisms.

- **External Coordination**
  Playing a central role in the coordination of international activities in nuclear security, while avoiding duplication and overlap.

- **Supporting the Nuclear Security Framework Globally**
  Supporting the international legal framework for nuclear security through the promotion of the relevant binding and non-binding instruments and the development of comprehensive nuclear security guidance for States.

- **Coordinated Research Projects**
  Promoting research and development to support effective nuclear security.

- **Assessment through Self-assessment and/or through Peer Review Missions**
  Providing of peer review and advisory services and developing self-assessment methodologies to assist States to sustain and improve their national nuclear security regime.

- **Human Resources Development**
  Developing, strengthening and maintaining skills through education and training to ensure sustainable and robust national nuclear security regimes.

- **Risk Reduction and Security Improvement**
  Assisting States to improve the security of nuclear material and capacities to respond effectively when material is detected out of control and reducing the risk that material could be used in criminal or other intentional unauthorized acts.

The objective of the Nuclear Security Plan is to contribute to global efforts to achieve worldwide, effective security wherever nuclear or other radioactive material is in use, storage and/or transport, and effective security of the associated facilities. This work is carried out across different programme areas including:

- **The IAEA Incident and Trafficking Database (ITDB)** system is a unique asset that assists the IAEA, participating States and selected international organizations in improving nuclear security. It is an essential component of the information platform that supports the implementation of the IAEA Nuclear Security Plan.

- **The Division of Nuclear Security** maintains and analyses a growing collection of authoritative information on the subject. This information is disseminated through the IAEA to Member States.

- **Reporting to ITDB is voluntary.** As of 31 December 2013, 125 States were participating in the ITDB programme. At the end of 2013, States had reported — or otherwise confirmed via the ITDB — 2477 incidents since the database was established in 1995. These have included incidents involving criminal activities and numerous incidents of sensitive nuclear material out of regulatory control.

- **The ITDB system** was established in 1995 to record and analyse incidents or trafficking involving nuclear and other radioactive material. It incorporates all incidents in which nuclear and other radioactive material is out of regulatory control. Communication with participating States is maintained through the network of national points of contact (POCs). The ITDB system receives information from POCs on incidents ranging from illegal possession, attempted sale and smuggling to unauthorized disposal of material and discovery of lost radioactive sources. The ITDB scope covers all types of nuclear material as defined by the IAEA's Statute (i.e. uranium, plutonium and thorium), naturally occurring and artificially produced radioisotopes and radioactively contaminated material, such as scrap metal. States are also encouraged to report incidents involving scams or hoaxes where material is purported to be nuclear or otherwise radioactive. The Secretariat carries out analyses of all incidents in an attempt to identify trends and/or characteristics to assist in the prevention of misuse of nuclear or radioactive material.

- **Needs Assessment: Review & Advisory Services**
  States need information to understand the nature of the threat and any improvements in their own national nuclear security regimes. Tools to assist, upon request, and support States in the area of nuclear security include: the Integrated Nuclear Security Support Plan, which determine the major nuclear security actions to be implemented and serves as the basis for subsequent interaction with a State; peer reviews and advisory services such as the International Physical Protection Advisory Service which evaluates the effectiveness of existing physical protection arrangements at facilities and related locations; and International Nuclear Security Advisory Service, which can be tailored to a specific area of interest in a State's detection and response systems, major public events or nuclear forensics.

- **Capacity Building**
  Education and training play an essential role in nuclear security capacity building. A well trained cadre of staff, competent in all aspects of nuclear security and its complexities, helps to establish and maintain a national nuclear security regime that is sustainable over time. The IAEA runs over 80 courses per year worldwide, training over 2000 people annually. To address the needs of senior managers, the IAEA developed the first ever Master's Programme in Nuclear Security.

- **Contributing to the Nuclear Security Framework**
  The international legal framework for nuclear security takes into account both binding and non-binding instruments. Among its nuclear security activities, the IAEA facilitates adherence to and implementation of the legal framework by assisting States, upon request, in effectively implementing their obligations under the relevant international instruments, such as the Convention on the Physical Protection of Nuclear Material and its 2005 amendment. Nuclear security guidance produced by the IAEA in the Nuclear Security Series (NSS) of publications helps States to meet the requirements set out in the legal instruments, bringing together best practices for broad implementation. NSS publications cover a range of issues such as security culture, design basis threat methodology, and nuclear forensics and are issued in four categories: Nuclear Security Fundamentals, Recommendations, Implementing Guides, and Technical Guidance.

- **Risk Reduction**
  In recent years, the international community has recognized that there is a broader threat whereby radioactive materials may be used in malicious acts such as the construction of an improvised nuclear explosive device or a radiological dispersal device. The IAEA assists States to improve the security of facilities and locations where such materials are used or stored through the provision of physical protection upgrades; to assist them in their national efforts to minimize the use of HEU and to develop detection and response capabilities for effective border control; and to provide support to ensure the security of major public events.

DEPARTMENT OF SAFEGUARDS

DELIVERING EFFECTIVE NUCLEAR VERIFICATION FOR WORLD PEACE

The IAEA works to enhance the contribution of nuclear energy to peace and prosperity throughout the world by helping to ensure that nuclear material is not diverted to nuclear weapons or other nuclear explosive devices. For more than 40 years, the IAEA has been verifying States' compliance with their commitment to the peaceful use of nuclear material pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

The NPT makes it mandatory for all non-nuclear-weapon States to conclude comprehensive safeguards agreements with the IAEA and thus allow for verification through the implementation of IAEA safeguards. In 1997 as part of the IAEA's efforts to strengthen its safeguards system, the Model Additional Protocol was developed to equip the system with better tools to provide assurance about both declared and undeclared nuclear activities.

The IAEA also implements safeguards with regard to declared nuclear material in selected facilities in the five nuclear-weapon States that are party to the NPT under their respective voluntary offer agreements. For non-NPT States, the IAEA applies safeguards pursuant to item-specific safeguards agreements.

The IAEA's safeguards system serves to deter the proliferation of nuclear weapons by detecting, as early as possible, the misuse of nuclear material or technology, and by providing credible assurances that States are honouring their safeguards obligations.

The IAEA's safeguards system functions as a confidence-building measure and, if countries are found to be violating their agreements, as an early warning mechanism for the international community.

SAFEGUARDS BASICS

At the end of 2013, safeguards were being applied in 181 States with safeguards agreements in force with the IAEA, of which 122 also had additional protocols in force. Approximately 800 staff contribute to fulfilling the organization's verification mission. Verification activities include inspections in the field as well as ongoing monitoring and evaluation at the IAEA's Headquarters in Vienna.

"The nuclear world continues to change. Projections show a clear increase in the use of nuclear energy in the years to come. At the same time, financial difficulties are expected to continue in most parts of the world. Taken together, these developments pose a challenge to IAEA safeguards: we will have more nuclear material and activities to safeguard — with fewer resources. I believe that all our stakeholders want the quality of our safeguards work and conclusions to remain high. The credibility of our work is in everyone's interest. It is important, therefore, that our Member States know about and understand what we are doing at Headquarters and in the field. We'll continue to do things better and smarter, and to find ways to improve our productivity."

Tero Varjoranta
Deputy Director General and Head of the Department of Safeguards

In addition to its main base in Vienna, the Department of Safeguards has analytical laboratories in Seibersdorf, Austria, and regional offices in Tokyo and Toronto.

In the field, some 250 inspectors conduct approximately 2000 inspection missions each year to verify over 1200 nuclear power plants, research reactors, conversion plants, fuel fabrication plants, reprocessing and enrichment facilities, as well as storage facilities.

Under a comprehensive safeguards agreement, the inspector has a variety of verification activities to perform at a facility. They encompass the verification of nuclear material accountancy and the verification of facility design. In those States with an additional protocol in force, additional access is provided for (complementary access). The IAEA also increasingly deploys remote monitoring systems to help check that States are not diverting nuclear material from declared facilities.

At Headquarters, all available safeguards-relevant information, including that obtained from State declarations and open sources as well as from inspections, is carefully analysed, assessed and evaluated.

Elements of this work may be conducted at the IAEA's analytical laboratories (see page 14 for more detail) and within a wider network of associated laboratories located in numerous Member States.

On the basis of the IAEA's overall analysis an annual safeguards implementation plan is drawn up for, and then applied in, each State. Each year the Secretariat produces a Safeguards Implementation Report containing the safeguards conclusions drawn for each State based on the result of activities carried out by the IAEA according to the particular safeguards agreement in force.

The effectiveness and efficiency of IAEA safeguards depend, to a large extent, on the effectiveness of State and regional systems of accounting for and control of nuclear material and on the level of cooperation of State and regional safeguards authorities with the IAEA.

To help States build their capacity to comply with their safeguards obligations, the IAEA holds regular training courses for relevant personnel from its Member States, and provides support for the development of national infrastructures.

Ensuring that the global non-proliferation regime is credible and effective should be in everybody's interest.

It is the joint responsibility of all stakeholders in the safeguards and non-proliferation community to make it so. In this regard, it is essential that everyone works together in helping the IAEA execute its mandate.

In that spirit, the IAEA needs to forge strengthened partnerships with States and State authorities.

The IAEA needs to build upon what is already working well and spread best practices more widely.

SCIENCE ESSENTIAL IN VERIFYING PEACEFUL USE OF NUCLEAR MATERIAL

The IAEA is now in the final 12–16 months of a multiphase project to modernize its safeguards analytical capabilities that will help it meet the verification challenges of the next 30 years and beyond.

This capital project, the largest ever undertaken by the IAEA, involves forecasting and defining analytical

requirements; designing the laboratories, site infrastructure and security improvements; and completing their construction on time and within budget without interrupting ongoing operations. Known as the Enhancing Capabilities of the Safeguards Analytical Services project or ECAS, the project has a multi-year budget of just over €80 million; at the start of 2014, extrabudgetary funding of over €8 million was still required to meet the full funding of the project.

A major part of the project is the establishment of a new Nuclear Material Laboratory (NML) in Seibersdorf, Austria. The new NML building, recently constructed on the IAEA's premises, will replace the existing Safeguards Analytical Laboratory building that has been in operation since 1976. The transfer of analytical functions to the new NML is progressing in a phased process expected to run throughout 2014.

The core mission of the NML is the analysis and reporting of results from nuclear material accountancy verification samples, which may include uranium, plutonium, spent fuel, and high activity liquid waste materials. The IAEA's Director General, Yukiya Amano, has said that the new NML will provide the IAEA with a modern and expandable capability for nuclear sample analyses, collected from all points along the nuclear fuel cycle.

Adding to the Laboratory's workload in the modern era are nuclear material samples collected from outside the declared areas of safeguarded facilities. Such samples may have different forms and compositions compared with normal verification inspection samples, and may require special handling and analytical processing in the NML.

The successful completion of the extension of clean laboratory space for the Environmental Sample Laboratory (ESL), on time and within budget, represented another significant project milestone. State-of-the-art mass spectrometry equipment of unparalleled precision is now operating in the Clean Laboratory Extension, constructed 2010–2011. The ESL enables IAEA scientists to detect and measure minute particles of uranium found in swipe samples collected by IAEA inspectors and to identify the isotopic composition of particles weighing as little as the DNA in one human cell. This capability, which IAEA scientists may extend in the future to the analysis of plutonium, constitutes a powerful tool for confirming the absence of undeclared materials and activities in States under safeguards.

Together, the NML, including its On-Site Laboratory at the Rokkasho Reprocessing Plant in Japan, and the ESL comprise the IAEA Safeguards Analytical Laboratories. According to the IAEA's Director General, Yukiya Amano, "The role played by the IAEA's Analytical Laboratories in safeguarding nuclear material around the world is vital in upholding the integrity of the Nuclear Non-Proliferation Treaty".

DEPARTMENT OF MANAGEMENT

"The Department of Management (MT) is a partner and a business enabler that champions change and efficiency, leveraging a common purpose. We support a scientific manager in recruiting the right expert, help a technical officer coordinate the purchase of radiation equipment, work with the other Departments to increase efficiency on a continuous basis (MT launched the Partnership for Continuous Improvement in 2013), ensure that all Board documents are translated and distributed on a timely basis to our Member States, make payments to participants at meetings, and so on."

Janice Dunn Lee
Deputy Director General and Head of the Department of Management

PROVIDING SERVICES TO SUPPORT THE IAEA'S PROGRAMMES

The **Division of Budget and Finance** provides financial services in support of all IAEA programmes and manages the IAEA's financial information systems. These services include: programme budgeting, payments and accounting, and reporting on the use of financial resources to senior management, the Board of Governors and Member States.

The **Division of Conference and Document Services** organizes meetings and conferences, and provides translation services in the IAEA's six official languages for documents of the policy making organs. In addition, it manages the IAEA's publishing programme, through which a range of scientific and technical publications are issued, by providing editorial, layout, printing and distribution services.

Administrative support is the responsibility of the **Division of General Services**, which provides a range of general administrative and infrastructure support services covering: operational maintenance; facilities management; archiving and records management; travel; transportation; housing and insurance; and property management. The Division also manages the Commissary at the Vienna International Centre.

The **Division of Human Resources** provides a range of services for the IAEA's staff, covering human resources planning, recruitment, staff development, career management, and compensation and benefits, as well as medical and health related services.

The **Division of Information Technology** provides a range of information and communication technology services to the IAEA. These services cover the: IT Service Desk; IT business solutions; network and telecommunication, IT infrastructure and information management.

The **Office of Procurement Services** procures all external goods and services for the IAEA, issuing purchase orders and contracts for the supply of goods and services for delivery to IAEA counterparts in Member States and for delivery to IAEA Headquarters and the laboratories in Vienna, Seibersdorf and Monaco.

The **Agency-wide Information System for Programme Support** introduces new processes and IT applications that will enhance the IAEA's ability to plan, manage and report on its activities, streamline its business processes and strengthen financial transparency. Two plateaus of this project have already been implemented covering finance, procurement, and programme and project budgeting and assessment. Plateau 3, scheduled for implementation in 2014, covers human resources and payroll management, while Plateau 4, scheduled for 2015, deals with travel and meetings management.

OFFICES REPORTING TO THE DIRECTOR GENERAL

Director General's Office for Coordination

The Director General's Office for Coordination (DGOC) is responsible for a number of functions that are essential to support the Director General in performing his responsibilities. These include providing overall policy coordination, external relations with Member States and stakeholders, policy planning and strategy, as well as coordinating the activities of the New York and Geneva offices, which liaise with the United Nations and its agencies.

Office of Internal Oversight Services

The Office of Internal Oversight Services (OIOS) was established to strengthen the IAEA's internal oversight services and its ability to ensure management efficiency and programme effectiveness and to enhance accountability. The Office assists the IAEA in accomplishing its objectives by providing independent internal oversight services through four of its functional areas: internal audit, programme evaluation, management services and investigations.

Office of Legal Affairs

The mission of the Office of Legal Affairs (OLA) is to provide the highest standard of legal services to the IAEA Secretariat, Policy-Making Organs and to Member States in the implementation of the IAEA's activities. The Office provides advice on matters related to the IAEA's Statute and on the conduct of the meetings of the Board of Governors and the General Conference. Furthermore, it provides legal advice and support to all Departments of the IAEA to ensure that the IAEA's activities are conducted in accordance with applicable agreements, rules, governing policies and relevant jurisprudence. It also coordinates the IAEA's legislative assistance programme, which assists IAEA Member States in the development of their national nuclear legislation, and performs the depositary functions for the multilateral treaties that have been adopted under the auspices of the IAEA and/or in respect of which the Director General serves as depositary.

Office of Public Information and Communication

The Office of Public Information and Communication (OPIC) has the corporate responsibility to manage and develop digital and print communication products, manage relations with the media and the public, and produce audio and video materials to promote support for the IAEA's mission and activities.

Secretariat of Policy-Making Organs

The objectives of the Secretariat of the Policy-Making Organs (SEC PMO) are to enable the Policy-Making Organs (the General Conference and Board of Governors) to effectively perform their statutory responsibilities and their other functions and to ensure that all meetings of the Policy-Making Organs are conducted efficiently.

OVERVIEW OF THE IAEA DIRECTOR GENERAL'S ADVISORY GROUPS

SUPPORTING DEPARTMENTS IN PROGRAMME IMPLEMENTATION

Several advisory groups report directly to the IAEA's Director General, providing expert advice in programme implementation.

The **Advisory Group on Nuclear Security (AdSec)** is a standing group of experts with high professional competence to advise the Director General in the field of nuclear security. AdSec's functions are to review the IAEA's current and proposed activities in the area of nuclear security, to make recommendations on measures to strengthen the IAEA's role and activities in the area and provide guidance on priorities, and to advise on current and emerging nuclear security issues.

The **Emergency Preparedness and Response Expert Group (EPREG)** is a standing group of senior experts with high professional competence and demonstrated leadership in the field of preparedness for and response to nuclear and radiological emergencies appointed by the Deputy Director General, Head of the Department of Nuclear Safety and Security. EPREG's objective is to advise the IAEA on strengthening and sustaining effective international emergency preparedness and response.

The **International Expert Group on Nuclear Liability (INLEX)** is a standing group of senior experts which provides advice on issues related to nuclear liability as requested by the Director General or the Director of the Office of Legal Affairs. It serves three major functions, namely: (a) to create a forum of expertise to explore and advise on issues related to nuclear liability; (b) to enhance global adherence to an effective nuclear liability regime; and (c) to assist in the development and strengthening of the national nuclear liability legal framework in IAEA Member States.

The **International Nuclear Safety Group (INSAG)** is a group of experts with high professional competence in the field of safety working in regulatory organizations, research and academic institutions and the nuclear industry. INSAG is convened under the auspices of the IAEA with the objective to provide authoritative advice and guidance on nuclear safety approaches, policies and principles. In particular, INSAG provides recommendations and opinions on current and emerging nuclear safety issues to the IAEA, the nuclear community and the public.

The **Standing Advisory Group on Nuclear Applications (SAGNA)** is a group appointed by the IAEA's Director General to provide programmatic and policy advice on the use of nuclear applications and sciences.

The **Standing Advisory Group on Nuclear Energy (SAGNE),** established in 2000, provides programmatic and policy advice on the IAEA's activities in the area of nuclear power, nuclear fuel cycle and waste technology, nuclear science, capacity building and nuclear knowledge management for sustainable energy development. Appointed by the Director General, its members are senior experts drawn from governments, research and technological centres, academic institutions and the nuclear industry.

The **Standing Advisory Group on Safeguards Implementation (SAGSI)** was founded in the mid-1970s and comprises a group of up to 20 safeguards experts appointed by the Director General to advise him on safeguards implementation issues.

The **Standing Advisory Group on Technical Assistance and Cooperation (SAGTAC)** was established in 1996 to advise the Director General on the IAEA's technical cooperation strategy and policies. It provides advice for enhancing scientific, technological and security benefits for Member States.

Members of these groups come from various backgrounds and are appointed by the Director General. They are drawn from national authorities, nuclear research and technological centres, academic institutions, international organizations and multilateral agencies. The members serve on the group in a personal capacity and not as representatives of government or organization.

CROSS-DEPARTMENTAL ACTIVITIES

Much of the IAEA's programmatic work requires collaboration and cooperation among several disciplines, such as health, food and water security, nuclear safety, and nuclear energy, including fusion.

HUMAN HEALTH: A DEVELOPMENTAL PRIORITY

Poor health limits the potential of people everywhere, especially in developing countries. In areas where food and clean water are hard to come by, disease prevention and cure may seem far out of reach. The IAEA's TC programme works to improve the health of people in developing countries around the world.

Cancer, malaria, tuberculosis, HIV/AIDS and malnutrition are major health concerns for developing countries. People affected by these illnesses often cannot continue to work or even to care for their families. Poor health exacerbates the poverty cycle. Low income families have a higher rate of illness. Illness leads to medical costs and often the loss of employment, which in turn thrusts families deeper into poverty.

The IAEA's human health activities carried out through the IAEA's TC programme aim to provide developing countries with specialized skills and infrastructure to prevent, detect and cure major illnesses. The IAEA helps Member States to plan and evaluates programmes to improve nutritional status of populations It also helps to establish quality assurance programmes for radiation dosimetry and cancer treatment.

Fighting Cancer

Funding for cancer control measures is a problem for many underdeveloped countries whose health systems are geared towards addressing communicable diseases but not chronic ones. Radiation therapy is a major part of cancer treatment, but requires trained specialists, high-tech equipment and an established infrastructure. The IAEA promotes the safe and effective use of radiation therapy by providing assistance in the form of hospital radiotherapy machines, training for cancer control specialists, radiotherapy professionals and expert guidance for regulatory control over radioactive materials.

The IAEA's TC programme has addressed cancer care for over fifty years. As cancer has emerged as a major global health problem, the Programme of Action for Cancer Therapy (PACT) and TC undertake complementary projects to enable developing countries to introduce, expand and improve comprehensive strategic national plans for cancer control using PACT core competencies, international partners and the Department of Technical Cooperation's technical assistance expertise.

Developing countries are supported through TC projects that help Member States set up nuclear medicine capabilities in hospitals and laboratories. IAEA medical physics training programmes ensure that Member States can rely upon trained staff able to provide quality diagnostic imaging and nuclear medicine services in a safe and secure manner.

Building Capacity in Nuclear Medicine and Diagnostic Imaging

The IAEA works on enhancing Member States' capability to address human health needs through the use of imaging and therapeutic applications, which complement conventional techniques. Many activities involve the clinical applications of standard and emerging technologies such as single photon emission computed tomography–computed tomography and positron

emission tomography–computed tomography for cancer and cardiovascular diseases. The emergence of hybrid imaging instruments has further enhanced the improvement of clinical management of these two major causes of death. In therapeutic applications, the IAEA works to ensure the availability of essential radiopharmaceuticals for routine clinical use in developing countries. The IAEA experts also promote activities related to the improvement of quality management systems in the clinical practice of nuclear medicine to heighten the profession.

Ensuring Accurate Dosimetry and High Quality Medical Radiation Physics

Medical practices utilizing radiation, such as radiation therapy and diagnostic imaging, must rely on adequate dosimetry and medical physics work. The IAEA contributes to ensuring safe and effective use of radiation in medicine worldwide. This is done through the development of dosimetry protocols, guides and recommendations on quality assurance in radiation medicine, and through the implementation of various projects in medical radiation physics. At the same time, the IAEA Dosimetry Laboratory provides dosimetry services to Member States. Traceable dosimetry calibration services are provided through the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories. Independent dosimetry audits and comprehensive clinical audits are offered to radiation medicine facilities worldwide.

Addressing Drug Resistance

Drug resistance is a growing challenge for the control of infectious diseases such as malaria and tuberculosis. It is essential to detect and treat patients infected with resistant strains to prevent continued transmission. Information on drug resistance helps countries to tailor intervention programmes, including the reintroduction of cheaper drugs once the level of resistance falls. The IAEA has helped build capacity in Member States through projects that monitor drug efficacy and resistance.

Fighting Malnutrition with Nuclear Techniques

Undernutrition in early life is associated with poor cognitive performance, low productivity and, when accompanied by excessive weight gain later in childhood, increased nutrition-related chronic diseases in adulthood. The IAEA builds technical expertise in its Member States to use stable isotope techniques to develop and monitor nutrition interventions aimed at promoting maternal, infant and young child nutrition. Stable isotopes are safe and can be used throughout the lifecycle in community settings to monitor infant feeding practices, body composition, absorption of minerals and body reserves of vitamin A. Stable isotope methods can also be used to evaluate interventions aimed at promoting healthy lifestyles and physical activity to control obesity and related chronic diseases.

WATER FOR LIFE

The United Nations Millennium Development Goals for water and the environment focus on halving by 2015 the proportion of people without access to safe drinking water and basic sanitation and on ensuring environmental sustainability. Meeting the targets on water and sanitation will contribute to the realization of other Millennium Development Goals, including eradicating extreme poverty and hunger, promoting gender equality, reducing child and maternal mortality and providing universal primary education.

Water supply and water quality problems are two of the foremost development needs faced by the world today. One billion people have no access to safe drinking water, and only about 15% of the population enjoy relative abundance of drinking water. Nearly five million people die each year from preventable diseases carried by unsafe water; most of these are children. Growing populations, more extensive use of water for agriculture, rising industrial growth and climate change put more strain on freshwater supplies. Improving the assessment of water

resources is a key requirement to meeting growing and competing demands for fresh water.

The IAEA has been a pioneer in developing isotope hydrology as a powerful and effective scientific tool. Water contains varying concentrations of naturally occurring isotopes that can be measured using nuclear techniques. Isotopes provide unique information, or 'fingerprints' of water resource characteristics — such as age, origin, and renewal rate, as well as vulnerability to pollution, salt water intrusion and climate change — in a cost efficient, accurate and easy-to-use way.

The IAEA Water Availability Enhancement Project (IWAVE Project) has been undertaken to assist Member States in identifying and filling gaps in hydrological data to improve their ability to conduct comprehensive water resource assessments. These include evaluations of water quality, quantity, water use, as well as resource vulnerability and sustainability. Currently, three pilot studies are under way in Costa Rica, Oman and the Philippines.

Aquifers play a large and growing role in supplying potable water, with more than half the world's population currently relying on aquifers. Many of these underlie national boundaries. The IAEA is studying several major underground aquifers, including the Nubian Sandstone Aquifer System in Africa and the Guarani Aquifer System in South America.

The IAEA provides Member States with information and skills in the peaceful application of nuclear technologies to better understand and manage their water resources and their environment. Member States receive IAEA support in the use of isotopic techniques to understand the source, extent and behaviour of water resources, as well as their vulnerability to pollution. Isotope hydrology also helps to identify the origin and extent of pollution or saline water intrusion, and provides valuable, objective information to support sustainable water resource management. TC projects also support the development of comprehensive national and transboundary water resource plans.

A regional, long term TC water project in the Sahel will help promote sustainable development and management of the fresh water contained in the five large transboundary aquifers shared by 13 countries. The region is up to 1000 km wide and stretches across the African continent from the Atlantic Ocean to the Red Sea. Persistent droughts in the Sahel region have led to a humanitarian crisis. Around 1.5 million children in the Sahel are facing severe malnutrition and risk death from starvation or disease. The project supports information and technology sharing as well as capacity building. Ultimately, the availability of reliable and coherent information about the Sahelian aquifers will form the basis for the joint management of these precious resources.

The project helps countries to fill gaps in basic hydrological information about these aquifers, to transfer technical expertise in the use of groundwater relevant nuclear techniques, and to enable countries to participate as equal partners in the assessment of these aquifers. The five-year project is being undertaken with partners such as UNESCO, the Japan International Cooperation Agency (JICA), and the Sahara and Sahel Observatory and has so far benefited from the generous financial support not only of Japan, but also of Sweden, and the USA.

Using nuclear methods to quickly and reliably map transboundary aquifers provides countries with the data they need to equitably share and manage these precious resources.

The IAEA works through its TC projects to tackle water issues in Africa, Asia, Europe and Latin America, addressing a variety of groundwater and surface water resource challenges. It supplies developing countries with training, technical and analytical support through projects, expert services and equipment. The IAEA Isotope Hydrology Laboratory's analytical support and services ensure high quality isotope measurements around the globe, as well as aiding Member States in setting up their own laboratories. Working together with other national and international organizations, which provide both financial and collaborative support, ensures the efficient facilitation of programmes.

Conserving Soil, Water and Improving Farming Practices

Nuclear technology is also applied to investigate farming practices that affect soil fertility, soil salinity, soil degradation and erosion. Over 10 isotopic and nuclear techniques have been developed for use in assessing the effectiveness of farm management practices in retaining soil, water and applied nutrients for land productivity. This will also minimize environmental impacts. As a result, Member States are able to develop integrated soil–water–nutrient management practices that (i) enhance sustainable agriculture with a strong resilience and adaptation to climate change and variability and (ii) contribute to an increase in soil productivity and a reduction in greenhouse gas emissions. Member States also establish or improve analytical laboratories that can measure environmental radioactivity and pollutants in marketable foodstuffs and in the oceans. With TC support, Member States can apply nuclear techniques to gather information on the source and distribution of agricultural pollutants. This information is used to develop effective management practices to prevent, minimize and control groundwater pollution, and helps to ensure the conservation of natural and agricultural resources for food crop production and environmental sustainability.

NUCLEAR TECHNIQUES TO STRENGTHEN FOOD SECURITY

Nuclear techniques are applied to improve agricultural efficiency and sustainability, thus enhancing food security and contributing towards the fulfilment of sustainable development goals. The IAEA supports Member States in addressing challenges to food security and specific agricultural problems such as the impacts of climate change on agricultural systems.

Today, more 800 million people do not have enough food to meet their daily needs. Within the coming 40 years, the global population is expected to from seven to nine billion people. To feed all, farmers will have to produce 70% more food. Yet right now, climate change makes droughts and floods more severe and storms more violent, destroying crops and threatening food security. The impacts of climate change effects are expected to worsen farming conditions, especially in developing countries. It is therefore important to enhance land productivity and soil resilience against the impacts of climate change and variability on soil erosion, salinization, degradation, which all can contribute to a decline in land ecosystem services and water storage.

About 500 million smallholder farmers produce as much as 80% of the food consumed in developing countries. They need help in producing more food with limited natural resources, external inputs and difficult growing conditions. Sustainable soil–water management technologies are already helping smallholder farmers in developing countries to meet those challenges. Isotopic and nuclear techniques are currently being implemented in Asia, Africa and Latin America to assist Member States in developing soil–nutrient-water management practices that can enhance soil resilience, restore degraded soils, avoid salinization and erosion, minimize greenhouse gas emission and ultimately advance food security and sustainable agriculture.

Increasing Food Security

The IAEA supports mutation breeding programmes in Member States in the implementation of nuclear technologies to increase food security and biodiversity. This involves the development of techniques to induce mutation for desired traits, such as yield, quality and greater resilience to climate change. The needs of Member States are met by supporting adaptive R&D, providing irradiation services and transferring methods through IAEA TC and CRP programmes. Mutation breeding provides a rapid response to Member States taking 5–7 years, as compared to 10–15 years for conventional breeding, to develop a new variety. These robust mutant crop varieties benefit farmers directly by increasing yields and expanding domestic and export markets. The increased revenue contributes also to socio-economic development.

Controlling insect Pests

The IAEA assists Member States with the development and use of the sterile insect technique (SIT) to control insect pests that are vectors of animal or human diseases such as tsetse flies and mosquitoes; to reduce losses by plant pests to agricultural commodities; to limit insecticide use and its negative impact on the environment; and to facilitate international trade in agricultural commodities by helping to overcome phytosanitary quarantine barriers. Technology transfer through the IAEA's TC programme is based on the development, validation and integration of environment-friendly nuclear techniques. For instance, around a third of the annual citrus production in the Neretva valley in Croatia is spoiled by damage caused by the worms of fruit flies. Most of the people in the region are involved in growing citrus fruit with revenues of about 30 million euros a year. Male flies, sterilized using gamma rays, are released on an area-wide basis into the wild, where they mate with females of the pest population, but there is no reproduction. As a result, fruit fly damage in the area under SIT treatment fell by 96%, fewer export shipments are rejected by importing countries and farmers are able to significantly reduce their use of insecticide, thereby protecting rural communities and also the environment.

Ensuring Food Safety and Cutting Wastage

Post production techniques such as food irradiation can also stop the spread of invasive insect pests, thereby opening export markets, as well as ensure food safety,


Farmer **Erwin Ortega** is growing and selling a variety of barley called 'Centenario' that was developed using nuclear technology under an FAO/IAEA project

prevent wastage and minimize losses. Efficient controls to ensure food quality and safety rely on nuclear and related techniques to verify the authenticity of food and prevent 'food fraud', analytical technologies are also used to monitor for contaminants, helping to ensure the efficient use of agrochemicals and veterinary medicines whilst maintaining food safety.

Enhancing Livestock Productivity

The IAEA also helps Member States to improve their national food security in improved livestock productivity. The focus of this support is on the efficient use of locally available feed resources, adequate management practices and breeding programmes for indigenous breeds. Nuclear techniques can analyse the efficiency of animal feeds and help improve reproduction strategies. The Joint FAO/IAEA programme has been using nuclear and related molecular techniques for genetic characterization, identification of advantageous traits in animals for marker-assisted breeding and maintenance of biodiversity. These are the key tools for the sustainable increase of productivity in animal agriculture. The IAEA's TC programme can arrange expert assistance through training in Member States by recognized experts.

Nuclear techniques to control insect pests that are vectors of livestock diseases, as well as to diagnose, control and prevent the spread of animal diseases and those diseases that can be transmitted from animals to humans are a further IAEA focus of support for developing Member States. Moreover, the IAEA through the Joint FAO/IAEA Division has been extensively involved in the eradication of animal diseases with major economic impact. Rinderpest, the second disease, after small pox in humans that has been fully eradicated worldwide was eradicated, inter alia, with the major long term involvement of the Joint Division. This tradition continues nowadays, with involvement in capacity building for early detection and response to the globally threatening avian influenza virus in Member States.

Member States acquire expert support, training and equipment through the IAEA's TC programme to ensure the safe use of radiation for a number of agricultural purposes, ranging from the sterile insect technique to suppress insect-borne diseases to fast, inexpensive animal disease diagnosis in the field.

MANAGING SPENT FUEL AND RADIOACTIVE WASTE SAFELY

Like any form of industrial activity, electricity production using nuclear power produces a waste by-product. For nuclear electricity generation, the spent fuel produced is highly radioactive and needs to be isolated, contained, stored and managed safely. The amount of spent fuel to be managed will continue to increase.

As nuclear power generation expands, and as applications of nuclear science and technology continue to grow, so too have the volumes of radioactive wastes needing to be managed. However, the volumes are not large when taken in a global context.

"Nuclear power historically produces less waste when compared with other conventional energy generating sources of similar capacity", according to Gary Dyck, Head of the IAEA's Nuclear Fuel Cycle and Materials Section.

A typical, modern, light water reactor, for example, will probably produce about 20 tonnes of spent nuclear fuel in a year. In comparison, a coal-fired plant of the same size will emit up to six million tonnes of carbon dioxide directly into the atmosphere, in addition to other effluents the plant may produce.

"Having a small amount of waste that can be safely contained, isolated, managed and disposed of is actually an advantage that we get as a result of using nuclear power for electricity generation", Mr Dyck said.

Nevertheless, its management is demanding because of radioactivity and its possible harmful effect on people and the environment. "The IAEA has programmes to support Member States in all aspects of the nuclear fuel cycle, from mining for uranium to safe disposal of nuclear spent fuel", Mr Dyck said.

Establishing a Global Safety Regime

Promoting the safe management and disposal of radioactive waste has been a major cornerstone of the IAEA's work. It has fostered international cooperation in waste management since the Agency was established in 1957.

The IAEA's programme on waste management reflects the diverse range of interests among its Member States, and activities are designed to benefit Member States regardless of their degree of sophistication in the uses of nuclear energy.

On the safety front, internationally binding legal instruments and IAEA safety standards today cover activities throughout the entire nuclear fuel cycle, including disposal. They address the safety aspects of spent fuel and radioactive waste management and provide important guidance and points of reference for countries wanting to implement a spent fuel and radioactive waste management solution.

At the same time, the IAEA works with countries interested in developing specific disposal solutions for radioactive waste. One area given particular focus is safety assessment — that is, developing methodologies to prove that the chosen solution is safe and sustainable for long periods of time.

But important hurdles remain in the implementation of safe, permanent disposal solutions for radioactive waste, particularly in the case of spent fuel and high level waste. Several countries have already built infrastructures for managing radioactive waste and spent fuel, but no final solution for geological disposal of this type of waste has yet been implemented in any country. There are various reasons for this, ranging from inadequate human and technological resources to political will and public acceptance.

Geological Disposal of Radioactive Waste

Regardless of the spent nuclear fuel strategy adopted — reprocessing or direct disposal — the spent fuel or high level waste from reprocessing will still need to be permanently disposed of in the end. Three countries — Finland, France and Sweden — are doing pioneering work in establishing a solution for deep, geological disposal for high level waste and progress has been positive.

Finland

Finland is leading the march towards finding a permanent solution for geological disposal of high level waste. Finland is now looking at acquiring a construction licence for its underground facilities and structures. A licence for operation is expected by 2020.

Other IAEA Initiatives

Many IAEA Member States have smaller or less developed nuclear programmes, but still have a need to safely manage and dispose of their radioactive waste. In a

majority of cases this is waste resulting from non-power activities such as agriculture, medicine, industry and research.

The IAEA has also established a variety of networks in different areas of nuclear waste management which are highly beneficial for Member States. The networks provide a forum for information exchange and dissemination and also enhance cooperation between experts in developed and less developed programmes. Through this exchange, the IAEA is able to help those countries seeking assistance in the area of spent fuel and radioactive waste management.

REMEDIATION: PREVENTING EXPOSURE TO RADIATION

The IAEA works to protect people and the environment from harmful radiation exposure. In the past, large and small sites have been radiologically contaminated by industrial activities, mining, accidents and nuclear weapons development. In an often long term, costly 'remediation' process, the radioactive contaminants are removed, immobilized or isolated. Remediation aims to prevent the radioactive contaminants´ movement into waterways, the food chain or air, thus reducing or preventing human exposure to radiation now and in the future. When responsible management applies best practices, there should be little or no need for remediation.

Prevention

The best remediation strategy is prevention, which begins with strong national legislation, and independent regulatory institutions. The resulting safety culture can ensure that people and the environment are protected from radioactive contamination. The IAEA helps establish and strengthen legal and institutional frameworks by developing and issuing safety standards.

Radioactive contamination knows no borders, thus globally effective management is essential. As the first global legal instrument of its kind, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management obligates the 64 countries that are party to the Joint Convention to establish "effective defences against potential hazards" to people and the environment from the "harmful effects of ionizing radiation, now and in the future".

The IAEA's experts support governments' implementation of the Joint Convention, through peer review missions and advisory services to help them move ahead with remediation and strive for a harmonized approach to remediation.

Nuclear Life Cycle

To prevent new mistakes, the IAEA is strongly promoting the life cycle approach. In essence, nuclear activities have to be planned with the end in mind. With each activity, with each project, all the steps from beginning to end are planned so that there will be no need for remediation at the end of the project. The activity is then implemented to avoid this step.

As the interest in nuclear power rises and the demand for uranium increases, newcomers will begin considering uranium mining. The IAEA helps these newcomer countries to design and implement mining activities to make sure that remediation at the end will not be required.

When the entire nuclear life cycle is subject to regulation and oversight, waste products are handled responsibly, making remediation unnecessary. Responsible management preserves resources for future generations, while it improves our lives and cuts costs today.

Contaminated Legacy Sites

As a result of many past activities, in various industries, there are sites that are radiologically contaminated. The sources of contamination are well known. Activities include uranium mining and other industries that deal with naturally occurring radioactive materials. There are also some defence programmes that resulted in

radiologically contaminated sites; in addition there have been radiological and nuclear accidents that have caused contamination. These sites may potentially affect the public´s health as well as the environment, therefore remediation of these sites is needed. For many years, the IAEA has been helping countries remediate contaminated legacy sites, which are found in both developed and developing countries. Regardless of the sites' history, they share many common causes.

Regulating Legacy Sites

Legacy sites, by nature, require high standards of regulatory supervision to ensure their responsible management. To help countries address these challenges, the IAEA, in cooperation with the Norwegian Radiation Protection Authority, launched the International Working Forum on Regulatory Supervision of Legacy Sites (RSLS) in October 2010. The International Forum brings together experienced regulators with those new to supervising legacy sites. This project supports the legacy sites' effective regulation by promoting the use of the IAEA's safety standards, as well as good international practices.

Central Asian Initiative

One of the world's most challenging remediation projects is found in Central Asia at the uranium mining and milling legacy sites in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. Radioactivity at these sites can find its way into food ingested by cattle and people — for instance, through well water that has been contaminated by the water runoff from the uranium mill tailings.

Additionally, if these materials are not adequately controlled, they can contaminate building materials, thus exposing inhabitants to higher levels of radiation. Through the IAEA's TC programme, assistance is being provided to Central Asian countries to assist with remediation of their uranium legacy.

Chernobyl

The Chernobyl accident in April 1986 released vast amounts of radionuclides into the environment. The IAEA provides technical assistance on the remediation of agricultural land and technical leadership for funding organizations to ensure that projects will lead to substantive, predictable environmental improvement.

The IAEA is heavily engaged in assessing remediation efforts in this region and also in the remediation of past and current radiological impacts from the accident. Through the IAEA's TC programme, the IAEA has provided support exceeding US $14 million over the past 20 years.

Network Solution

Legacy sites are often a bundle of complex issues that demand effective resolution such as assessing the extent of the contamination, determining where contaminants pose risks for current and future populations, communicating with the public, as well as choosing the appropriate technologies and methods to stabilize and secure the sites. Networks of individuals engaged in remediation activities are one way to assemble the expertise and experience that countries confronting a remediation challenge will need to tackle the job.

DECOMMISSIONING: EVERY GENERATION'S OBLIGATION

Throughout the world, nuclear technology is used in medicine, industry, agriculture and environmental research to help save lives, provide energy, boost productivity, increase food output and protect oceans and fresh water reserves. Yet, to ensure a sustainable future for all, it is vital to ensure that means are established for dealing with the restoration legacy from the activities from which this generation has benefited and that unreasonable burdens are not passed on to future generations.

Decommissioning, i.e. the removal of nuclear and other radiological facilities, is an essential step in accomplishing that. It enables the safe reuse of a site, as well as any buildings or parts of the facility, for other nuclear, industrial

or general purposes, ensuring the protection of people and the environment.

Currently, there are numerous nuclear facilities around the world that have outlived their usefulness and are being decommissioned.

Decommissioning a nuclear facility involves dismantling the buildings and all the associated equipment, properly disposing of any radioactive material, and finally, in a step that is referred to as remediation, ensuring that the land on which the nuclear facility was located, as well as the surrounding area, is once again fit for use by human beings and animals. Even though there are many technical, practical and economic reasons for decommissioning nuclear facilities, the most compelling reason is ethical responsibility.

Like the construction and operation of a nuclear installation, decommissioning is a complex process that requires a great deal of expertise. It can sometimes seem like an all-too daunting task.

Challenging Tasks

Primary challenges faced by countries include having facilities that have been shut down and facilities that are still operating at the same site sharing a common infrastructure. This makes implementation of decommissioning projects quite difficult. The radioactive materials that are collected during decommissioning, as well as legacy radioactive waste stored at inoperative sites, need to be safely managed. However, disposal and storage space for these materials may be limited.

But IAEA Member States do not have to go it alone.

Sharing Burdens

"A major role of the IAEA is to develop guides and safety standards relating to decommissioning projects", says Pil-Soo Hahn, Director of the IAEA Division of Radiation, Transport and Waste Safety. "We can assist Member States in building up their national regulatory infrastructure."

RESEARCH REACTORS: POWERING SCIENCE AND INNOVATION

Research reactors provide versatile platforms for scientific research, technical innovation, education, and the production of myriad medical and industrial isotopes. There are over 240 research reactors in operation in more than 50 countries around the world, according to the IAEA's Research Reactor Database. Many of these are in developing countries in Africa, Asia, Eastern Europe and Latin America, where they are being used to improve overall scientific knowledge and support the application of nuclear techniques to achieve national or regional development goals in health care, agriculture and industry.

Their primary purpose is to supply neutrons for research and other purposes. Neutrons offer researchers an exact means of studying materials. For instance, engineers can verify the integrity of safety critical parts for automobiles, aircraft or spacecraft, oil and gas delivery and other industrial processes.

Research reactors enable biologists to see how water and nutrients move though a plant's capillaries, or how bones decay due to osteoporosis. Research reactors are used to analyse pollution, to better understand and preserve delicate and priceless cultural artefacts, and to improve batteries and fuel cells. Their data helps neurologists better understand complex brain functions and geologists can determine the age of ancient rock. Through neutron induced transmutations, silicon is modified at the atomic level for use in computers and mobile telephones. Transmutation also produces radioisotopes that are essential in diagnosing and treating cancer, heart or neurological diseases. The IAEA is helping to ensure a stable and continuing supply of radioisotopes by supporting research reactor coalitions and helping to develop new capabilities for existing research reactors to ensure the stable and secure provision of radioisotopes.

To promote research reactor safety, the IAEA applies a Code of Conduct on the Safety of Research Reactors, develops safety standards and guides and supports Member States in their application, improves safety practices, provides safety review services, and monitors and enhances the safety of research reactors under project and supply agreements. Through the IAEA's TC programme, training, expert missions, fellowships and equipment procurement are organized to deliver the necessary skills and tools to establish a safe and sustainable research reactor infrastructure in developing countries. Research institutes and scientists from the developing and developed world work together on IAEA-supported coordinated research projects that stimulate research.

The IAEA provides expert support to Member States considering building a research reactor to develop indigenous nuclear competence and infrastructure. Training helps develop the necessary competence to launch, operate and decommission a research reactor programme. This training is supplemented by guidance developed by experts with demonstrated experience in relevant projects worldwide.

The IAEA supports initiatives in fuel conversion and repatriation projects that assist Member States with the development and qualification of new research reactor fuels and uranium targets used to produce medical isotopes. These projects strive to minimize the civilian use of highly enriched uranium (HEU) by converting HEU fuel and targets to low enriched uranium (LEU), and assisting States with the management of spent nuclear fuel as well as the back end of fission based, medical isotope production processes.

NUCLEAR FUSION: HARNESSING THE POWER OF THE STARS

Nuclear fusion powers the sun and the stars. Hydrogen is fused to helium and to heavier elements. The resulting nuclei have a lower mass than the hydrogen that went into the fusion reaction. This missing mass is converted into energy according to Einstein's $E=mc^2$. Lots of energy! In fact, nuclear fusion is the power source of the visible universe — everything you see when you look up to the night sky.

Conventional solar power indirectly uses the fusion reactions in the sun, and so do wind power and biofuels. All fossil fuels are nothing but fusion energy stored for a long period of time, and even the energy stored in uranium ultimately was once derived from fusion power. It is therefore only logical that mankind should try and harness fusion power directly, here on Earth. The IAEA has been instrumental in setting up the ITER International Fusion Energy Organization, accompanying and guiding the process from 1988 to 2006. Now ITER, the first experimental fusion reactor expected to produce more energy output than input, is under construction in the South of France. The IAEA is an observer in the ITER Council and acts as a bridge between the ITER members (China, the European Union, India, Japan, Korea, the Russian Federation, and the United States of America) and all other IAEA Member States.

While ITER is under construction, plans are being made for the next steps following ITER, in particular for the first demonstration reactor(s), called DEMO, that will feed electrical power from fusion reactions into the grid. The IAEA is accompanying this process in the same way it did for the formation of the ITER Organization, through the facilitation of information exchange, workshops, meetings and fostering international collaboration. The new DEMO Workshop series that particularly looks at the technological aspects of future fusion power stations was started in 2012.

Taking place every two years, the IAEA Fusion Energy Conference is the largest and most important event in the field, bringing together about 1000 fusion scientists from around the world. It is the largest regular IAEA event besides the annual General Conference. The next conference will be the 25th of the series and will take place in October 2014 in St. Petersburg, Russian Federation.

The IAEA Nuclear Fusion journal, published in cooperation with the Institute of Physics, is the acknowledged leading journal in fusion physics. It is the only scientific journal published by the IAEA.

The technology to actually build a fusion power station requires many atomic, molecular, plasma-surface interaction and nuclear data. The IAEA aims to build a community across disciplines of researchers working towards fusion energy by coordinating international collaboration to produce, evaluate and disseminate this large volume of crucial data. Information on the fundamental data and relevant fusion applications is available through databases and webpages maintained by the Nuclear Data Section, including the Fusion Evaluated Nuclear Data Library (FENDL) that provides a reference data set for fusion applications.

IAEA AT WORK
2014 Edition
was produced by the Office of Public Information and Communication
with contributions from:
The Department of Technical Cooperation
The Department of Nuclear Sciences and Applications
The Department of Nuclear Energy
The Department of Nuclear Safety and Security
The Department of Safeguards
and
The Department of Management

Photos: IAEA

14-0353

IAEA

For more information on the IAEA, its activities and the IAEA Secretariat's Departments, please visit www.iaea.org or follow the IAEA on Facebook, Twitter, YouTube and Flickr.

Contact:
IAEA Office of Public Information and Communication
info@iaea.org

April 2014