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Report of the Commission of Eminent Persons on the Future of the Agency

Note by the Director General

- During the General Conference in September 2007, the Director General announced that he was establishing an independent Commission of Eminent Persons to reflect upon the nature and scope of the Agency's programme up to 2020 and beyond. Membership of the Commission was drawn from a wide range of expertise — public policy making, management, finance and technology. The Commission was chaired by Professor Ernesto Zedillo, former President of Mexico. The Commission's report addresses the many challenges and opportunities which the Agency faces in the coming years and sets out concrete recommendations. The Director General trusts that the report will receive thorough consideration by Member States.
- A background document prepared by the Secretariat in February 2008 for the work of the Commission is attached as an annex.

REINFORCING THE GLOBAL NUCLEAR ORDER FOR PEACE AND PROSPERITY:

THE ROLE OF THE IAEA TO 2020 AND BEYOND

Report prepared by an independent Commission at the request of the Director General of the International Atomic Energy Agency

May 2008

This Commission is fully independent. Members serve in their personal capacity and not under instructions from any government or organization. The report reflects strictly personal views of the members of the Commission and is in no way an expression of their views in their official capacity nor the views of any government or organization with which they are affiliated. The members of the Commission endorse the report as a whole but do not each subscribe to every statement and recommendation in the text. In particular, Dr. Wolfgang Schüssel would have preferred a more skeptical perspective on the prospects of nuclear energy. Dr. Rajagopala Chidambaram, Senator Lamberto Dini and Ms. Anne Lauvergeon, on the other hand, believe that the report does not always give a balanced representation of nuclear energy issues. They feel that the safety and security risks have been exaggerated and consider that these issues are being adequately addressed and improvements continually made, with the constructive support of the IAEA, resulting in increased safety and security of nuclear energy. In their opinion, the expansion of nuclear energy can be pursued in a safe and secure manner, provided the required institutional and safety framework is put in place in the countries that are newcomers to nuclear energy. While fully appreciating the importance of global nuclear disarmament, they do not accept that there should be a direct correlation between disarmament and deployment of the peaceful uses of nuclear energy. At any rate, they estimate that the issue of disarmament is beyond the Statute of the IAEA and should not be within the scope of this report, for it is being addressed by the Conference on Disarmament in Geneva.

Commission members

Ambassador Oluyemi Adeniji (Nigeria) – former Minister of Foreign Affairs, Nigeria; former Member of the Board of Governors of the IAEA

Lajos Bokros (Hungary) – Professor of Economics and Public Policy, and Chief Operating Officer of the Central European University, Budapest, Hungary

Lakhdar Brahimi (Algeria) – Visiting Scholar at the Institute for Advanced Study, Princeton; former UN Under-Secretary-General, Special Adviser to the Secretary-General, and Chair of the UN Panel on Peace Operations

Dr. Rajagopala Chidambaram (India) – Principal Scientific Advisor to the Government of India, and DAE-Homi Bhabha Professor; former Chairman of the Atomic Energy Commission; former Director of the Bhabha Atomic Research Centre

Senator Lamberto Dini (Italy) – President of the Foreign Affairs Committee of the Italian Senate

Gareth Evans (Australia) – President and Chief Executive Officer, International Crisis Group; former Australian Foreign Minister; former Minister for Resources and Energy

Louise Fréchette (Canada) – Distinguished Fellow, The Centre for International Governance Innovation; former Deputy Minister and former UN Deputy Secretary-General

Anne Lauvergeon (France) – Chief Executive Officer of AREVA

Kishore Mahbubani (Singapore) – Dean, Professor in the Practice of Public Policy, Lee Kuan Yew School of Public Policy, National University of Singapore; former Ambassador to the UN, and former President of the UN Security Council

Ambassador Ronaldo Mota Sardenberg (Brazil) – President of the National Telecommunication Agency of Brazil; former Permanent Representative of Brazil to the UN; former Minister of Science and Technology, Brazil

Ambassador Pius Yasebasi Ng'Wandu (Tanzania) – former Minister of Science, Technology, and Higher Education, and Minister of Water, United Republic of Tanzania

Senator Sam Nunn (United States) – Co-Chairman and Chief Executive Officer of the Nuclear Threat Initiative; former United States Senator

Ambassador Karl Theodor Paschke (Germany) – former UN Under-Secretary-General for Internal Oversight Services; former Permanent Representative of the Federal Republic of Germany to the IAEA

Dr. Wolfgang Schüssel (Austria) – former Federal Chancellor of Austria; Leader of the Parliamentary Group of the Austrian People's Party

Academician Evgeny Velikhov (Russia) – President of the Russian Research Centre Kurchatov Institute; Academician and Secretary of the Russian Academy of Sciences

Professor Wang Dazhong (China) – Honorary Chairman of Tsinghua University Council; Member of Chinese Academy of Sciences; former President of Tsinghua University; Director of the Institute of Nuclear Energy Technology (INET) of Tsinghua University

Dr. Hiroyuki Yoshikawa (Japan) – President of the National Institute of Advanced Industrial Science and Technology, Tokyo; former President of the University of Tokyo

Ernesto Zedillo, *Chair* (Mexico) – Director of the Yale Center for the Study of Globalization; former President of Mexico

The Commission wishes to thank Graham Allison (Harvard University) and Ambassador T.P. Sreenivasan who served with excellence as Executive Directors of the project; Matthew Bunn (Belfer Center, Harvard University) who played a key role in the research and drafting of the report; and Haynie Wheeler (Yale Center for the Study of Globalization) for her assistance to the project. The Commission also acknowledges with appreciation William Martin who served as the Project Coordinator appointed by the IAEA.

Contents

Executive Summary

The international community has both auspicious opportunities and significant challenges to tackle as the world moves into its seventh nuclear decade. Expanded use of nuclear technologies offers immense potential to meet important development needs. In fact, to satisfy energy demands and to mitigate the threat of climate change – two of the 21st century's greatest challenges – there are major opportunities for expansion of nuclear energy in those countries that choose to have it. But those opportunities also pose complex and broad-ranging safety and security questions that must be addressed effectively.

The International Atomic Energy Agency (IAEA), in its continuing quest to maximize the contributions of nuclear technologies to human well-being, while minimizing the risks, deserves the unstinting support of the international community. The Agency is unique in the mission assigned to it by member states, the authorities that are granted in its Statute and in safeguards agreements to inspect nuclear activities around the world, its global expertise in nuclear science and technology, its well-earned reputation for objectivity and technical competence, and its role at the center of so many aspects of the world's nuclear future. The Agency's roles in nuclear safeguards, safety, and security complement each other: measures to strengthen any of these "three S's" can have important benefits for the others, and all of the three S's are essential to the future growth of nuclear applications. A strengthened IAEA with adequate authority, resources and personnel is absolutely essential to reinforce the global nuclear order for peace and prosperity.

Nonproliferation, disarmament, and peaceful use – the three pillars of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) – are integrally linked, and achievements in each area are likely to require progress in the others. In particular, gaining agreement on the steps needed to strengthen the global nonproliferation regime will require meaningful progress toward nuclear disarmament and toward making the benefits of nuclear energy potentially available to all. Hence, a bold agenda is required that seeks to address all of these challenges simultaneously.

In this report we call for a reinvigorated global nuclear order that will reduce risks while allowing rapidly growing contributions to human well-being from nuclear technologies. If successful, this new order could lead, ultimately and effectively, to an era of Atoms for Peace and Prosperity as envisioned at the Agency's conception in 1953. A reinforced global nuclear order will emerge as a product of increased collective action and partnership, expanded transparency, increasingly effective standards for safety and security worldwide, new nonproliferation measures, and progressive steps to reduce and ultimately eliminate nuclear weapons.

Four strong partnerships are needed to forge a reinvigorated nuclear order: first, between nuclear weapons states and non-nuclear weapon states; second, among nuclear technology and fuel-cycle suppliers, states that want nuclear energy, and the IAEA; third, among the states, the private sector, and international agencies; and fourth, among developed countries, developing countries, international development institutions and the IAEA.

The spiraling cost of fossil fuels and the impending threat of climate change, against which nuclear power is recognized as an important mitigating option, may make a renaissance of nuclear energy likely in the near future. International cooperation should be strengthened immediately to ensure that any possible expansion of nuclear energy will be safe and secure and will not contribute to nuclear weapons proliferation. The IAEA will have the responsibility to help newcomer states put in place the necessary infrastructure needed to develop nuclear energy safely, securely and peacefully. It should work with member states to coordinate research to design reactors that are economical, safe and proliferation-resistant. It must expand its efforts to help states establish safe and sustainable approaches to managing nuclear waste, and to build public and international support for implementing them. The Agency will also be required to develop international nuclear safety standards and to promote the harmonization of certification processes for new reactor models. Shared regional nuclear plants, mechanisms for the assured supply of nuclear fuel, including international banks of enriched uranium, multinational management of the entire fuel cycle, estimation of global resources of uranium and research and development of thorium fuel cycles are among the endeavors that will result in additional responsibilities for the IAEA.

The IAEA's technical assistance in developing countries for nuclear applications in health, agriculture, industry, environment, hydrology and biological and physical research is important both for its direct contribution to human well-being and because it helps to build broad support for the Agency itself and its larger energy, safety, security, and non-proliferation missions. In many applications outside the nuclear energy sector, the nuclear component may be only a small part of the whole effort, but crucial to success, and the IAEA is the only agency with the necessary expertise. Also, the nuclear community's extensive knowledge in areas such as thermal engineering, materials, and computational fluid dynamics can be networked through the IAEA to contribute significantly to other technologies. The Agency's technical cooperation program needs to be expanded and diversified to ensure it keeps pace with the growth in the Agency's other activities. This will entail a higher outlay and assured and predictable funding for nuclear applications and technical cooperation. Demand for technical assistance will always exceed the resources allocated for it, but developing countries' expectations for such support from the IAEA need to be better satisfied in the future.

Safeguards are a core mission of the IAEA and will continue to be a central part of its work. In fact, the IAEA's safeguards responsibilities have been expanding rapidly. From 1984 to 2007 the amount of nuclear material under safeguards increased more than tenfold. Member states are calling on the Agency to implement the Additional Protocol as well as to pursue a country-level, information-driven approach to safeguards that requires the Agency to examine a broad range of additional and more sophisticated types of information. The IAEA's existing authorities should be interpreted to give the Agency the responsibility to inspect for indicators of nuclear weaponization activities. As has become clear from recent events, sometimes transparency going well beyond the measures called for in the Additional Protocol is needed to provide confidence that a state's nuclear program is entirely peaceful. The IAEA should work closely with member states developing new fuel cycle processes, so that effective safeguards, nonproliferation, and physical protection measures can be designed into such new systems from the outset. Clearly, further increases for safeguards work will be needed if nuclear energy grows and other circumstances change in the future. Yet, since the early 1980s, the Agency was subject to zero real growth in funding, except for a modest increase approved in 2003. Given these increased responsibilities, a substantial increase in IAEA resources for safeguards is urgently required. IAEA member states should provide the funds needed to ensure that the effectiveness of safeguards is not compromised by lack of resources.

Though nuclear security is fundamentally the responsibility of individual states, the IAEA has an important role to play in addressing the threat of nuclear terrorism. It is the only global body with relevant competence and expertise relied on by a wide range of countries. States should negotiate binding agreements that set effective global nuclear security standards. They should agree to give the IAEA an important role in developing those binding standards and assisting in and confirming their implementation. The IAEA should develop model legislation that will help states fulfill their UNSC 1540 obligations to enact effective national laws prohibiting acts related to nuclear terrorism and nuclear smuggling. The IAEA should expand its efforts to ensure effective security for the most dangerous radiological sources worldwide and increase the priority it gives to preventing nuclear smuggling. And it should continue its efforts to help states prepare to cope with the consequences of a radiological dispersal.

Although nuclear safety has improved enormously in recent decades, the risk of an accident at any given reactor must continue to be reduced. The IAEA's role in persistently improving the global safety regime is critical and must be strengthened. The Agency should lead an international effort to establish a global nuclear safety network, and ensure that critical safety knowledge, experience, and lessons learned are broadly exchanged. Over time, with the IAEA's involvement, states should enter into binding agreements to adhere to effective global safety standards and to be subject to international nuclear safety peer reviews. Member states and the IAEA should strengthen their critically important efforts to ensure that countries embarking on nuclear power programs develop sound safety infrastructures, including effective and independent regulatory bodies. The Agency should expand its efforts to assist states in assessing and strengthening the nuclear safety culture.

Article VI of the NPT legally obligates the nuclear weapons state parties to negotiate in good faith toward nuclear disarmament, and at the 2000 NPT Review Conference, they agreed that the treaty represented an "unequivocal undertaking" to "accomplish the total elimination of their nuclear arsenals." This commitment is an integral part of the NPT bargain. The need for the NPT to become universal cannot be stressed enough. States must recommit to the vision of a world free of nuclear weapons. They must take firmer steps to reinvigorate the grand bargain that was struck 40 years ago. The renewed grand bargain will need to combine steps that can be taken immediately with a vision for the longer term, to draw in states that are not parties to the NPT. The IAEA is not the lead agency or forum for nuclear disarmament, but progress towards disarmament, or the lack of it, deeply affects the IAEA's nonproliferation mission. And the IAEA's rich experience in verification must be utilized as disarmament proceeds.

The stronger global nuclear order we propose would feature greatly expanded international cooperation and transparency, with new partnerships for nuclear energy, development, disarmament, non-proliferation, safety, and security. It would:

- Help enable a safe and secure expansion of nuclear energy in those countries that seek it, helping to power a growing global economy while mitigating the threat of climate change;
- Make it possible for nuclear technologies to expand their role in saving lives, growing crops, and providing jobs in the developing world;
- Reduce the dangers of nuclear accidents and nuclear terrorism; and
- Provide a path toward dramatically reduced dangers to humanity from nuclear weapons and nuclear proliferation.

While building the reinvigorated global nuclear order we propose will require actions by many parties going well beyond the IAEA, a strengthened IAEA with additional resources, able to attract and retain the best personnel, will be essential. The global investment in the crucial mission of the IAEA with immense consequences for world security has been remarkably small. The safeguards budget of the IAEA, which is meant to safeguard hundreds of tons of nuclear material in hundreds of facilities in scores of countries, is not more than the budget of the police department of the city in which it is located. Investments in nuclear security, nuclear safety, nuclear energy, nuclear applications and technical cooperation are even smaller. Modernization of the Agency's scientific and information infrastructures is long overdue.

A thorough reform of the funding of the Agency has become all the more urgent with the additional tasks that this report envisages for the Agency in 2020 and beyond to effectively seize the opportunity of Atoms for Peace and Prosperity. Without additional and reliable funding, the IAEA will not be able to:

- Carry out independent analysis of safeguards samples, essential to provide credible verification of the non-proliferation of nuclear weapons. Urgent funding is needed to shore up the failing infrastructure and instrumentation, and ensure the safety and security, of the Safeguards Analytical Laboratory.
- Play its essential role in combating nuclear terrorism and in ensuring the safety of nuclear power plants and other nuclear facilities. The staffing of these vital programs currently has to rely to a very large extent on unpredictable voluntary funding.
- Provide an adequate response, in terms of prompt international coordination and assistance, to a nuclear accident or terrorist act involving nuclear or radioactive material.
- Ensure that the many new countries considering introducing nuclear power programs do so in a carefully planned, and safe and secure, manner.
- Respond to pressing global crises in food security, health and the availability of drinking water through the use of nuclear techniques, for example by helping to ensure transboundary control of insect pests harmful to fruit and vegetables, developing sustainable crop varieties tolerant to harsh conditions, helping address the growing cancer epidemic, especially in the developing world, and underpinning desperately needed improvements in water resources management.
- Meet, in a timely manner, urgent requests relating to verification of non-proliferation. Currently, voluntary funding has to be sought for unforeseen high priority needs.

The increase in funding must be accompanied by a renewed and transparent effort by the IAEA Secretariat to further improve its already impressive record of efficiency. It must not rest on its laurels but seek every opportunity to further develop a management culture that emphasizes accountability, a readiness to accept change, and effective coordination with other organizations. The IAEA's personnel policies also require reform.

The Commission unanimously believes that to enable the IAEA to properly accomplish its duties, it should be allocated considerably larger resources by its members. We recommend that the Board of Governors provide an immediate one-time increase in the IAEA's budget by €80 million for *inter alia* refurbishing the Safeguards Analytical Laboratory and for adequate funding of the Agency's Incident and Emergency Response Center.[1] The Board should also agree to consistent annual increases in the regular budget to underpin the expansion of the Agency's security and safety work, other activities in support of newcomer states embarking on nuclear programs, and an expansion of work in nuclear applications and technology transfer. The exact amount of additional regular budget should be determined after a detailed review of the budgetary situation and additional workloads of the Agency, but the Commission estimates that increases of about €50 million annually in real terms might be necessary during several years.

In the longer time frame, the regular budget will need to continue increasing in order to meet the growing demands for IAEA services. A substantially bigger regular budget – by 2020 perhaps twice as large as the present one – would allow the needed expansion of work on nuclear reactors and the fuel cycle, security and safety, and support for meeting basic human needs through nuclear applications and technical cooperation. It would also meet an additional funding requirement in the verification area to ensure an independent and credible system, and address other existing unfunded liabilities.

The Commission endorses the idea that the IAEA is an "extraordinary bargain," considering that it carries out its responsibilities of immense value to humanity at a very low cost. By 2020 and beyond, these responsibilities will increase dramatically as mankind and the Agency face new opportunities and challenges. In the new partnerships that the Commission envisages for nuclear energy, development, disarmament, non-proliferation, safety, and security, the IAEA's strengthened role would require additional authority, resources, personnel and technology. The cost of providing these would be insignificant compared either to the benefits to be gained or to the risks and costs of failure to act. Now is the time to choose.

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1 We have taken as credible the figure that was provided in the Director General's Report (footnote 22, page 24, "20/20 Vision for the Future").

1. Introduction: Opportunities and Challenges

The international community has auspicious opportunities and significant challenges to tackle as the world moves into its seventh nuclear decade. Expanded use of nuclear technologies offers immense potential to meet important development needs. In fact, to satisfy energy demands and to mitigate the threat of climate change – two of the 21st century's greatest challenges – there are major opportunities for expansion of nuclear energy in those countries that choose to have it. Other nuclear technologies are playing an important role in economic and social development and can play a larger role in the future, by helping to prevent and treat deadly diseases, control insect pests, manage safe water supplies, and develop more drought- and disease-resistant crops. But nuclear technologies also pose complex and broad-ranging safety and security challenges that must be addressed effectively.

The Commission's Charge

With a record of fifty years of distinguished service to humanity, recognized in the award of the Nobel Peace Prize in 2005, the International Atomic Energy Agency (IAEA) is actively exploring how the world and the Agency must adapt to seize the opportunities and cope with the challenges. In late 2007, IAEA Director General Mohamed ElBaradei established this Commission to advise on how the nuclear future might evolve to 2020 and beyond, what the world is likely to demand of the IAEA, and what steps need to be taken to allow the IAEA to fill those needs.

In its largest sense, the question before us is: what actions must the international community take to maximize the contributions to human well-being from nuclear technologies, while minimizing their risks? The answers we offer focus first and foremost on steps the IAEA can take. But we also emphasize that additional significant steps will need to be taken by other multilateral institutions, national governments, industry, and other key stakeholders in the global nuclear system.

Our Commission was greatly assisted in its work by an excellent background report, "20/20 Vision for the Future," prepared by the Director General of the IAEA. The Director General's report is a comprehensive, professional, and accessible document. As that report and many other inputs to the Commission make clear, the IAEA plays critical roles in nuclear energy, nuclear applications, nuclear nonproliferation and safeguards, nuclear safety, and nuclear security.

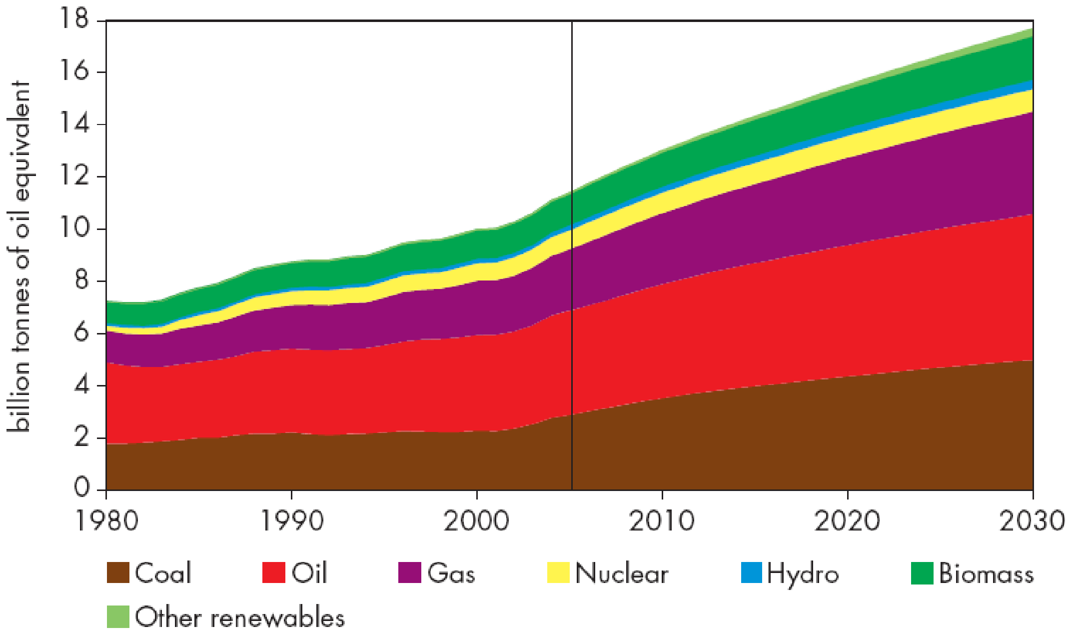
The IAEA is unique in the mission assigned to it by member states, the authorities granted in the IAEA Statute and in safeguards agreements to inspect nuclear activities around the world, its global expertise in nuclear science and technology, its well-earned reputation for objectivity and technical competence, and its role at the center of so many aspects of the world's nuclear future. The Agency's roles in nuclear safeguards, safety, and security complement each other: measures to strengthen any of these "three S's" can have important benefits for the others, and all of the three S's are essential to the future growth of nuclear applications.

Facts and Trends that Frame the Opportunities and Challenges

Ten key facts and trends frame the nuclear opportunities and challenges the world now faces.

1. **Energy demand is surging worldwide.** To sustain rapid global economic growth will require doubling the supply of energy, and tripling the supply of electricity, by 2050. (Figure 1.1 shows projected energy demand and fuel use to 2030.) Meeting these demands will stretch all current sources of energy supply and require major improvements in efficiency. At the same time, mitigating climate change will require shifts in the fuel mix.
2. **Billions of poor people need energy and other life-saving and job-creating technologies.** Four out of every ten people on earth today live on less than $2 a day. The suffering and loss of human potential caused by this poverty is the greatest tragedy of our time. Combating global poverty requires economic growth, and economic growth requires adequate and reliable supplies of energy; indeed, the Human Development Index correlates very strongly with per capita energy consumption. Applications of nuclear techniques in areas such as agriculture and the management of water resources also hold promise for improving the living standards of the poor.

Figure 1.1: **World Primary Energy Demand**



Source: International Energy Agency, *World Energy Outlook 2007,* reference scenario.

3. **Energy prices are increasing.** Current oil prices of more than $100 a barrel are fueling frictions and development setbacks around the world. In coming decades, growing competition for supplies of oil and natural gas will exacerbate geopolitical tensions and heighten the risk of conflicts. Conceivably, a broader reliance on nuclear energy, whose prices are much less dependent on its fuel costs, could help ameliorate those tensions and risks.

4. **Drastic steps are needed to reduce greenhouse gas emissions.** In a world still dependent on burning coal, oil, and natural gas for 80 percent of its energy supply, surging energy use causes surging emissions of greenhouse gases, disrupting the climate with potentially catastrophic results. A major transformation of global energy use and supply, involving substantial growth in low-carbon energy production, will be required to stabilize atmospheric concentrations of greenhouse gases and thus mitigate climate change.

5. **Substantial growth in “clean” energy production will be required to mitigate climate change.** Though opinions differ about its future growth rate, nuclear energy is a readily expandable source of low-carbon baseload electricity, and in the future might also help to meet other energy needs, such as for hydrogen production and water desalination. Today, 439 nuclear power plants with a capacity of 369 gigawatts-electric (GWe) in 30 countries provide some 15 percent of the world’s electricity, meeting approximately 6 percent of global primary energy demand. Producing this amount of electricity with oil would require some 650 million metric tons of oil per year. For nuclear plants to provide a significant fraction of the low-carbon energy likely to be needed in the 21st century would require a three-fold increase or more in nuclear capacity by 2050. With such a global tripling, nuclear plants would provide 15 to 25 percent of the world’s electricity supply.

6. **Nuclear energy’s recent growth has been slow but has started to speed up.** Since the aftermath of the Three Mile Island and Chernobyl accidents, the global growth of nuclear energy has been slow, and in recent years only about 4 GWe of nuclear power generation capacity has been connected to the grid each year worldwide. Yet today, two large third-generation reactors are under construction in Western Europe (Finland and France) and more are planned in the UK and Eastern Europe; a significant number of US utilities have engaged in construction and operating license processes to build new nuclear power plants; Russia is investing billions of dollars to rapidly expand its nuclear energy capacity; Japan and South Korea have expansion programs

underway, while China and India have both started substantial expansions of their nuclear energy infrastructure, suggesting that by 2050, nuclear power might grow as much as tenfold in Asia; South Africa is selecting a supplier for two reactors, and possibly twelve more; Brazil is contemplating a new expansion of its nuclear energy capacity; and dozens of countries are now considering building their first nuclear power plants.

7. **Nuclear safety has improved significantly but the risk of accidents persists.** A wide range of safety indicators make clear that nuclear safety in many countries has improved significantly since the Three Mile Island and Chernobyl accidents. The third-generation nuclear reactors now being built are designed to reduce further the risk of nuclear accidents and any potential adverse impact on health and the environment. But the Davis-Besse incident in the United States in 2002 – where less than a centimeter of steel remained in the steel pressure vessel to prevent a major loss of coolant, in a sequence of events that had never been included in probabilistic risk assessments – is a reminder that maintaining nuclear safety is an ongoing process that requires the utmost care, not only at the design stage but also during operation. Some of the oldest-design reactors still in use in several countries pose particular concerns, and in newcomer states that are just establishing their regulatory infrastructures, teams of qualified personnel, and nuclear safety cultures, the safety of reactors will require special attention. A serious accident anywhere would impair any prospect for large-scale global growth of nuclear energy.

8. **Nuclear terrorism poses a real threat to all.** Government studies in several countries have made clear that a sophisticated and well-financed terrorist group that acquired enough highly enriched uranium (HEU) or separated plutonium might be able to construct a crude nuclear bomb that could incinerate the heart of any of the world's major cities.[2] If such an attack occurred, no matter where, its economic and security consequences would affect every country. Security for nuclear weapons, installations, and materials has improved substantially in many countries over the past decade. But seizures of small quantities of stolen HEU or plutonium – most recently in Georgia in 2006 – make clear that at some locations these materials are still vulnerable to theft. Most of the material seized over the years has never been reported missing, suggesting that at some sites material control and accounting measures are also inadequate. No specific and binding global standards for nuclear security yet exist. Appropriate steps are also required to further protect major nuclear facilities from sabotage and to improve controls over dangerous radiological sources. A terrorist nuclear bomb or a major radioactive release from terrorist sabotage of a nuclear facility could cancel any chance for large-scale growth in nuclear energy use.

9. **The nuclear nonproliferation regime must be strengthened.** Recent years have seen some significant successes in stemming the spread of nuclear weapons, with Libya's decision to give up its secret nuclear weapons program; Belarus, Kazakhstan, and Ukraine sending all the nuclear weapons on their soil back to Russia and joining the Treaty on the Nonproliferation of Nuclear Weapons (NPT) as non-nuclear-weapons states; the breakup of the global black-market nuclear technology network that was led by Pakistan's A.Q. Khan; the adoption of the Additional Protocol[3] designed to strengthen safeguards agreements; and more effective information-driven approaches to safeguards. Significantly, in 1990 South Africa terminated its nuclear weapons program and in 1991 it signed the NPT and welcomed the IAEA to conduct an unprecedented verification of its nuclear rollback. Indeed, there are now more states that have started nuclear weapons programs and verifiably given them up than there are states with nuclear weapons. Historically, nonproliferation efforts succeed more often than they fail. At the same time, however, the stresses in the system have grown. If Iran and North Korea both become established nuclear weapons states, other states would come under increased pressure to follow suit and the global nonproliferation regime would be severely weakened. If nuclear weapons continue to be seen as offering security and prestige, and states that maintain them continue to send the message that nuclear weapons are essential to security, more states may seek such weapons. If, as nuclear energy grows and spreads, the dual-use technologies that make it possible to produce nuclear

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2 Matthew Bunn, *Securing the Bomb 2007*, Cambridge, MA and Washington, D.C.: Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative, September 26, 2007.

3 The text of the Additional Protocol is online at <http://www.iaea.org/Publications/Documents/Infcircs/1997/infcirc540.pdf>

weapons material also spread, more and more states may be in a position to leave the global regime and produce nuclear weapons on short notice. In short, as the UN High-level Panel on Threats, Challenges, and Change warned, "we are approaching the point at which the erosion of the non-proliferation regime could become irreversible and result in a cascade of proliferation."[4]

10. **Progress on disarmament is slow.** Four decades after the NPT was signed, some 25,000 nuclear weapons still exist – thousands of them on quick-launch alert. The nuclear weapons states point to ongoing reductions in their nuclear stockpiles as evidence that they are fulfilling their NPT Article VI obligations to negotiate in good faith toward nuclear disarmament. By contrast, many of the non-nuclear-weapons states see the progress as too slow, and believe that the nuclear weapons states are not serious about carrying out their obligations. Some states with nuclear weapons are pursuing the production of weapons-grade material and indeed seem to be increasing their reliance on nuclear weapons, laying plans for maintaining nuclear arsenals indefinitely. At the 2000 NPT Review Conference, the nuclear weapons states committed to an "unequivocal undertaking" to "accomplish the total elimination of their nuclear arsenals," and to taking 13 "practical steps" to fulfill the NPT's disarmament obligation. But few of these steps have yet been implemented, and the 2005 Review Conference collapsed in part because a major nuclear power refused even to discuss them. This situation causes festering resentment over "double standards," and what are seen as efforts to perpetuate the inequities of the nonproliferation regime. The mounting resentment makes it much more difficult to agree on steps that are urgently needed to strengthen the global effort to stem the spread of nuclear weapons – even though such steps would serve the interests of all. While the IAEA is not the lead forum or agency for disarmament, this resentment could seriously impede the IAEA's ability to accomplish its other missions.

[4] *A More Secure World: Our Shared Responsibility, Report of the Secretary-General's High-level Panel on Threats, Challenges and Change* (2004). <http://www.un.org/secureworld/>

2. A Reinforced Global Nuclear Order

If the world fails to seize the opportunities and to meet the current challenges – in particular by failing to give the IAEA the authorities and resources it requires to carry out its missions – there is a serious risk that the world will move on to a downward path fraught with significant dangers. In such a world, large-scale growth of nuclear energy would be unlikely, meeting the challenge of climate change would be more difficult, and human needs that require energy would be harder to satisfy.

Major steps are required to seize a potentially huge opportunity: for a safe and secure nuclear order in which atoms, for those countries that so wish, provide low-carbon energy that helps to sustain global economic growth while helping to avoid severe climate disruptions. Non-proliferation, disarmament, and peaceful use – the three pillars of the Nonproliferation Treaty – are integrally linked, and achievements in each area are likely to require progress in the others. In particular, gaining agreement on the steps needed to strengthen the global nonproliferation regime will require meaningful progress toward nuclear disarmament and toward making the benefits of nuclear technology available to all. Hence, a bold agenda is required that seeks to address all of these challenges simultaneously.

In this report we call for action on this bold agenda, to reinvigorate the global nuclear order so as to reduce risks while allowing rapidly growing contributions to human well-being from nuclear technologies. In the Commission's judgment, the cost and risks of taking such action now – including the costs of building a stronger and more effective IAEA – are tiny in comparison to the costs and risks of failing to act.

If it can be created, this strengthened nuclear order could ultimately produce an era of Atoms for Peace and Prosperity, as was the hope when the IAEA was conceived in 1953. This is a task that goes well beyond the IAEA's mandate and capabilities, but reinforcing the IAEA will be crucial. A stronger nuclear order will emerge as a product of increased collective action and partnership, expanded transparency, increasingly effective standards for safety and security worldwide, new nonproliferation measures, and progressive steps to reduce and ultimately eliminate nuclear weapons. National governments, private industry, industry associations and other non-government organizations, academic organizations and research laboratories, the public, and the press will all have to work along with the United Nations, the IAEA, and other international institutions to create the stronger structure we envisage. Indeed, nuclear technologies are only one element of the broader security and development agenda. Achieving effective, sustainable, and equitable security and development will require a broad range of steps going far beyond the scope of this report, including a reinvigorated United Nations and Security Council, as well as a strengthening of the multilateral institutions for development.

Four strong partnerships are needed:

1. **A partnership between nuclear weapons states and non-nuclear weapons states** that takes major steps to strengthen the global nonproliferation regime and major steps toward nuclear disarmament. Action on both of these fronts serves the security interests of all states, and action on both will be required to achieve agreement on either.

2. **A partnership among nuclear technology and fuel-cycle suppliers, states that want nuclear energy**, **and the IAEA,** to provide assured supply of nuclear fuel products and services, and of services for used fuel and waste management, under international supervision and control.

3. **A partnership among states, the private sector, and international agencies**, in which all parties share both the responsibilities and costs of assuring that the use of nuclear energy remains safe and secure, and does not contribute to nuclear proliferation.

4. **A partnership among developed countries, developing countries, international development institutions, and the IAEA**, to ensure that the world community maximizes the contribution of nuclear technologies to development and human well-being and minimizes the risks to human health and the environment.

The following sections of our report provide specific recommendations for achieving the goals of these four partnerships, particularly (though not exclusively) focusing on the role the IAEA should play. These goals can be expressed by three “yes’s” and three “no’s”:

- A safe and secure expansion of nuclear energy for countries that seek it
- Enlarging the contribution of nuclear applications to human well-being
- Substantive and rapid progress in nuclear disarmament
- No nuclear proliferation
- No nuclear terrorism
- No nuclear accidents.

These propositions lead us to say a final “yes:” to a stronger IAEA, with the authority, information, technology, high-quality personnel, and resources it needs to help build the reinforced nuclear order that is required.

3. A Safe and Secure Expansion of Nuclear Energy for Countries that Seek It

Planning for the growth of nuclear energy is accelerating, as was noted in Section 1 above. China, India, Russia and South Africa in particular are planning large programs to build new nuclear power plants. In the United States, utilities are planning new nuclear reactors for the first time in many years. New nuclear projects are planned in as many as half the European Union member states. Japan and South Korea are pursuing expansion programs. Many developing countries have announced plans to build nuclear power plants.

The expected growth in nuclear energy will inevitably place new demands on the IAEA, requiring expanded resources. The Agency must continue its work on developing safety standards particularly for the benefit of newcomers in the use of power plants for electricity generation. If states without nuclear weapons do not establish new fuel-cycle facilities, the additional demands for safeguards may be modest, but there will nonetheless be substantial growth in the need for the IAEA to help establish national frameworks and infrastructure for the safe and secure use of nuclear energy. To meet these needs, the Agency will require additional resources for its departments concerned with nuclear energy and technical cooperation.

The economics of complex and sensitive nuclear fuel-cycle facilities (for uranium enrichment or spent fuel reprocessing) do not warrant a multiplication of these facilities. They rather call for establishing large-scale multinational facilities in a limited number of locations that are optimized to respond to worldwide needs. Countries that choose to develop nuclear energy without investing in such facilities must be assured that at all times they will be able to obtain the necessary supplies to operate their reactors over the long term.

The continued effective operation of the world's fuel-cycle market provides the first and basic level of supply security on reliable and competitive terms. The suppliers' responsibility is to serve the competitive world market, and to offer long-term supply contracts with attractive and reliable terms. The security of supply achieved by such long-term contracts would be enhanced if supplier states were to grant guaranteed generic export licenses, underpinned by a legally binding commitment not to revoke such licenses provided the recipient country continues to meet its non-proliferation obligations, as determined by the IAEA.

The leading fuel-cycle supplier states and the Agency are currently working to establish additional mechanisms for assured fuel supply, including two more layers of guarantees: a collective guarantee by suppliers (industry and states) in case of a contract disruption for political reasons other than nonproliferation; and an IAEA-controlled inventory of enriched uranium that could be used as a last resort, with associated arrangements to provide assurances regarding fuel fabrication.

Such mechanisms would help countries have access to nuclear power while reducing the need to construct proliferation-sensitive facilities themselves. Countries should not be asked, however, to give up their legal right to develop such facilities.

Other initiatives are in progress to promote international cooperation for the safe and secure expansion of nuclear energy. Russia has launched a number of proposals, stretching back to President Putin's speech at the United Nations Millennium Summit of September 2000, which called for a new, safe, and secure approach to nuclear energy. More recently, Russia proposed the development of a global network of international fuel-cycle centers that could provide assured fuel-cycle services to nuclear reactors throughout the world without spreading sensitive technologies. Russia has established the International Enrichment Center at Angarsk, offering interested nations the opportunity to participate in the Center's management and profits without accessing the technology, much as the EURODIF consortium has done in France since the mid-1970s. Urenco represents a somewhat different multilateral approach in which the participants share the technology, but following a recent agreement the technology is now confined to a single entity under the control of the Cardiff Treaty among France, Germany, the Netherlands, and the United Kingdom.

The IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) brings many states together to consider approaches to safer, cheaper, more secure, and more proliferation-resistant nuclear systems, with effective management of nuclear waste. The United States and a group of other leading nuclear technology states have established the Generation IV International Forum to develop the next generation of nuclear reactors and fuel cycles. In 2006, the United States proposed a Global Nuclear Energy Partnership (GNEP), and a group of states has now agreed to a GNEP statement of principles focusing on cooperating in the safe, secure, and proliferation-resistant development of nuclear energy. The leading fuel-cycle suppliers and the IAEA are working to establish multinational mechanisms for assured fuel supply.

Germany has proposed the establishment of an international enrichment facility under fully international control; Austria has proposed placing all transactions regarding nuclear fuel under the auspices of a Nuclear Fuel Bank; the United Kingdom has put forward the Enrichment Bond initiative to provide robust back-up guarantees against politically motivated interruptions of enrichment supply; Japan has proposed to take care of all front-end activities of the fuel cycle and to entrust the IAEA with the task of further improving the transparency of the market. As is pointed out in Section 6 of this report, the multilateralization of the nuclear fuel cycle would also make a decisive contribution to nonproliferation efforts.

At their 2006 energy summit, the G-8 countries strongly supported international cooperation to develop and expand nuclear energy. Such developments and expansion require efficient management of natural resources and of radioactive wastes – which may include extensive recycling to better use the energy contained in uranium and to reduce the volume and radio-toxicity of the ultimate waste – and appropriate conditioning and engineered technologies for waste disposal.

Developing solutions to the nuclear waste problem that are sustainable and acceptable to the public is essential. The IAEA has an important role to play in fostering international cooperation, reviewing national approaches, building international consensus, and communicating to the public a balanced assessment of the solutions and risks involved. States are pursuing different approaches to the nuclear fuel cycle. Whatever approach they take, they must adopt and maintain the highest standards of safety, security, and proliferation-resistance. Through programs like INPRO, the IAEA can play a key role in establishing international approaches and criteria that help ensure that such standards are maintained.

National governments, private companies, and consortia among them will lead in developing and deploying new nuclear energy systems. But the IAEA must play a central part in setting the standards and establishing the frameworks that could allow nuclear energy to grow safely, securely, and with minimum proliferation risk.

Continued and expanded contributions from the IAEA in the following areas will be indispensable:

- Setting safety, security, and nonproliferation standards, helping states to meet them, and reviewing states' performance in implementing them.
- Assisting "newcomer" states in energy planning and decisions on whether to pursue nuclear energy, and, at these states' request, providing technical support for establishing appropriate infrastructure, regulations, cadres of trained personnel, and safety culture.
- Promoting international exchange of ideas, experience, and critical data.
- Promoting the development of technological solutions that enhance the sustainability, economics, safety, and proliferation-resistance of nuclear energy systems and reduce their generation of long-lived waste.
- Encouraging the development of – and possibly managing – new forms of international and regional cooperation on nuclear energy, including new mechanisms for assured fuel supply, internationally controlled fuel-cycle facilities, international consortia to provide comprehensive services for nuclear energy, international sharing of nuclear reactors, and, in the future, international facilities for storing spent fuel, retiring nuclear waste, and storing fissile material.

Recommendations

- International cooperation should be strengthened immediately to ensure that an expansion of nuclear energy will be safe and secure and will not contribute to weapons proliferation.
- The IAEA should encourage "newcomer" states that have not yet done so to sign and ratify all international conventions related to nuclear energy, so they can benefit from the harmonized dispositions that those conventions provide in developing the institutional framework and infrastructures they need for introducing nuclear energy.
- The IAEA – using its document *Milestones in the Development of a National Infrastructure for Nuclear Power*[5] as a framework, and working with supplier states and donor states – should help "newcomer" states to consider their options; to put in place the necessary infrastructure to develop nuclear energy safely, securely, and peacefully; and to launch their nuclear energy programs. In particular, the Agency can help these states in: (a) energy planning; (b) nuclear law and regulations, including the establishment of effective and independent nuclear regulatory authorities; (c) preparation for waste management and environmental protection; (d) site selection; (e) safety and security standards and culture; (f) personnel training; (g) quality assurance; (h) understanding available financing options; (i) best practices; (j) operating technology; (k) nuclear knowledge management; and (l) management efficiency. This assistance can be optimized by coordination with efforts that are underway under cooperation agreements between supplier and recipient states.
- The IAEA should continue to work with member states and industry to coordinate and influence research and development on nuclear energy and to promote international cooperation on advanced nuclear science and technology. It should encourage states to design the highest levels of safety, security, and proliferation-resistance (including safeguardability) into new nuclear systems from the outset. Programs such as INPRO are important in this regard, and should be continued. The IAEA should continue to support R&D in member states on a wide range of next-generation nuclear energy options, including fast reactors, high-temperature reactors, small factory-built sealed-core reactors, and accelerator-driven systems, among others. Further, R&D should be promoted to advance the technologies for closing the nuclear fuel cycle and for the use of thorium to solve many of the challenges of enhanced nuclear deployment. Such R&D should include nuclear systems for electricity generation, but also for hydrogen production and water desalination; it should also include innovative approaches to the fuel cycle that may improve economics, safety, proliferation-resistance, or waste management. The IAEA should also continue to support international R&D on nuclear fusion, which may be an important energy option for the longer term.
- The IAEA should enhance its cooperation with scientific organizations such as the International Council for Science (ICSU), the InterAcademy Council (IAC), and the InterAcademy Panel on International Issues (IAP), with a view to encouraging nuclear scientists to work on research of relevance to the IAEA. The Agency would also benefit from the development of a network of scientists interested in the cutting-edge issues of energy.
- The IAEA should expand its efforts to help states establish safe and sustainable approaches to managing spent fuel and nuclear waste, including recycling and waste minimization, and to build public and international support for implementing these approaches.
- International initiatives and cooperation should be encouraged to assure nuclear fuel supply to countries without increasing the risks of spreading sensitive technologies. To this end, the nuclear industry should maintain the existing trend towards assured long-term supply contracts that provide assurances of fuel-cycle supply through market mechanisms; fuel-cycle suppliers should enter into collective arrangements to step in and provide services in the event of an interruption in supply. Supplier states should develop and adopt a generic export license system guaranteeing that supply will not be interrupted except in the case of a breach by the recipient country of its nonproliferation obligations, as determined by the IAEA. The IAEA should encourage these

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[5] *Milestones in the Development of a National Infrastructure for Nuclear Power.* Vienna: IAEA, 2007.

arrangements for assured supply, and play a leading role in backing them up. This could be done, as a last resort in the near term, by means of international banks of enriched uranium and associated arrangements to provide assurances regarding fuel fabrication as a last resort backup to a layered network of fuel assurance mechanisms. This would boost countries' confidence that they can rely on nuclear fuel supplies without building their own fuel-cycle facilities. The IAEA Board of Governors should give high priority to the establishment of a multi-layer fuel-cycle supply assurance mechanism.

- The IAEA should also encourage the establishment of internationally owned and controlled fuel-cycle centers, and promote a steady trend toward increasing the multilateral or international ownership and control of enrichment and reprocessing worldwide. These steps would significantly contribute to international nonproliferation efforts and allow more countries to take part in owning and profiting from such facilities without spreading sensitive dual-use technologies.
- To run a nuclear facility efficiently and prevent it from spreading technologies that could contribute to nuclear weapons programs will always require a single manager. But, to quote IAEA Director General Mohamed ElBaradei, the ultimate goal "should be to bring the entire fuel cycle, including waste disposal, under multinational control, so that no one country has the exclusive capability to produce the material for nuclear weapons."[6]
- The IAEA should encourage the establishment of mechanisms for fuel leasing or spent fuel take-back, and for multinational or international spent-fuel storage, processing, or disposal sites, so as to optimize the geographical or geological location of such sites and the costs associated with developing them. (The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management recognizes that each state that generates nuclear waste bears the responsibility for managing it safely, but also recognizes that in some cases this responsibility can be discharged through international cooperation.) Assured arrangements for fuel leasing or spent fuel take-back would provide a powerful incentive for countries to rely on the world market for fuel-cycle supply, rather than establishing at great cost their own sensitive dual-use facilities. Reactor-leasing arrangements, focused on factory-built reactors that already contain lifetime cores of fuel, should also be explored.
- Member states, industry, and the IAEA should work together to establish multinational partnerships to provide standardized, factory-built, medium and small reactors with extremely high levels of safety and security to any countries that wish to acquire them. The reactors should be provided with comprehensive fuel services. Consideration should be given to implementation models that might make the benefits of nuclear energy available even to states that lack the expert personnel and infrastructure needed to build or operate reactors on their own. Nuclear supplier states and international financial institutions should consider providing financing for such efforts. Such financing should include paying for the necessary IAEA services throughout the life cycle of these projects. Potentially, such comprehensive services could be made so attractive that few states would want to follow any other approach, thus yielding a wide array of advantages for safety, security, and nonproliferation.
- The IAEA should work with states to encourage the establishment of shared regional nuclear plants. These can help countries whose electricity demand or power grid is too small to justify their own large baseload plants to access nuclear energy, if they so wish.
- In cases where neighboring states disagree over the safety, security, and impact of nuclear facilities, the IAEA should be prepared to take a role in mediating and providing objective assessments if the concerned states ask it to do so.
- The IAEA should help states around the world with knowledge management in high-technology nuclear-related areas.

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[6] Mohamed ElBaradei, "Reviving Nuclear Disarmament," conference on "Achieving the Vision of a World Free of Nuclear Weapons," Oslo, 26 February 2008.

- To further the considerable work being done to develop international nuclear safety standards and common practices, the IAEA should promote the harmonization of certification processes for new reactor models. This would allow beneficial sharing of safety approaches and help to optimize the subsequent work of safety authorities in different countries that are deploying the same reactor designs.
- The IAEA should work with member states to prepare better estimates of the global resources of uranium likely to be available at different prices as technology and exploration advance, including more rigorous assessments of the potential for recovering uranium from unconventional sources (including low-grade terrestrial deposits, phosphates, and, eventually, seawater). In parallel, the IAEA should work with member states to explore world thorium resources and to coordinate research and development on thorium fuel cycles.
- The IAEA should prioritize those areas where it can make the most difference, especially where the activities of member states and the private sector leave significant gaps.

4. Enlarging the Contribution of Nuclear Applications to Human Well-being

Nuclear technologies and techniques can offer vital benefits for improving human well-being throughout the world: fighting disease, helping to grow food, addressing food security and safety, managing safe water and other natural resources, and more. In the near term, these will be the areas where nuclear technologies can make their biggest contributions to helping the world's poor.

As part of its statutory mandate "to accelerate and enlarge the contribution of atomic energy to peace, health, and prosperity throughout the world," the IAEA has a key role to play in helping developing countries make use of nuclear technologies. Yet in recent years, the Agency's target budgets for technical cooperation have fallen short even of zero real growth, and a substantial number of approved projects have gone unfunded.

The IAEA's work in helping developing countries with nuclear applications is important not only for its direct contribution to human well-being but also because it helps to build broad support for the Agency itself and its larger energy, safety, security, and nonproliferation missions. For the majority of member states, which have no nuclear power reactors, technical cooperation in applications of nuclear techniques in agriculture, human health, industry, environment, hydrology, or biological and physical research is a primary benefit of membership in the IAEA. These programs are crucial to making the Agency relevant to the entire human family. Developing countries have seen the advantage of couching their demands for technical assistance within the larger context of the Agency's immediate need to deal with proliferation, security, and safety issues, and the Agency has responded with a careful mix of priorities and programs.

Nuclear technologies are only one part of the broader development agenda, and the IAEA is not the lead international agency for development, health, food, or agriculture. The IAEA therefore must work in partnership with developed countries, developing countries, and international development institutions to ensure that the world community maximizes the contribution of nuclear technologies to development and human well-being – allowing each of the actors to fill the roles for which it is best suited.

Knowledge from the nuclear community is often helpful in pursuing non-nuclear technologies, and the IAEA is the only UN agency with the necessary nuclear knowledge. Within the energy sector, the nuclear community around the world, which the IAEA is uniquely positioned to network, can contribute significantly to other technologies. In renewable energy technologies, for example, the nuclear community's extensive knowledge is a valuable resource in areas such as thermal engineering, materials, and computational fluid dynamics. Outside the energy sector, in many applications the nuclear component may be only a small part of the whole effort but it may be crucial to success.

In human health care, nuclear techniques have unique characteristics that make them an essential complement to traditional technologies. Indeed, as populations age and suffer increasing chronic diseases, from cardiac problems to cancer, techniques such as nuclear medicine and radiation therapy will become even more important in providing earlier, more accurate diagnoses and safer, more effective treatments. Nuclear technologies will remain central even while non-nuclear technologies also improve. Already, the largest number of IAEA's technical cooperation projects are related to human health issues. Because no other international organization has the mandate of supporting nuclear applications in human health, wider recognition of the role the IAEA plays will significantly raise the demands for the Agency's assistance.

Nuclear techniques have also contributed significantly to improving global food security and safety. The IAEA, through its partnership with the Food and Agriculture Organization of the United Nations, has played an indispensable role not only in developing nuclear technology but also in building capacity and transferring technology to member states for key agricultural projects. The goals of these projects include improving the efficiency and sustainability of land and water management; breeding new crops with special qualities and adapted to marginal environments; improving animal production and health; controlling insects that are major pests of plants and livestock; and increasing food safety while facilitating international trade.

Global food supplies and agricultural resources will increasingly come under pressure from climate change and an expanded demand for food, feed, and biofuels from a growing world population. Nuclear techniques can be used to provide accurate information on the efficiency of land and water management practices, which can be used to adapt to climate change and enhance food and biofuel production. To preserve agricultural resources and the environment, isotopic techniques will increasingly be important to develop efficient management strategies for water – including groundwater – and soils. The IAEA's activities to induce mutations for improving crop productivity will become more important to develop crop varieties that can grow under the harsher conditions brought about by climate change and on marginal lands not yet exploited for agriculture. Since most of the IAEA's member states do not have the mature capacity to use these nuclear techniques, the involvement of the Agency in building capacity and transferring techniques for more efficient land and water management – which are considered to be in the "public good" domain – will remain crucial for sustainable agriculture and the socio-economic stability of these member states.

Nuclear techniques can also help increase agricultural productivity by reducing the major losses that are caused by plant and animal pests and diseases. Techniques for diagnosing transboundary animal diseases, focusing on nuclear and nuclear-related molecular technologies, will be increasingly important for early and rapid detection in both the laboratory and the field. Area-wide application of the Sterile Insect Technique (SIT) to protect crops and livestock from pests is a unique technology in which the Agency has global leadership and an excellent track record. Expanding international agricultural trade will increasingly require the integration of pre- and post-harvest pest-control measures such as SIT and food irradiation, so that member states can meet regulations for international agricultural export markets.

The optimal role for the IAEA in helping with nuclear applications will change over time. With economic growth and the broad adoption of nuclear technologies in many countries, requests from member states for IAEA work in these areas will increase. But in many mature technologies, developed countries and private firms may be able to provide the necessary technology and expertise. The IAEA's activities should focus on helping with safety and security standards, regulations, and training to ensure that these technologies will be used safely and securely. The IAEA can also develop products and processes for states and development agencies. Regional programs – such as the use of isotope hydrology in the Sahel region to trace and measure groundwater and the use of the SIT to eliminate pests in North Africa – are likely to grow in importance.

The IAEA could significantly enlarge its contribution to human well-being if it can combine a reorientation in its technical assistance – towards helping establish the frameworks for efficient, safe, and secure use of nuclear technologies – with a substantial increase in the technical cooperation budget.

Recommendations

- If the Agency is to fully discharge its mandate to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world, the funding of the IAEA's Technical Cooperation Program should be made more predictable and assured; the Technical Cooperation Fund should be increased substantially.
- Following the examples of the Program of Action for Cancer Therapy and the SIT, wherever possible the IAEA should seek to partner with other organizations that can provide additional funding beyond the Technical Cooperation Fund to help developing countries make beneficial use of nuclear techniques.
- Recipient states should pay some portion of the costs of technical cooperation, on a sliding scale based on ability to pay.
- The IAEA should work in partnership with other development agencies and with member states to direct its development cooperation to areas where nuclear technologies and its own particular capabilities can make a significant contribution to human well-being, such as disease prevention

and control, food safety and security, hydrology, and sustainable management of natural resources and ecosystems. The foremost consideration in planning and administering its technical assistance program should be to ensure a cost-efficient, direct, and measurable impact on the recipient country's priority social and economic needs. The Agency, the country concerned, and international development agencies should be partners in development, and measurable benefits should go to end users such as health professionals and farmers.

- Developed and developing member states and the IAEA should work together to develop nuclear applications that suit the needs of developing countries, by utilizing mechanisms such as coordinated research programs, the IAEA laboratories, and national laboratories and research and development institutions.
- Helping states improve nuclear safety and security, including through careful nuclear waste management, should be a fundamental part of the IAEA's assistance efforts. The implementation of safety and security measures in Agency-sponsored efforts should be subject to rigorous international peer reviews.
- Wherever technologies that could have any application to a nuclear weapons program are involved, the Agency should conduct a thorough proliferation-risk assessment before agreeing to any particular project. Where such risks are involved, the Agency should provide assistance only when appropriate arrangements for managing the risk have been put in place, and the benefits outweigh the remaining risks.
- Use of the SIT for area-wide pest control should be expanded to new species of plant and animal pests, including those causing human diseases.
- The Agency should work with other international organizations to harmonize practices and set the highest health and environmental standards in the field of nuclear applications in food and agriculture.
- The Agency should make greater use of laboratories in member states except where independence and confidentiality concerns would prevent this.
- The IAEA should gradually move from buying and providing equipment to helping states identify the most effective technologies to acquire, and helping with safety and security standards, regulations, and training to ensure that these technologies will be used safely and securely.
- The Agency should help governments and private organizations develop the capability and infrastructure to manage nuclear and radiological applications on their own. It should undertake projects designed to improve the scientific infrastructures of developing countries and help to train and educate their scientists and technicians, and its laboratories should also be used as facilities for training scientists from the developing world. The Agency should have benchmarks for each country to determine the stage at which the country will no longer need IAEA assistance in a particular sector.
- The Agency should share information with other agencies, policy makers, and civil society concerning the benefits and risks of nuclear energy and nuclear applications.

5. Substantive and Rapid Progress in Nuclear Disarmament

The IAEA is not the lead agency or forum for nuclear disarmament; nuclear disarmament negotiations take place between nuclear weapons states, at the United Nations, and at the Conference on Disarmament. But progress toward disarmament, or the lack of it, will deeply affect the success of the IAEA's nonproliferation mission.

Article VI of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) legally obligates the nuclear weapons state parties to negotiate in good faith toward nuclear disarmament, and at the 2000 NPT Review Conference, they agreed that the treaty represented an "unequivocal undertaking" to "accomplish the total elimination of their nuclear arsenals." This commitment is an integral part of the NPT bargain. The need for the NPT to become universal cannot be stressed enough. States must recommit to the vision of a world free of nuclear weapons and take firmer steps in that direction.

True, the nuclear weapons states have significantly reduced their nuclear arsenals since the end of the Cold War. Under bilateral treaties and unilateral initiatives, the United States and Russia have each dismantled thousands of nuclear weapons. France and the United Kingdom have also reduced their much smaller nuclear arsenals, and the United Kingdom has launched an initiative to explore international approaches to verifying disarmament. All of the NPT nuclear weapons states have ceased producing plutonium and highly enriched uranium for weapons, and the United States, Russia, and the United Kingdom have declared portions of their stockpiles of plutonium and HEU to be excess to their military needs and have begun reducing these excess stocks. Indeed, in the US-Russian HEU Purchase Agreement alone, [7] enough HEU for some 13,000 nuclear weapons has already been blended to low-enriched uranium (LEU); in recent years, almost 10 percent of the electricity in the United States has been fueled with material from dismantled Russian nuclear weapons.

But the nuclear weapons states still possess some 25,000 nuclear weapons. The danger of large-scale nuclear war has greatly decreased since the end of the Cold War but it has not disappeared, and these weapons continue to pose an existential threat to civilization. Thousands of them remain on quick-launch alert, placing the human future in the hands of decisions that must be made within minutes and risking nuclear catastrophe from false warnings or fatal miscalculations. Some of the nuclear weapons states have been designing new nuclear weapons and laying plans that will explicitly allow them to maintain their nuclear arsenals indefinitely. The reductions that have occurred have either not been verified at all, or have been verified only between the United States and Russia, offering just limited transparency to the broader international community to confirm that these important steps are being accomplished.

The long-sought and long-promised Comprehensive Test Ban Treaty continues to languish without entering into force, because some nuclear weapons states have failed to ratify it. The Conference on Disarmament has made no progress for a decade, and negotiations for a fissile cutoff agreement have still not begun. Although at the 2000 NPT Review Conference the nuclear weapons states committed to 13 practical steps toward nuclear disarmament, few of those steps have been taken, and at the 2005 Review Conference – which ended in total failure – the official US position was that these steps were no longer relevant. The 2005 United Nations World Summit declaration made no reference at all to disarmament or nonproliferation.[8]

Given these circumstances, the non-nuclear-weapons states believe that the nuclear weapons states are failing to fulfill their Article VI obligations. When many states without nuclear weapons are asked about implementing the Additional Protocol, or phasing out their use of highly enriched uranium, or entering into new multilateral fuel-cycle arrangements, they ask: "what about disarmament?" As urgent as stronger steps may be to stem the spread of nuclear weapons, and as much as they serve the

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[7] This refers to an agreement by which HEU from dismantled Russian nuclear weapons is blended to proliferation resistant low-enriched uranium and sold to the US as fuel for commercial nuclear power plants.

[8] Resolution adopted by the General Assembly, October 24, 2005.
<http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN021752.pdf>

security of all, it is extraordinarily difficult to convince non-nuclear weapons states to commit to strengthening the nonproliferation side of the NPT bargain when they believe that the nuclear weapons states have reneged on the disarmament side of the bargain. When the world's most powerful states give every sign that they consider nuclear weapons essential to their security, they strengthen the hand of nuclear weapons advocates elsewhere.

A world free of nuclear weapons will not be achieved quickly, and will require action by many actors in the international system, going far beyond the mandate and capabilities of the IAEA. New approaches to verifying compliance with treaty obligations, to providing security for states in the absence of nuclear weapons, and to punishing states that violate the regime will certainly be required, and new methods to control the sensitive elements of the nuclear fuel cycle will likely be needed as well. As four senior US statesmen have written, "In some respects, the goal of a world free of nuclear weapons is like the top of a very tall mountain. From the vantage point of our troubled world today, we can't even see the top of the mountain, and it is tempting and easy to say we can't get there from here. But the risks from continuing to go down the mountain or standing pat are too real to ignore. We must chart a course to higher ground where the mountaintop becomes more visible."[9]

States both with and without nuclear weapons must join in a new partnership to strengthen the global nonproliferation regime and take major steps toward nuclear disarmament. Action on both of these fronts serves the security interests of all states. What is needed is an ambitious reinvigoration of the grand bargain that was struck 40 years ago in the NPT. The renewed grand bargain will need to combine steps that can be taken immediately with a vision for the longer term, and to draw in states that are not parties to the NPT. As the four senior US statesmen have argued, "Without the bold vision, the actions will not be perceived as fair or urgent. Without the actions, the vision will not be perceived as realistic or possible."

What the IAEA's future role in disarmament might be remains to be determined. International nuclear verification will certainly be essential as disarmament proceeds, and the IAEA's existing capabilities and experience make it well suited to play a central role in that endeavor. The IAEA was created as a result of US President Dwight Eisenhower's famous "Atoms for Peace" address, in which he envisaged that the United States and the Soviet Union would remove large quantities of nuclear material from their weapons stockpiles and provide them to the Agency to be used for peaceful purposes, linking nuclear arms reductions and peaceful use. The IAEA's Statute requires the Agency to conduct its activities "in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament and in conformity with any international agreements entered into pursuant to such policies."

The IAEA has decades of experience in verifying nuclear material, and it would be logical, as disarmament proceeds, for states to give the Agency a central role in monitoring the huge stockpiles of fissile material that would be freed from nuclear weapons programs. Indeed, under the US-Russia-IAEA Trilateral Initiative, technologies, procedures, and model legal agreements have already been developed that would make it possible for the IAEA to monitor fissile material released from weapons programs without compromising sensitive information – even if the material remains in classified form – and to ensure that the material's removal from weapons programs is legally irrevocable. For other elements of disarmament, such as reductions in delivery systems or the dismantling of nuclear warheads themselves, other verification approaches and institutions may be needed.

Recommendations

- The nuclear weapons states must honor their commitments under Article VI of the NPT. They should recommit to the goal of a world free of nuclear weapons, and to implementing the steps agreed at the 2000 NPT Review Conference.
- As one early step in the transition towards a world free of nuclear weapons, the governments with nuclear weapons should clearly state that nuclear weapons have no purpose except to deter attacks with nuclear weapons, and should commit never to use or threaten to use nuclear weapons against

[9] George P. Shultz, William J. Perry, Henry A. Kissinger, and Sam Nunn, "Toward a Nuclear-Free World," *Wall Street Journal,* 15 January 2008.

states that do not have such weapons. These states should take successive actions to make nuclear weapons increasingly irrelevant to operational military planning and to international affairs.

- Other early steps should include: deep reductions in existing arsenals; removal of all nuclear weapons from quick-launch alert; transparent security and accounting for, and reductions in, tactical nuclear weapons; verifiable dismantling of excess nuclear weapons; secure and verified storage and disposition of all plutonium and HEU not required for remaining military purposes; ratification of the Comprehensive Test Ban Treaty; and a verifiable global treaty ending the production of nuclear materials for nuclear weapons.
- Verification of nuclear arms reductions should be international, to give all states, not just the United States and Russia, confidence that reductions are being carried out as agreed. In particular, the United States and Russia should use the procedures developed in the Trilateral Initiative to place excess nuclear materials under IAEA monitoring, and they should provide the IAEA with enough additional resources to pay for monitoring without reducing its other important activities. The IAEA appears to be the most appropriate organization for verifying an end to the production of fissile materials outside of safeguards.
- States that are not now parties to the NPT should join in a new partnership for disarmament and nonproliferation, capping, reducing, and ultimately eliminating their nuclear arsenals as other states do the same. They should ratify the Comprehensive Test Ban treaty and support the negotiation of a fissile cutoff agreement.

6. No Nuclear Proliferation

Some notable recent victories have been achieved in the effort to stem the spread of nuclear weapons – often with the IAEA playing an important role.

But the nonproliferation regime is under stress. To strengthen the global nonproliferation regime and prevent a cascade of proliferation, the following steps are imperative:

- Strengthened safeguards
- New approaches to managing the nuclear fuel cycle
- More effective export controls and measures to stop black-market networks
- Stronger enforcement (which pertains to the UN Security Council)
- New measures to reduce demand for nuclear weapons.

Strengthened Safeguards

Safeguards are a core mission for the IAEA and must continue to be a central part of its work. The IAEA's greatest asset in this area is the authority, granted by the Statute, the NPT, and by safeguards agreements, for its inspectors to carry out inspections.

The safeguards system has changed drastically in recent years, with the Additional Protocol giving the Agency much broader access to information and sites and the Agency focusing on a more information-driven, country-level approach, designed to increase confidence that no nuclear material has been diverted from declared sites and that there is no evidence of clandestine nuclear activities elsewhere.

The IAEA's authorities, technologies, personnel, and resources should be reviewed with a view to further increasing the effectiveness of IAEA safeguards. Dozens of parties to the NPT still lack even a comprehensive safeguards agreement, and several states with important nuclear activities have not yet accepted the Additional Protocol. The growth and spread of nuclear power generation – and particularly the establishment of new facilities for uranium enrichment, spent-fuel reprocessing, or processing of direct-use nuclear material – will require additional resources for safeguards. Moreover, as has become clear from recent events, sometimes transparency going beyond the measures called for in the Additional Protocol is needed to provide confidence that a state's nuclear program is entirely peaceful. Ultimately, states should agree to incorporate those measures in an "Additional Protocol Plus." The latter would confirm the IAEA's right and obligation to access sites and information related to nuclear material production technologies (such as centrifuge manufacturing facilities) and to nuclear weaponization activities, as well as the Agency's right to private interviews with individuals who may know about such activities.

Recommendations

To strengthen the Agency's ability to provide the necessary confidence, states should agree to give the IAEA access to additional information, sites, and people, along with the money, qualified personnel, and technology that it needs to carry out its mission. The IAEA should take additional steps to strengthen its safeguards culture, and adopt new approaches to recruiting, training, and retaining highly qualified personnel. Each of these issues is treated below.

Access to all necessary information, locations, and people

- All states should ratify the Additional Protocol, which should become the universal standard for nuclear verification. Supplier states should make the Additional Protocol a condition for granting export licenses of nuclear materials, services, and technologies.
- All states should adopt the principle and practice of transparency in their civil nuclear activities, providing the IAEA with access to any information, locations, and individuals in their countries that may help it carry out its mission. States that engage in sensitive nuclear activities, in particular, should offer full transparency concerning all aspects of their civilian nuclear activities, to build international confidence.

- All member states should provide the IAEA with the information it needs to do its job – including data on exports and imports of nuclear and related technologies, export denials, inquiries, and suspicious procurement attempts; information that states may have available from other sources; relevant police information, as appropriate; and more.
- The IAEA's existing authorities should be interpreted to give the Agency the responsibility to inspect for indicators of nuclear weaponization activities. The Agency should establish a small team of qualified specialists for that purpose.

Safeguards technologies

- Member states and the nuclear industry should increase their investment in developing new technologies to make safeguards more effective and efficient, and should establish mechanisms by which the Agency can commission development work to provide the technology advances that it needs.
- In particular, the IAEA should work closely with member states and industry participants that are developing new fuel-cycle processes, such as those proposed in INPRO, Generation IV, and the Global Nuclear Energy Partnership, so that effective safeguards, nonproliferation, and physical protection measures can be designed into such new systems from the outset.
- Additional resources should be provided for the IAEA's Safeguards Analytical Laboratory, to bring the lab to modern standards and allow it to do its job effectively. The IAEA should revise its personnel procedures to make it possible to attract highly qualified personnel for the laboratory.

A strengthened safeguards culture

- A strong safeguards culture is critical to the success of IAEA safeguards. The IAEA should perform regular in-depth assessments of its safeguards culture – just as it recommends that nuclear facilities regularly assess their safety culture – and take steps to correct any weaknesses identified.

Recruiting, training, and retaining qualified safeguards personnel

- The IAEA should launch a substantial campaign to recruit, train, and retain the highly qualified personnel needed to carry out its safeguards responsibilities.
- Member states should launch initiatives to attract and educate the next generation of specialists in safeguards-related technologies and give them incentives to pursue careers with the IAEA.

New approaches to managing the nuclear fuel cycle

The key technical challenge in a nuclear weapons program is to produce the needed nuclear material: highly enriched uranium or separated weapons-usable plutonium. It is important to restrain the spread of the technologies needed to make these materials but without taking away any state's sovereign rights to make its own fuel-cycle decisions.

The Commission's recommendations on fuel-cycle supply assurances, multilateral fuel-cycle approaches, fuel leasing and take-back arrangements, and other measures in this area, which can make an important contribution in the field of nonproliferation, were discussed in Section 3.

More effective export controls and measures to stop black-market networks

The experience of a global black-market nuclear network operating in some 20 countries for decades before it was shut down makes clear that additional steps are needed to control sensitive nuclear and dual-use technologies and prevent illicit technology networks from operating. One important new tool is UN Security Council Resolution 1540, which legally obligates all UN member states to provide "appropriate effective export controls, border controls, and transshipment controls." The IAEA has already begun to assist states to improve their export and import control systems.

Recommendations

- Early steps should include: all states putting in place effective export, border, and transshipment controls as required by UNSC 1540; expanded IAEA assistance in this regard, including development of model legislation; expanded international police, intelligence, and export-control cooperation, focused on stopping and preventing black-market nuclear networks; and an expansion of the IAEA unit focused on black-market technology networks, along with an expansion of its mission to include helping states to shut down these networks and find and fix leaks in their control systems. Governments and private firms with sensitive technologies should strengthen their partnerships to help these firms build strong internal compliance programs and give them incentives to provide key information on suspicious inquiries and procurements. Current international efforts to interdict money laundering and terrorist financing should be expanded to include interdiction of financing for illicit nuclear transactions.

- States should participate, within the limits of their capabilities, in voluntary initiatives such as the Global Partnership against the Spread of Weapons and Materials of Mass Destruction, and the Proliferation Security Initiative.

New measures to reduce demand for nuclear weapons

Controls on supply can only slow, not stop, the spread of nuclear weapons. Ultimately, the key is to reduce states' demand for nuclear weapons. This approach has been far more successful than is often realized. The vast majority of the world's states have concluded that their security is better served without nuclear weapons. Nevertheless, recent international events may have strengthened demand for nuclear weapons in some states, and action is needed to reduce this demand.

Recommendations

- The UN Security Council should go beyond its Resolution 1540 by: passing a new resolution making clear that the proliferation of nuclear weapons is a threat to international peace and security; legally prohibiting any state that withdraws from the Nonproliferation Treaty from using for military purposes any nuclear facility, materials, or technologies that it received for peaceful purposes while a party to the NPT; and legally imposing safeguards obligations, going well beyond the Additional Protocol, on any state that substantially violates its safeguards obligations.
- Steps are needed to devalue nuclear weapons – that is, to reduce their strategic, reputational, and diplomatic value. Nuclear weapons states must renew their commitment to nuclear disarmament and take steps in that direction in the near term.
- The major powers should reaffirm their obligations under the UN Charter not to use or threaten to use force against states that have not attacked them and do not pose an imminent threat.
- All states should work to resolve major global or regional conflicts that drive demand for nuclear weapons.
- States should ratify and bring into force the nuclear weapons-free zones that have been negotiated, and negotiate to create additional such zones.
- All states should work together to begin building new structures of international security that can give increased confidence to states around the world that threats to their security will be effectively addressed.

7. No Nuclear Terrorism

Since the 9/11 attacks in the United States, a great deal has been done to reduce the danger of nuclear or radiological terrorism. Individual states and cooperative programs have dramatically improved the security of nuclear stockpiles and facilities in the former Soviet Union and elsewhere around the world. Controls over radiological sources are improving in many countries. New international instruments have been put in place, including the Code of Conduct on the Safety and Security of Radioactive Sources, the amended Convention on Physical Protection of Nuclear Materials and Nuclear Facilities, the International Convention for the Suppression of Acts of Nuclear Terrorism, and more. Voluntary initiatives such as the Global Threat Reduction Initiative (focused on removing highly enriched uranium from sites around the world and improving security for research reactors and radiological sources) and the Global Initiative to Combat Nuclear Terrorism are engaging scores of countries around the world in efforts to reduce the danger of nuclear terrorism.

UN Security Council Resolution 1540 requires all states to establish “appropriate effective” laws prohibiting acts related to nuclear, chemical, or biological terrorism; to take “appropriate effective” measures to account for and secure toxic biological and chemical agents and fissile materials and provide “appropriate effective” physical protection for them; and to put in place “appropriate effective” border control and law enforcement efforts to interdict illicit trafficking in such items. A Security Council committee reviews states’ reports on their implementation of this resolution, and the IAEA has been providing advice and limited assistance in several areas covered by the resolution. But much more remains to be done.

Across the globe, the danger of nuclear and radiological terrorism remains very real. Some terrorist groups are actively seeking nuclear weapons and the materials and expertise needed to make them, and the seizures of stolen or lost material that continue to occur show that some of these materials remain vulnerable to theft.[10] Moreover, attacks on nuclear facilities have occurred in the past, and terrorists have repeatedly considered attempting a major sabotage of a nuclear power reactor, or spreading radioactive material with a so-called “dirty bomb.” Proper account should be taken of the fact that terrorist groups, including potential users of nuclear arms or materials, tend to flourish in countries where the state has been weakened by conflict.

Though nuclear security is fundamentally the responsibility of individual states, the IAEA has an important role to play in addressing these threats. It is the only global body with relevant competence and expertise relied on by a wide range of states. IAEA recommendations and standards, IAEA-led international reviews, and IAEA assistance to member states form useful parts of the evolving global nuclear security framework. The Agency has greatly expanded its nuclear security work under a series of nuclear security action plans. The IAEA actively helps member states to enhance nuclear security through capacity-building activities such as training, regulation development, exercises, reviews, and more. It is also helping to coordinate national, donor-state, and international nuclear security programs, to close gaps and reduce overlaps.

Here it is important to emphasize that nuclear material held under safeguards is not secured against theft. Despite their name, IAEA safeguards are not designed to ensure either safety or guarding. The purpose of safeguards is to *detect* any diversion of nuclear materials to military purposes by the safeguarded state; IAEA inspectors can detect a theft as readily as a diversion, but they cannot prevent material from being stolen. No program exists in which safeguards inspectors systematically report any security weaknesses they may observe, because the Agency’s safeguards agreements with member states require – in return for the authorization for inspectors to go to facilities to implement safeguards – that the Agency use the information only for safeguards purposes and keep it confidential.

Recommendations

- Member states should agree to give the IAEA an important role in helping them to define and put in place national security standards that are consistent with the International Convention on Physical Protection of Nuclear Materials and Facilities. Over time, with the Agency’s technical

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[10] Bunn, op. cit.

support, states should negotiate binding agreements that set effective global nuclear security standards and give the IAEA a precise mandate to confirm that these standards are being implemented.

- Within the constraints of necessary secrecy, measures should be developed to give all states confidence that other states are implementing the agreed standards. Ultimately, international reviews of both safety and security should become a regular part of business at nuclear facilities with HEU or separated weapons-usable plutonium, and at nuclear facilities whose sabotage could have widespread consequences, as well as at entities that transport HEU or separated weapons-usable plutonium.
- Every nuclear weapon and every cache of HEU or separated weapons-usable plutonium worldwide must be protected by security measures that can reliably defeat the threats that terrorists and criminals have shown they can pose. Nuclear facilities or parts thereof whose sabotage could have widespread consequences should receive similar protection.
- The nuclear industry should continue to emphasize a philosophy of sustained improvement in nuclear security, as it has in nuclear safety. The global nuclear community should lead an international effort to promote best practices in nuclear security, for example through a new organization such as the World Institute for Nuclear Security (WINS) proposed by the Nuclear Threat Initiative with broad international support.
- All states should implement the requirements of UNSC 1540. The IAEA should work with member states and with the Security Council's 1540 Committee to define what elements must be in place in order for nuclear physical protection, material accounting, and border control systems to be considered "appropriate effective" as required by UNSC 1540. It should work to establish mechanisms to review whether states have these essential elements in place and should help, where necessary, to put them into place. It should develop model legislation to help states fulfill their UNSC 1540 obligations to enact national laws that effectively prohibit acts related to nuclear terrorism and nuclear smuggling; such legislation should include severe criminal penalties.
- The IAEA should continue to develop the broad range of recommendations and standards related to nuclear security that are needed to build an appropriate global nuclear security framework, and should continue to develop and implement integrated nuclear security support plans for member states. These plans should be designed to build the capacity and commitment of states to sustain effective nuclear security measures with their own resources over the long haul. The IAEA should also continue to promote the broadest possible exchange and implementation of best practices in nuclear security.
- All states with nuclear weapons, HEU, or separated weapons-usable plutonium on their soil should seek to consolidate these stocks at the smallest practicable number of secure sites. Research reactors using HEU as fuel or targets for medical isotope production[11] should be converted to use low-enriched uranium or should be shut down. The IAEA, working with public and private donors, should assist states in these consolidation efforts, including converting HEU-fueled research reactors, returning HEU to the country of origin or to other secure locations, and providing assistance and incentives to encourage underutilized research reactors to shut down and allow any HEU they may have to be removed.[12] Addressing the issues posed by underutilized research reactors is also important for nuclear safety.

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[11] Some research reactors use HEU as their fuel. Others use LEU fuel, but insert HEU as "targets:" that is, the HEU is bombarded with neutrons in the reactor, producing various fission products, including Molybdenum-99, the most important medical isotope. Enough 90 percent enriched HEU to make two or three terrorist bombs is shipped from place to place each year for medical isotope production. The "waste" from this process remains essentially weapons-grade uranium, and is hardly radioactive at all, making this, too, a theft concern. Since medical isotopes can easily be made with LEU, this use of HEU ought to be phased out.

[12] In 2002, for example, cooperation among the governments of Yugoslavia, Russia, and the United States, the IAEA, and the private Nuclear Threat Initiative (NTI) made it possible to airlift 48 kilograms of 80 percent enriched HEU from a potentially vulnerable research reactor near Belgrade, eliminating a potential nuclear terrorist threat. A promise of assistance with the management of spent fuel and radioactive waste at this site, initially financed by NTI, proved to be an essential incentive for Yugoslav participation in this effort, and the IAEA continues to play a leading role in implementing this assistance and coordinating additional donations to address these issues at the site.

- All states should agree to phase out the civil use of HEU wherever practicable; to end further production of HEU for any purpose; and to reduce accumulated stockpiles of separated weapons-usable plutonium and HEU, both military and civilian, as rapidly as practicable.
- All states should strengthen international cooperation to detect and disrupt terrorist nuclear plots, establish police and intelligence units trained and equipped to deal with nuclear smuggling and nuclear terrorism, and put in place effective systems to detect attempts at nuclear smuggling.
- The IAEA should expand its efforts to ensure effective security for the most dangerous radiological sources worldwide, to recover and secure "orphan" sources (those no longer controlled by their original owner), to help states substitute less dangerous technologies where appropriate, and to reduce the danger of a possible "dirty bomb" attack. It should also increase the priority it gives to preventing nuclear smuggling – devoting more resources, highly qualified personnel, and leadership attention to this issue. Sufficient resources should be provided, for example, to conduct in-depth investigations and analyses of the most important nuclear smuggling cases.
- The new version of the IAEA's recommendations for physical protection of nuclear material, now being discussed, should include a minimum level of threat against which all nuclear material that could be used to make a nuclear bomb should be protected. Such a minimum threat to be defended against should also be considered one of the essential elements of an "appropriate effective" physical protection system as required by UNSC 1540. The new recommendations should also specify more detailed steps for preventing sabotage.
- It is imperative and urgent that the IAEA establish a regular process by which safeguards inspectors would report to the IAEA Office of Nuclear Security any nuclear security weaknesses they observe, with appropriate confidentiality. Preventing use of nuclear material by terrorists should be seen as part of preventing use for "any military purpose," which is the statutory purpose of safeguards. In this way, the sharing of information by inspectors will be possible under existing safeguards agreements. Safeguards inspectors should be trained to help them play this role.
- The IAEA should work with member states to construct expanded international databases on nuclear material characteristics for nuclear forensics (the effort to examine the characteristics of seized or exploded nuclear materials to help understand where they may have come from). Such a database should draw on the Agency's extensive safeguards data on nuclear materials in many states, with appropriate confidentiality, if the Agency determines that this is possible under the terms of existing safeguards agreements or can get the permission of relevant states.
- The IAEA should expand its nuclear security training and capacity-building efforts. Achieving the goals outlined above as the use of nuclear energy and nuclear applications expands around the world will require training large numbers of experts in several different fields of nuclear security.
- Because nuclear security measures will never be perfect, the IAEA should continue its efforts to help states prepare to cope with the consequences of a radiological dispersal. The IAEA should expand the capabilities of its Incident and Emergency Response Center, and will need additional funding for this purpose. Most of the needed response capabilities will be equally applicable to either an accident or a terrorist attack. Effective plans for public communication in such a crisis are particularly critical, to reduce the likelihood of panic.
- All states should sign, ratify, and implement the amended Convention on the Physical Protection of Nuclear Materials and Nuclear Facilities and the International Convention on the Suppression of Acts of Nuclear Terrorism, and should implement the Code of Conduct on the Safety and Security of Radioactive Sources.
- States should participate, within their capabilities, in voluntary initiatives such as the Global Initiative to Combat Nuclear Terrorism and the Global Threat Reduction Initiative, as well as in other international cooperative programs to improve nuclear security measures.

8. No Nuclear Accidents

As Chernobyl showed, a nuclear accident anywhere is a nuclear accident everywhere.[13] A major accidental release of radioactivity could cause widespread suffering and economic disruption, and undermine prospects for large-scale growth in peaceful nuclear applications. Member states and the IAEA must do everything they can to ensure that such an accident never occurs again.

Fortunately, nuclear safety has improved dramatically in recent decades, as shown by a wide range of national and international safety indicators. Nuclear operators bear the fundamental responsibility for safety, and they, along with national nuclear regulators, have played the leading role in achieving these global safety improvements. But many other actors have also contributed: the IAEA; nuclear industry designers and builders; associations such as the World Association of Nuclear Operators (WANO); other international agencies, such as the Nuclear Energy Agency of the Organization for Economic Cooperation and Development; other non-government organizations; and the press and the public.

The IAEA plays a wide range of important roles in supporting nuclear safety around the world. It:

- Develops and publishes crucially important safety standards, recommendations, and guides.
- Serves as the depositary for nuclear safety conventions, and helps to develop new instruments as necessary.
- Organizes international reviews of the safety of particular facilities at the request of member states; these reviews have led to major improvements in safety at many facilities.[14]
- Helps coordinate assistance to member states in improving safety measures.
- Helps coordinate exchanges of best practices, experience, and lessons learned.
- Collects and analyzes a wide range of international data important for safety.
- Organizes studies and discussions of key safety issues.

Looking ahead, if the number of nuclear power plants around the world is to grow substantially without increasing the total risk of a nuclear accident, the risk of an accident at any given reactor must continue to be reduced. As additional countries build nuclear power plants, it is essential that they establish strong safety measures, including competent, effective, and independent national regulators.

The world is still a long way from a regime of mandatory, effective global safety standards and comprehensive reviews of performance in meeting them. The IAEA roles in maintaining and continuously improving the global safety regime that emerged after Chernobyl are particularly critical, and must continue to be strengthened and expanded to ensure nuclear safety and protection from radio-toxicity. For example, IAEA's comprehensive reviews of performance in meeting safety standards should be expanded so as to cover all the world's operating reactors and nuclear installations, including research reactors and fuel-cycle facilities.

The IAEA's role in the peer review process conducted among the contracting parties of the nuclear safety conventions should be increased, and the parties to these conventions should be required to report on the results of the IAEA safety reviews in the national reports they must submit.

Knowledge and experience that contribute to nuclear safety and protection from radio-toxicity are accumulating rapidly, and the process of capturing, analyzing, and widely sharing experiences requires

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[13] Mohamed ElBaradei, "Major Impacts of the Chernobyl Accident", Opening Address at the International Conference, *Chernobyl – Looking Back to Go Forwards: Towards a United Nations Consensus on the Effects of the Accident and the Future*, Vienna, September 6, 2005.

[14] At present, the IAEA is not in a position to comprehensively assess the safety of reactors around the world or identify and address the highest-risk facilities, because all its safety reviews are undertaken purely at countries' discretion. In-depth reviews have been conducted for only a fraction of the world's operating reactors. The IAEA plays only a modest role in the peer review process conducted among the contracting parties of the nuclear safety conventions, and the parties to these conventions are not required to report on the results of the IAEA safety reviews in the national reports they must submit. The coverage of the nuclear safety conventions is still limited, and does not include research reactors or nuclear fuel-cycle installations.

more vigorous international cooperation and leadership. The IAEA has been promoting and assisting the development of regional safety networks, but more remains to be done.

Several initiatives have been launched to harmonize licensing procedures for new reactor designs. They include the European Utility Requirements (EUR) at the European level and the Multinational Design Evaluation Program (MDEP) at the OECD level. These initiatives should be encouraged and expanded, with the full support of the IAEA, as a way to share experience and best practices on safety design and regulation.

Safety is an enabling factor for sustainable use of nuclear technology, and must be embedded in the culture and actions of all individuals and organizations involved in nuclear activities. It is, however, essential to maintain an adequate separation between the promotional and safety aspects of nuclear programs. This will demonstrate the independence of safety decisions and increase public confidence.

Despite all prevention measures, accidents can still occur. Hence it is vital that countries be prepared to respond to such unlikely events. Within the framework of the safety conventions, the IAEA has the important role of coordinating international notification and assistance actions. It has established an Incident and Emergency Response Center, as noted in Section 7 above, but it does not yet have the resources to fully carry out this role.

Recommendations

- The IAEA should lead an international effort to establish a global nuclear safety network and ensure that critical knowledge, experience, and lessons learned about safety are exchanged as broadly as they need to be. This capacity-building effort should include, among other elements, training on the IAEA safety standards and on key safety issues and trends, along with efforts to promote strong safety cultures in all the firms and organizations relevant to nuclear safety.
- National regulatory agencies should continue to strengthen and harmonize their safety standards, with the ultimate objective of achieving a standardized and highly effective system of nuclear safety worldwide. In parallel, and in close consultation with national regulators, the IAEA should continue to consolidate and promote global nuclear safety standards.
- Granting that decisions on nuclear safety ultimately rest with national regulators, over time states should enter into binding agreements to adhere to effective safety standards and to be subject to international peer reviews of nuclear safety. Should peer reviews indicate that a facility poses a high risk of accident that cannot be readily remedied, a recommendation should be made to the pertinent national regulator to shut down that facility.
- Every state making use of nuclear energy should establish the highest nuclear safety regulations, and ensure that its regulatory body has the resources, expertise, independence, and culture required to enforce these rules. The IAEA should expand its efforts to assist states in this regard.
- The IAEA should expand its highly successful program of international safety reviews and encourage peer reviews of national regulators. These safety reviews should also be an integral feature of the national reports of the parties to the nuclear safety conventions.
- All players in the nuclear industry should continue to emphasize constant improvement in nuclear safety at the design, construction, and operation stages. The industry should permanently strengthen its efforts to exchange best practices, lessons learned, and peer reviews, through organizations such as the World Association of Nuclear Operators.
- All states, and in particular those that have or seek a nuclear energy program, should become parties to and abide by the international conventions on nuclear safety and civil liabilities.
- Member states and the IAEA should strengthen and coordinate their critically important efforts to ensure that countries embarking on nuclear power programs develop sound safety infrastructures, including effective and independent regulatory bodies. Companies exporting nuclear reactors should continue their policy of insisting on sound infrastructure and effective regulation in any state seeking a nuclear power plant. The IAEA should coordinate with pertinent public and private institutions to help each country meet its own safety rules and IAEA safety standards. This

coordination should also take into account the interests of the neighbors of the countries embarking on nuclear power programs.

- The IAEA should develop new services for countries with, or seeking, nuclear energy programs in order to support them, their regulators, and their nuclear licensees in building a strong safety culture and acquiring the competences to honor it.
- The IAEA should work with key regional stakeholders to ensure that states adhere to nuclear safety standards and implement them effectively.
- While all major nuclear facilities should be subject to periodic international safety reviews, the IAEA should place its highest priority on identifying and helping to fix the few facilities worldwide that pose the highest risks of a nuclear accident, based on the IAEA safety standards.
- Every state making use of nuclear energy should regularly review the safety culture at all its major nuclear facilities, and require immediate action where the safety culture appears to be weakening. The IAEA should expand its efforts to assist states in assessing and strengthening their nuclear safety culture.
- Member states and the IAEA should support the trend toward standardized reactor designs and the harmonization of certification processes for new models of reactors, which allow sharing of experience and lessons learned that can lead to significantly improved safety.
- The third generation of reactors has been designed to achieve substantially improved levels of safety. Fourth-generation reactors, now being developed, should be designed to achieve still higher safety levels, taking advantage of advances in technology, including employing passive and inherent safety measures to the extent practicable. The IAEA should work more with states developing such next-generation systems toward this end, including through the INPRO program.
- Member states should strengthen their preparedness to cope with nuclear emergencies, and should provide the IAEA's Incident and Emergency Response Center with the resources it needs to play its role as the global hub for emergency preparedness and response to nuclear accidents.
- The IAEA should work with member states to ensure that promotional and safety activities are adequately separated in nuclear programs worldwide and in its own programs.
- Member states and the IAEA should work together to ensure that nuclear safety efforts draw appropriately not only on nuclear experts but also on scientists and engineers from other disciplines.

9. Toward a Stronger Global Nuclear Order and a Stronger IAEA

The record of the IAEA during its first half century speaks for itself. The Agency has pursued with dedication and efficacy its mandate to promote safe, secure, and peaceful use of nuclear technologies through international cooperation, while providing safeguards needed to ensure that facilities for nuclear energy do not contribute to military purposes. The Agency has come to play critical roles in nuclear safety, nuclear security, nuclear energy development, and nuclear applications worldwide. And its objective technical assessments have played a central role in matters of international security.

Over the years, the IAEA has assumed new responsibilities as new opportunities and challenges presented themselves, including the entry into force of the Nonproliferation Treaty (NPT), the development of new technologies, clandestine programs to acquire nuclear weapons in certain states, and the emergence of terrorism. Funding for additional activities has come from diverse sources, some of them voluntary, unpredictable, and with strings attached. The Agency has, however, managed to maintain a certain balance among its statutory activities, and has carried out its diverse responsibilities efficiently and effectively. Uniquely in the UN system, the IAEA's core strength lies in its science and technology abilities.

Looking ahead, the Commission recommends a bold agenda to maximize the contributions to human well-being from nuclear technologies while minimizing the risks, making possible a new era of Atoms for Peace and Prosperity. As outlined earlier in this report, this is a task that goes well beyond the IAEA's mandate and capabilities. The stronger global nuclear order we propose would feature greatly expanded international cooperation and transparency, with new partnerships for nuclear energy, development, disarmament, non-proliferation, safety, and security. It would:

- Help enable a safe and secure expansion of nuclear energy in those countries that seek it, helping to power a growing global economy while mitigating the threat of climate change.
- Make it possible for nuclear technologies to expand their role in saving lives, growing crops, and providing jobs in the developing world.
- Reduce the dangers of nuclear accidents and nuclear terrorism.
- Provide a path toward dramatically reduced dangers to humanity from nuclear weapons and nuclear proliferation.

Modest improvements in existing approaches are unlikely to be sufficient to seize these opportunities or meet these challenges. A bold approach is required, that seeks to address intertwined issues in parallel.

In the stronger nuclear order that we propose, a strengthened IAEA that has adequate resources and can attract and retain the best personnel will be essential. The Agency will face escalating demands in several quarters.

The likely growth and spread of nuclear energy, in response to growing concerns over prices and availability of fossil fuels and the threat of climate change, will increase the demands on the IAEA to:

- Help "newcomer" states establish the necessary infrastructure to develop nuclear energy safely, securely, and peacefully.
- Help strengthen global frameworks for ensuring that nuclear energy growth is safe, secure, and proliferation-resistant.
- Support nonproliferation-oriented mechanisms for assured supply of nuclear fuel, including international banks of enriched uranium and establishment of additional multilateral fuel-cycle centers.
- Help member states with training and nuclear knowledge management.

- Expand its contribution to the development of safe and sustainable methods of managing spent fuel and nuclear waste.
- Help member states coordinate R&D on next-generation nuclear energy systems, which may offer improvements in cost, safety, security, resource management, waste management, and proliferation resistance.
- Assess global resources of uranium and thorium.

Another source of increased demands on the Agency will be the expanding role of nuclear technologies in promoting development and human well-being. The IAEA's technical assistance to developing countries with nuclear applications in health, agriculture, industry, environment, hydrology, and biological and physical research helps to build broad support for the Agency and its larger energy, safety, security, and non-proliferation missions. The IAEA's Technical Cooperation Program needs to be expanded and diversified to ensure it keeps pace with the growth in the Agency's other activities. This will entail a higher outlay and assured funding for nuclear applications and technical cooperation. Demand for technical assistance will always exceed the resources allocated for it, but developing countries' expectations for such support from the IAEA need to be better satisfied in future.

The Commission has dwelt at length on the interrelationship between nonproliferation and disarmament, and urges the international community to take a number of measures to honor its obligations for nuclear disarmament. Substantial steps are needed to strengthen the global effort to stem the spread of nuclear weapons and to move toward disarmament. Stronger measures to prevent proliferation and new steps toward disarmament serve the security interests of all, and neither is likely to be achieved without the other. While the IAEA is not the lead forum or agency for disarmament, perceptions of progress or lack of progress in disarmament directly affect many of the Agency's other critical missions, and with its decades of experience in monitoring nuclear materials the IAEA may have an important verification role to play as disarmament proceeds, requiring substantial additional resources.

Safeguards are a core mission of the IAEA and must continue to be a central part of its work. In fact, the IAEA's safeguards responsibilities have been expanding dramatically. From 1984 to 2007 the amount of nuclear material under safeguards increased from 1,090 to 11,874 "significant quantities" (1089%).[15] Member states have already called on the Agency to implement the Additional Protocol (which inevitably requires additional resources for a period in the transition to integrated safeguards) as well as to pursue a country-level, information-driven approach to safeguards that requires the Agency to examine a broad range of additional types of information, from open sources to satellite photographs, and to track black-market nuclear networks. Further increases for safeguards work will be needed if nuclear energy grows and other circumstances change in the future. Yet, since the mid 1980s, the Agency was, for the most part, subject to zero real growth in funding, the only significant departure being a modest increase approved in 2003. Given these increased responsibilities, a substantial increase in IAEA resources for safeguards is clearly required. IAEA member states should provide the funds needed to ensure that the effectiveness of safeguards is not compromised by lack of resources.

Nuclear and radiological terrorism are serious dangers. Terrorists are actively seeking nuclear weapons and material to inflict catastrophic destruction on their targets. Thefts and losses of nuclear and radiological material point to a continuing need for strengthened security measures. Nuclear security is fundamentally the responsibility of individual states, but the IAEA has a critical role to play by supporting its members in setting security standards and by organizing international peer reviews to confirm full compliance with these standards. Over time, member states should enter into binding agreements that set effective global nuclear security standards, and the IAEA should be given a role in helping to develop these standards and confirming their implementation. The Agency will need additional, and more predictable, resources to fully implement its existing nuclear security responsibilities and to take on an expanded role in this area.

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[15] The IAEA defines "significant quantities" as 8 kilograms of plutonium and 25 kilograms of contained uranium 235 for highly enriched uranium.

Although nuclear safety has improved substantially in recent decades, thanks to the work of nuclear operators and regulators, the IAEA, nuclear vendors, builders, national governments, associations, the press and the public, the highest standards of nuclear safety will be required as nuclear energy grows. The IAEA's role in maintaining, implementing, and continuously improving the global nuclear safety regime is critical and must be strengthened. In particular, in states that are building their first nuclear power plants the IAEA should play a major role in helping to ensure the highest levels of safety and security, including through training and the establishment of effective and independent regulatory bodies. Member states should enter into binding agreements setting effective standards for nuclear safety, as for nuclear security, and regular international nuclear safety peer reviews should become the norm. All of this will require a substantial increase in the Agency's resources focused on nuclear safety.

Effective plans for public communication in a crisis resulting from a nuclear accident are vital to build public confidence and reduce the likelihood of panic. A modest addition to its annual budget would drastically increase the IAEA's ability to meet member state demands for reviews of, and assistance with, emergency preparedness; upgrade its emergency communications capabilities; and strengthen its capability to respond rapidly to a major emergency. The IAEA will also have an important role in coordinating the international response to a nuclear or radiological incident, and further resources are required to expand the capabilities of its Incident and Emergency Response Center.

Seen against the immense consequences for world security, global investment in the crucial mission of the IAEA has been remarkably small. For example, the safeguards budget of the IAEA – which is meant to ensure the security of hundreds of tons of nuclear material in hundreds of facilities in scores of countries – is no larger than the budget of the police department of the city in which the Agency is located. IAEA budgets for nuclear security, nuclear safety, nuclear energy, nuclear applications, and technical cooperation are even smaller. Modernization of the Agency's scientific and information infrastructures is long overdue. The Safeguards Analytical Laboratory alone requires sizeable investments to make it fully functional. In addition to a large deficit for infrastructure and technology investments, the Agency has a significant unfunded liability for health and other benefits for its former employees.

The long-standing policy of "zero real growth" – even while the IAEA's responsibilities have been dramatically increasing – has long ago cut into the Agency's ability to carry out its most critical missions. The increase approved in 2003 helped, but not enough. As early as 2002, a management review conducted by Mannet of Switzerland[16] concluded that, despite its efficient management of resources, the Agency was showing signs of systems stress and could not sustain its achievements or respond to increasing demands without concomitant increases in resources.

Member states have helped to address the IAEA budget problem by providing extra-budgetary contributions for particular purposes, such as inspection equipment and measures for preventing nuclear terrorism. In recent decades, these contributions have been critical to the Agency's ability to respond to new challenges. For example, more than 90 percent of the IAEA's funding for preventing terrorism currently comes from voluntary contributions. Most such contributions are highly unpredictable, making it very difficult to make long-term plans and hire permanent staff. Moreover, voluntary contributions are often tied to particular projects of interest to the donor, leaving other urgent priorities unfunded.

The IAEA also faces an incipient crisis in staffing. Much needs to be done to ensure that the IAEA is able to attract and retain the top-quality professionals it needs to carry out its multiple missions. Because of its participation in the UN Common System, the Agency has a retirement age of 62 years for most staff and only 60 years for a quarter of the staff. Half of its top management and its senior inspectors are expected to hit this limit and retire in the next five years. Several factors make it difficult for the IAEA to recruit and retain the experts it needs, particularly in highly technical specialties that are in demand in the private sector. These include the IAEA's policy of offering only three-year initial contracts (which may be extended to five or seven years, and only in limited cases for longer periods), and the Agency's salary structure. The IAEA's personnel policies make it difficult to

[16] "At What Cost, Success", Mannet of Switzerland, 14 October 2002.

hire needed talent quickly, and often result in a replacement arriving months after a key expert has left, resulting in major losses of institutional memory and expertise.

A thorough reform of the Agency's funding has become all the more urgent with the additional tasks that this report envisages for the Agency in 2020 and beyond, to seize the opportunity of Atoms for Peace and Prosperity. Without additional and reliable funding, the IAEA will not be able to:

- Carry out independent analysis of safeguards samples, essential to provide credible verification of the non-proliferation of nuclear weapons. Urgent funding is needed to shore up the failing infrastructure and instrumentation, and ensure the safety and security, of the Safeguards Analytical Laboratory.
- Play its essential role in combating nuclear terrorism and in ensuring the safety of nuclear power plants and other nuclear facilities. The staffing of these vital programs currently has to rely to a very large extent on unpredictable voluntary funding.
- Provide an adequate response, in terms of prompt international coordination and assistance, to a nuclear accident or terrorist act involving nuclear or radioactive material.
- Ensure that the many new countries considering introducing nuclear power programs do so in a carefully planned, and safe and secure, manner.
- Respond to pressing global crises in food security, health and the availability of drinking water through the use of nuclear techniques, for example by helping to ensure transboundary control of insect pests harmful to fruit and vegetables, developing sustainable crop varieties tolerant to harsh conditions, helping address the growing cancer epidemic, especially in the developing world, and underpinning desperately needed improvements in water resources management.
- Meet, in a timely manner, urgent requests relating to verification of non-proliferation. Currently, voluntary funding has to be sought for unforeseen high priority needs.

The needed increase in funding must be accompanied by a renewed and transparent effort by the IAEA Secretariat to improve on the Agency's already impressive record of efficiency. It must seek every opportunity to develop a management culture that emphasizes accountability, readiness to accept change, and effective coordination with other organizations. The IAEA's personnel policies also need reform, to allow the Agency to compete successfully with the private sector to employ the experts it needs.

Recommendations for a stronger IAEA

The Commission's recommendations on actions to reinforce the global nuclear order, including actions to be taken by the IAEA, are offered in the preceding sections of this report. Recommendations for strengthening the Agency are offered below.

- The unique scientific and technological capabilities that the IAEA brings to all its activities should be sustained and enhanced.
- The Board of Governors should agree to provide an immediate one-time increase in the IAEA's budget by €80 million for *inter alia* refurbishing the Safeguards Analytical Laboratory and for adequate funding of the Agency's Incident and Emergency Response Center.[17] The Board should also agree to consistent annual increases in the regular budget to underpin the expansion of the Agency's security and safety work, other activities in support of newcomer states embarking on nuclear programs, and an expansion of work in nuclear applications and technology transfer. The exact amount of additional regular budget should be determined after a detailed review of the budgetary situation and additional workloads of the Agency, but the Commission estimates that increases of about €50 million annually in real terms might be necessary during several years.
- In the longer time frame, the regular budget will need to continue increasing in order to meet the growing demands for IAEA services. A substantially bigger regular budget – by 2020 perhaps

[17] We have taken as credible the figure that was provided in the Director General's Report (footnote 22, page 24, "20/20 Vision for the Future").

twice as large as the present one – would allow the needed expansion of work on nuclear reactors and the fuel cycle, security and safety, and support for meeting basic human needs through nuclear applications and technical cooperation. It would also meet an additional funding requirement in the verification area to ensure an independent and credible system, and address other existing unfunded liabilities.

- To better inform planning and budget debates, the Agency should establish a comprehensive approach to assessing its future resource requirements, and should estimate the negative impacts and consequent risks of particular levels of budget constraint or gauge what could be done with particular levels of budget increases.
- The statutory functions of the Agency – including in nuclear energy, nuclear applications, development, safety, security, and safeguards – should be fully funded from assessed contributions. Voluntary contributions can help cover unforeseen expenditures in any of these areas, but should no longer be relied on for day-to-day financing of core missions.
- The Technical Cooperation Fund should continue to be based on negotiated targets, but it should be adequate to cover the new areas of activity covered in this report, predictable on a multi-year basis, and assured. Recipient states should pay some portion of the costs of technical cooperation, on a sliding scale based on their ability to pay. The Agency should consider a variety of approaches to such payments, and may wish to reassess the National Participation Cost system that was adopted in 2004, which in some cases may divert funds that states might otherwise have spent to support vital technical cooperation projects in their countries.
- A Contingency Fund should be established from assessed contributions to alleviate problems arising from delay in payments and to enable the Agency to respond to emergencies such as nuclear accidents, terrorist attacks, or urgent verification requests.
- The Agency and its member states should examine a variety of options for innovative financing arrangements that could supplement or even replace the current system of budget assessments. For example, efforts should be made to develop mechanisms under which states would pay the Agency a portion of the monetized value of the reduction in risk resulting from the Agency's activities. The Agency should also consider other user fees or participation fees for its services, keeping in mind both the needs of developing countries and the need to maintain incentives for states to accept safety and security reviews.
- Qualified public and private organizations should be invited to expand their support for the Agency. Such donations should be used only for purposes and activities authorized by the Board of Governors.
- Regional institutions in the field of safety and safeguards should be encouraged to expand their cooperation with the Agency to achieve better synergies and allocations of resources.
- The Agency should adopt a flexible and transparent personnel system focused on attracting, training, and retaining the highly qualified personnel that it needs. The member states should give the Director General flexibility to offer attractive terms to specially qualified and indispensable personnel, including the possibility of higher salaries, career employment, and other benefits. Exemption should be sought from the regulations of the UN Common System to meet the special needs of the Agency.
- Member states should work with the IAEA to establish programs to attract and train appropriate experts to work at the IAEA, and to give their nationals incentives to pursue placements at the IAEA (ranging from salary bonuses to career advancement opportunities on their return home).
- The Agency should continue to pursue opportunities to increase efficiency by using modern methods of management and communications. In particular, it should make needed investments in information technology that can bring significant payoffs in efficiency and economy in the long term.

Conclusion

The UN High-level Panel on Threats, Challenges, and Change characterized the IAEA as an "extraordinary bargain," considering the very low cost at which the Agency carries out responsibilities of immense value to humanity. By 2020 and beyond, these responsibilities will increase dramatically as mankind and the Agency face new opportunities and challenges in the nuclear arena. In the new partnerships that the Commission envisages for nuclear energy, development, disarmament, nonproliferation, safety, and security, the IAEA's strengthened role would require additional authority, resources, personnel, and technology. The cost of providing these would be insignificant compared either to the benefits to be gained or to the risks and costs of failure to act. Now is the time to choose.

Abbreviations and Acronyms

EUR	European Utility Requirements
FAO	Food and Agriculture Organization of the United Nations
GNEP	Global Nuclear Energy Partnership
HEU	highly enriched uranium
IAC	InterAcademy Council
IAEA	International Atomic Energy Agency
IAP	InterAcademy Panel on International Issues
ICSU	International Council for Science
INPRO	Innovative Nuclear Reactors and Fuel Cycles
LEU	low enriched uranium
MDEP	Multinational Design Evaluation Program
NPT	Treaty on the Nonproliferation of Nuclear Weapons
NTI	Nuclear Threat Initiative
OECD	Organization for Economic Cooperation and Development
R&D	research and development
SIT	Sterile Insect Technique
TCF	IAEA Technical Cooperation Fund
UNSC	United Nations Security Council
WANO	World Association of Nuclear Operators
WINS	World Institute for Nuclear Security

Annex

20/20
Vision for the Future

Background Report

by the

Director General

for the

Commission of Eminent Persons

February 2008

IAEA
International Atomic Energy Agency
Atoms for Peace

20/20
Vision for the Future

Background Report by the Director General for the Commission of Eminent Persons

IAEA
International Atomic Energy Agency
Atoms for Peace

Contents

Executive Summary

For fifty years the International Atomic Energy Agency (the 'Agency') has worked to bring the benefits of nuclear technology to humankind, while minimizing its risks. This report presents the results of a review by the IAEA Secretariat of the role of the IAEA up to the year 2020 and beyond. It consists of a 'foresight' analysis, a forward-looking review and prioritization of the Agency's key areas of work, and a brief discussion of resource issues.

Trends over the coming decades indicate a growing world economy, a continuing rise in population, and increasing pressure on the environment. The rising demand for low carbon emitting energy supplies to fuel sustainable development is likely to have a strong impact on the IAEA, as it could lead to substantial growth in the use of nuclear power and, correspondingly, increased concerns about the associated risks. In addition, continuing population growth and longer human life spans will create challenges for food security, water availability, resource conservation, environmental protection and human health — problem areas which nuclear applications and technology can help address. The increasingly interdisciplinary nature of science and technology will provide opportunities for the IAEA to develop partnerships with a range of stakeholders to advance nuclear R&D, particularly in areas where research to serve the needs of the most disadvantaged is underfunded, or where no other actor is qualified or willing to take the lead.

"Nuclear techniques will continue to be used to help address challenges to basic human needs."

A substantial increase in the use of nuclear power would result in calls for the Agency to give priority to promoting the efficient, safe and secure use of facilities in States, including those new to nuclear power, as well as helping to prevent and mitigate nuclear accidents. Its activities in this respect are likely to continue to include the establishment of authoritative guidelines, as well as the dissemination of experience, new knowledge and best practices, the provision of training, and the organization of peer reviews.

The Agency may be asked to play a catalytic role in developing, and perhaps managing, a new framework introducing greater international management of the nuclear fuel cycle. This could initially cover a multinational regime for the assurance of fuel supply, and might later expand to multinational management of spent fuel. An expected increase in the need for the storage, reprocessing and recycling of spent fuel will create additional demands for the IAEA's technical support. Work on the disposal of radioactive waste, in particular high level waste, and the decommissioning of older reactors will also have high priority.

Nuclear techniques will continue to be used to help address challenges to basic human needs. Member State capacities in the nuclear field, however, have developed significantly over the past five decades, and in addition to the IAEA a range of new partners, in particular the private sector, are becoming involved. The timing may thus be right for the IAEA to begin to shift its focus in its technology transfer work from operational activities towards more normative functions (for example, setting guidelines and standards), greatly increasing its emphasis on partnerships and networking, and on its role as an information hub. In collaboration with other key partners, priority should be given to providing more comprehensive, issue driven, assistance in three thematic clusters: disease prevention and control; food safety and security; and natural resource management and ecosystem sustainability. There is scope for the IAEA's laboratories to become increasingly 'virtual' — managing rather than carrying out practical activities. The result will be more targeted services and activities. Safety and security in nuclear applications will remain a priority.

An expansion in the civil use of nuclear technology brings with it increasing concern about the risk of accidents and the threat of nuclear terrorism. The Agency will continue to give high priority to strengthening prevention measures at both the national and international levels, and establishing measures to help ensure a rapid and coordinated response should prevention fail. The development of the currently planned security guidelines and safety standards should be complete by 2010 and 2020, respectively. An evolution in the 2020 timeframe from voluntary to mandatory international peer reviews could help increase safety worldwide and help enhance public confidence.

The spread of nuclear material, technology and know-how may pose increased proliferation risks in a globalized world. The IAEA is likely to remain a major actor in preventing the spread of nuclear weapons.

Although a revival in nuclear power would require additional verification ('safeguards') activities, the IAEA's workload is not likely to increase proportionally if States accept greater transparency measures under a new verification standard. The need for IAEA inspectors in the field is likely to decrease due to the use of new technology and a change in the way States are evaluated. Verification activities will increasingly become information driven, with more evaluation work at the Agency's headquarters. Meeting future challenges will require a robust IAEA 'toolbox' containing: the necessary legal authority to gather information and carry out inspections, state-of-the-art technology, a high calibre workforce and sufficient resources.

"Restrictive budgetary policies imposed on the IAEA have led to a significant shortfall in resources ..."

The IAEA may be called on to take on new roles in the future, such as verifying fissile material from dismantled weapons or verifying compliance with a potential global ban on the production of fissile material for weapons. It could thus contribute to both non-proliferation and disarmament.

Restrictive budgetary policies imposed on the IAEA have led to a significant shortfall in resources — including, in particular, insufficient capital investment in the Safeguards Analytical Laboratory where critical nuclear samples are analysed — as well as heavy reliance on voluntary contributions for key areas such as safety, security and technical cooperation. The focus on efficiency gains, management reform and internal streamlining will remain rigorous. Also, certain activities that the Agency has carried out for many years could be outsourced, partnered or left to other players, public or private. This could result in savings. However, a significant increase in funding will nevertheless be required for the IAEA to carry out the activities foreseen in this report.

Consequently, funding for core activities needs to be through assessed contributions rather than, as sometimes at present, through unpredictable and conditional voluntary contributions. In addition, where appropriate, innovative funding mechanisms, such as private donations, endowments, user fees and sponsorships, will be explored.

The major challenges likely to face the Agency in the 2020 timeframe are: growth in the use of nuclear power, brought on by the demand for clean energy; greater demand for the use of nuclear applications in health, food and the environment; increased emphasis on maintaining a high level of safety; combating the threat of nuclear terrorism; and strengthening of the safeguards system to ensure its effectiveness, credibility and independence.

20/20
Vision for the Future

Background Report by the Director General for the Commission of Eminent Persons

Introduction

In late 2007, the Director General established a Commission of Eminent Persons to review the current activities and make recommendations regarding the future activities and priorities of the IAEA (the 'Agency') in the light of recent and expected developments relevant to the Agency's mission. In order to provide the necessary background information for the Commission, he initiated a review by the Secretariat of the likely role of the Agency up to the year 2020 and beyond. This report presents the outcome of that review.

The report begins with a 'foresight' analysis — based on a survey of best current projections — of what the world might look like in the 2020 timeframe in terms of developments that would affect the mission of the Agency. This is followed by four sections outlining corresponding major changes foreseen in the Agency's work, in terms of both "what kind of IAEA the world will need" and "how the IAEA can best fulfil that need". The report then addresses the current financial challenges to the Agency, and discusses how existing funding mechanisms, as well as innovative approaches, can best be used to meet those challenges.

Context

The IAEA was established in 1957, at a time when the world was beset by fears of a proliferation of nuclear weapons, but also a time when emerging nuclear science and nuclear techniques were raising hopes of benefits in many spheres of human life. The mandate of the newly formed IAEA — subsequently captured in its 'Atoms for Peace' logo, derived from US President Eisenhower's seminal speech to the United Nations General Assembly in 1953 — was to help alleviate those fears and realize those hopes.

"The IAEA was established in 1957, at a time when the world was beset by fears of a proliferation of nuclear weapons, but also a time when emerging nuclear science and nuclear techniques were raising hopes of benefits in many spheres of human life."

In the intervening decades, the role of the Agency has grown, evolving in response to Member State needs. Early expansion in civilian nuclear power was accompanied by the development of nuclear applications in health, agriculture, hydrology and industry. In 1970, the hitherto limited Agency 'safeguards' programme took on greater significance when, under the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), all non-nuclear-weapon States Party undertook to sign a safeguards agreement, granting the Agency inspection and monitoring powers to verify that nuclear material was being used only for peaceful purposes. Later, in the 1990s, after the uncovering of Iraq's clandestine nuclear weapons programme, the need to strengthen Agency safeguards became apparent and a 'model additional protocol' to safeguards agreements was enacted, designed to grant the Agency more information as well as extended access to national nuclear sites.

In 1986, the Agency responded to the accident at the nuclear power plant in Chernobyl by undertaking a fundamental expansion of its safety programme. This programme has since become a major factor in promoting a worldwide, broadly based, 'culture' of safety in the use of nuclear power and other nuclear applications.

Similarly, the attacks of 11 September 2001 led to an immediate expansion of Agency activities relating to nuclear security — helping countries to protect against, and be ready to respond to, terrorist attempts to acquire nuclear weapons, attack nuclear facilities or misuse radioactive material.

These events also led to the development of international treaties, conventions and other instruments for safety and security.

At the same time, the transfer of nuclear technology to the developing world has evolved from the supply of equipment or the sending of expert missions to a focus on cooperation for sustainable development, building on the skills and infrastructure of Member States, which act as full partners in the process (the evolution from 'technical assistance' to 'technical cooperation').

To advance its Atoms for Peace mission, the IAEA must address both of the objectives for which it was founded. The priorities given to these two objectives differ among Member States. For the majority of developing countries, access to civilian nuclear technology has been the priority, while for developed countries emphasis has been placed on verification and security. Efforts to reach consensus on respective programmes of activity and budget levels are complicated further by the fact that the Agency's verification activities are driven by legal responsibilities for both the Agency and Member States — whereas there is no corresponding clear benchmark for technology transfer activities.

"The Agency can mobilize international technical expertise of considerable breadth and quality."

Despite its growing mandate and the recognition of the importance of its work — as witnessed, for example, by the awarding of the 2005 Nobel Peace Prize to the IAEA and the Director General — the Agency has for most of the past two decades been operating within budgetary restrictions (essentially 'zero growth') imposed on virtually all UN system organizations irrespective of their mandate or management practices. These have led to a chronic deficit in capital investment and an over-reliance in many areas on extrabudgetary contributions from individual countries — contributions that often come with restrictions and conditions on their use.

The IAEA in relation to other organizations

The question "Why the IAEA?" is touched on several times in the report. In general terms, the advantages offered by the Agency include: its special access to nuclear facilities, material and information; its independence and objectivity; its international character and ability to build consensus worldwide (and its considerable experience in doing so); and its capability to establish — and assist Member States in complying with — international norms and standards concerning nuclear matters. The Agency can mobilize international technical expertise of considerable breadth and quality. And, finally, it has vast experience as a clearing house for information that can help Member States make well informed decisions about assessing the risks and the benefits of nuclear options.

The IAEA's role and position in the multilateral system is well established. In certain areas, the IAEA will play a central or a leading role, for example in non-proliferation efforts and in the implementation of international conventions on safety and security. In other areas, it has a more supportive role, working in partnership with other inter-governmental bodies, NGOs and industry groups, such as the OECD/NEA, WANO and WNA, as well as academic institutions and professional societies. In the development area, the IAEA plays a more modest, but nevertheless important, role, contributing specific knowledge and capacity to the larger programmes of other UN organizations and public or private institutions.

Criteria and priorities

Within this context, several criteria have been used in determining where the Agency could most effectively concentrate its efforts and resources in the coming decades. The primary goal is to respond to the particular needs and priorities of Member States, with a focus on areas where other actors — such as other organizations and the private sector — cannot provide services as effectively as the Agency. In addition, assessments will continue to be made of nuclear techniques to ensure that they retain comparative advantages. In cases where nuclear techniques become mature, the Agency's work could evolve towards a more normative role (for example, setting guidelines and standards).

Towards 2020 and Beyond: Global Trends and Events Likely to Affect the IAEA

The major trends and developments which are shaping, or likely to shape, the world towards 2020 and beyond present both opportunities and challenges to the IAEA and its Member States in the advancement of human development and security. Demographic and economic trends will be major drivers. The United Nations predicts that the world population will grow from the current 6.5 billion to some 8 billion by 2030, while the World Bank estimates that the output of the world economy will grow at an annual rate of 3%, doubling from today's $35 trillion to $72 trillion in the same timeframe. In both cases, the contribution of developing countries will be significant: 97% of population growth will occur in the developing world, and economic growth will increasingly be powered by developing countries.

The projected demographic and economic patterns will drive a mounting demand for energy, a development of key significance to the IAEA. Growing urbanization and industrialization will cause electricity needs to grow even faster than energy needs in general. To meet those demands and sustain growth, countries will seek access to affordable and reliable energy supplies. Energy security is already considered to be a primary challenge for many countries.

At the same time, growing public awareness of the deteriorating state of the environment is likely to affect the energy choices and policies of countries. With the earth's natural resources already under considerable strain and concerns over climate change intensifying, there will be pressure for countries to reduce their dependence on fossil fuel based energy production and seek different options and solutions to support sustainable development. Nuclear energy is emerging as one potential option. Thus, many projections forecast significant growth in the use of nuclear power, with some countries introducing it for the first time and others expanding their existing capabilities. The IAEA will likely be called upon to help countries assess the nuclear power option and ensure that the projected expansion in the use of such energy takes place in a safe and secure manner.

"Growing urbanization and industrialization will cause electricity needs to grow even faster than energy needs in general."

Globalization — the increased interconnectedness of people and places — will be central to future economic growth. However, the benefits of globalization will not be shared equitably. Indeed, inequalities — within and between nations and regions — are likely to grow. International organizations such as the IAEA have a role to play in helping to narrow the gap and assisting those most in need. Nuclear techniques can play a small but sometimes important role in helping to address poverty, hunger and disease — problems likely to escalate in the face of growing populations, longer life expectancies, urbanization, water scarcity, food security and competition for natural resources.

Highly visible inequalities in income, wealth and access to basic human services and development opportunities may also lead to tension and conflict, both within and between countries. With extremist groups already interested in acquiring destructive capabilities, nuclear and radiological terrorism will continue to be a major threat. The detonation of a nuclear explosive device or the dispersal of radioactive material by a 'dirty bomb' could prompt unpredictable changes in society. Hence, countries are likely to pay increasing attention to taking preventive action, and to need IAEA expertise and assistance in this sphere.

Moreover, apprehension over the proliferation of nuclear weapons is likely to persist. The wider use of nuclear energy and the spread of nuclear know-how, technology and material may intensify these concerns. There is worry about the state of health of the nuclear non-proliferation regime, which the IAEA supports through verifying compliance with relevant legal agreements. Fears are intensifying that the regime is seriously threatened and needs to be bolstered in many ways.

Unforeseen events

Past unforeseen events — such as the Chernobyl accident in 1986, the 1991 discovery of a clandestine nuclear weapons programme in Iraq, and the terrorist attacks of 11 September 2001 — changed the world in significant ways. These events were strong catalysts for change within the Agency, resulting in important strengthening of the IAEA's verification, safety and security roles. They also underlined the need for flexible and rapid response and, in the longer term, reorientation of existing, or creation of new, programmes.

Future events with significant potential impact on the IAEA might include the clandestine development of a weapons programme, the theft of nuclear or radioactive material, the explosion of a 'dirty bomb', or a major accident at a nuclear facility. The social consequences of such events would be enormous and the economic impact would be far greater than the allocation of funds *in advance* to strengthen the safeguards, security and safety programmes of the IAEA. The Agency must be in a position to help minimize the likelihood of such events through prevention measures, and to react through emergency preparedness and response capabilities should they occur.

Nuclear Reactors and Fuel Cycle Facilities: Rising Expectations?

Historically, interest in nuclear power has fluctuated considerably. Following a rapid expansion in the IAEA's early years, particularly in the 1970s, growth slowed near the end of the 1980s for a variety of reasons, including the Three Mile Island and the Chernobyl accidents. Since that time, the pace of nuclear power growth has largely matched that of global electricity.

A significant change appears to be on the horizon due to a growing world population, economies consuming larger volumes of energy and electricity, growing concerns about climate change and greater confidence stemming from improved nuclear power plant performance and safety records. To meet future demand, States are turning to nuclear power as one potential solution. Indeed, nuclear power is projected to undergo a potentially significant expansion in the next decade, with some commentators envisaging even a nuclear 'renaissance'. To help plan and prepare for the future, the IAEA annually publishes two nuclear power growth scenarios, a high and low projection (Fig. 1).[1] The 2007 updates project that nuclear electricity generation may grow by 15–45% by 2020 and by 25–95% by 2030.

According to these scenarios, some countries will consider nuclear power for the first time, while others will expand their existing production capabilities. Future requests for IAEA assistance are likely to come particularly from States interested in exploring or initiating nuclear power programmes. They are likely to request assistance to ensure that their programmes will be efficient, safe and secure.

Another important shift that is projected is the location of this future growth. To date, nuclear power has been mainly used in industrialized countries. However, much of the future growth is expected to take place in the developing world: 16 out of the 34 new reactors currently under construction are in developing countries, particularly in Asia.

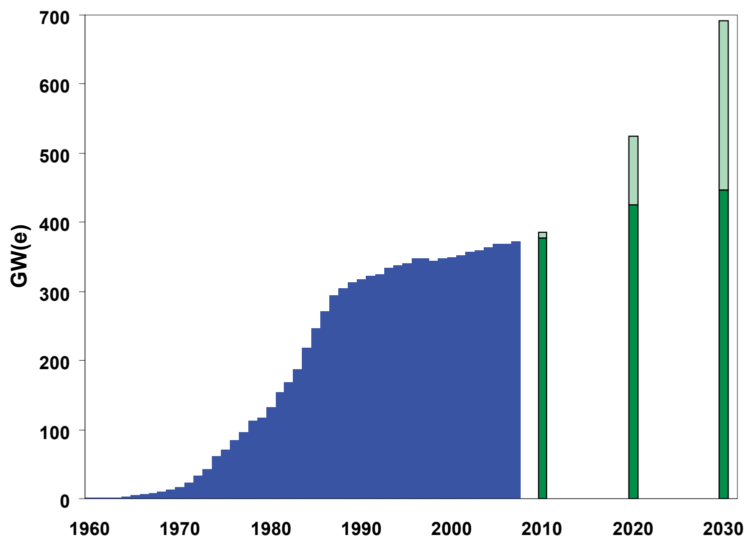

FIG. 1. Historical growth in global nuclear power capacity (blue) plus estimates of future growth according to the IAEA's low projection (dark green) and high projection (light green).

[1] Under the low projection, which assumes that no new nuclear power reactors will be constructed beyond those already under construction or currently planned, nuclear power will grow only slightly. The high projection takes into account nuclear projects proposed beyond those already firmly committed.

Any discussion on future energy trends will need to take into account the global energy imbalance. Currently, some 1.6 billion people live without access to electricity. In some African countries, annual per capita electricity use is as low as 50 kilowatt-hours, while in the member countries of the OECD it is 9700 kilowatt-hours — roughly 200 times higher.

While recognizing that each State must make its own energy choices and that 'one size does not fit all', the IAEA can help ensure that the nuclear power option is open and accessible for any State that chooses it. It will also need to continue emphasizing that the path to nuclear power requires a well defined 'roadmap', and helping States to take the various steps required along the way.

An expansion in nuclear power would require greater international cooperation. The IAEA provides a primary forum for stakeholders to meet, share their expertise and respond to future challenges. These stakeholders include States introducing nuclear power, States with existing nuclear power, and neighbouring States, as well as various actors such as technology providers, private companies, nuclear operators, NGOs and other international organizations.

Facilitating the efficient and responsible use of nuclear energy

The IAEA will continue giving high priority to facilitating the efficient, safe and secure use of nuclear power plants, fuel cycle facilities, research reactors and other facilities. The number of nuclear power reactors is predicted to increase by up to 60% and associated fuel cycle facilities up to 45% by 2030.[2] The IAEA foresees that related assistance requests could triple by 2020.

It will be particularly important to support the decision making processes of States introducing nuclear power for the first time — the 'newcomers' — and to ensure they can make informed choices on nuclear energy and technology.

The rising number of requests for general IAEA assistance in energy planning reflects the value of the IAEA's reputation for quality, independence and objectivity. Moreover, more countries are specifically evaluating the nuclear power option, a recent example being the States of the Gulf Coordination Council. The trend is expected to continue, and rising requests today for energy planning assistance are likely to translate into a growing number of requests in the future for implementation assistance. In addition to legislation and regulation, this assistance is likely to focus on developing and sustaining the necessary nuclear power infrastructure and building expertise in the organization that will run the power plant, complementing assistance provided by governments, private firms, industrial associations and other international organizations. The IAEA's comparative advantages will be in: establishing authoritative guidelines; disseminating experience, new knowledge and best practices; providing training; and assembling expert teams for peer reviews.

IAEA guidelines, such as the *Milestones in the Development of a National Infrastructure for Nuclear Power*,[3] distil the lessons from past experience to assist planning and speed efficient and safe implementation. The IAEA will also assist States in such areas as nuclear law, setting standards and building a safety and security culture, site selection, bid evaluation, quality assurance, financing options, knowledge management and plant life management (i.e. incorporating future refurbishment and eventual decommissioning into management planning from 'day one').

"... rising requests today for energy planning assistance are likely to translate into a growing number of requests in the future for implementation assistance."

[2] For planning purposes, the figures given here are for 2030 rather than 2020, taking into account that the IAEA will need to begin assisting States well in advance.
[3] IAEA Nuclear Energy Series No. NG-G-3.1, IAEA, Vienna (2007).

Growing requests for IAEA assistance are expected for nuclear energy used to desalinate sea water. Water, like energy, is a basic need, and competition for water resources is expected to increase in the future.

In those countries already operating nuclear power plants, the Agency will disseminate experience with operating technology, management efficiency, quality assurance, knowledge management and major refurbishments. With licence renewals now extending reactor lifetimes to 60 years, and with the increasing number of reactors worldwide, the IAEA foresees increased demand for all these activities.

Towards a new framework for the nuclear fuel cycle: Fuel supply assurances

A global nuclear expansion would likely drive a corresponding increase in the demand for nuclear fuel and fuel cycle services.

The IAEA Director General has proposed the creation of a new multinational framework for the nuclear fuel cycle. A fully developed framework is a complex endeavour to be developed in stages. The first step would be to establish mechanisms to assure the supply of nuclear fuel. States would have confidence that they would be able to obtain nuclear fuel in a predictable and stable manner over the longer term. While a well functioning market is likely to ensure this, a back-up mechanism could add further confidence by helping to protect against political disruptions. Such a mechanism will also make less likely the spread of sensitive fuel cycle facilities.

"States would have confidence that they would be able to obtain nuclear fuel in a predictable and stable manner over the longer term."

There has been considerable interest in this idea, with several States and other stakeholders proposing a variety of possible approaches for the assurance of supply. The various proposals now on the table envisage new responsibilities for the Agency, ranging from deciding when fuel supplies could be released to an ambitious vision of the actual construction, operation and monitoring of enrichment plants, with the former entailing only minimal cost and the latter very substantial investments.

This development, if it materializes, would mean a growing 'nuclear broker' role for the Agency. The Agency would take on the function of overseeing a nuclear fuel bank. That role is envisaged, in fact, in the IAEA Statute and now, more than a half a century later, it is being revisited.

Finding solutions for spent fuel and radioactive waste

The expansion of nuclear power will create new demands for spent fuel management and waste disposal. The Agency is likely to give high priority to these issues as they are often seen as creating potential risks and unsolved problems and have a high public visibility. The nuclear industry has over 50 years of experience managing spent fuel. The safety record is good, and the first priority will be to maintain that record in both experienced and newcomer countries.

High level geological waste disposal, however, has not yet been demonstrated. The Finnish, French, Swedish and US repository programmes are the most developed, although none of these countries is likely to have a repository in operation much before 2020. The IAEA could facilitate the flow of information from States which are most advanced in developing deep geological facilities or conducting research in this field. Also, it could assist countries to conduct more uniform assessments of their high level waste disposal options.

The disposal of low and intermediate level waste is established in several countries. However, Agency support will be needed to implement such disposal in additional countries, both those with nuclear power and those with only other forms of radioactive waste, such as that from hospitals.

For countries with limited waste or without access to geologically suitable disposal sites, multinational disposal at sites with good geology might be an option. Several studies have identified the potential benefits, in terms of possible economic, non-proliferation, safety and security advantages, of multinational disposal as well as the institutional and political issues standing in the way. The IAEA could help States arrive at a solution that fits their needs.

Helping to decommission nuclear facilities

The decommissioning industry is well established and will grow as many power and research reactors are expected to retire before 2020. The IAEA can help improve the flow of knowledge and experience among those engaged in decommissioning, and can encourage organizations in developed countries to provide decommissioning assistance to those with lesser capabilities.

A related area where the IAEA can provide advice is the remediation of uranium mines resulting from earlier mining activities. Most uranium today is produced from well designed and operated mines for which the IAEA has a role to play in helping to maintain the application of best practices, best technology and best standards. Overall, the need for IAEA assistance and attention will largely be in relation to new mines in less prepared locations.

Efficient use of research reactors

Many of today's research reactors will have passed retirement age by 2020. The number in operation is expected to decrease, from 245 today to between 100 and 150 in 2020. They will likely be replaced by new multi-purpose reactors that are fewer in number and more expensive, use low enriched uranium fuel and are built and/or operated by international consortia. States will increasingly need IAEA assistance with the decommissioning of older reactors and the management of spent fuel and waste. The need for assistance in strategic planning and institutional arrangements for possible regional and international research reactor coalitions, networks and shared-user facilities is expected to increase moderately.

Sharpening the focus on innovative activities

For innovation in nuclear reactor and fuel cycle technologies, increased international cooperation is required. The IAEA assembles diverse expertise, facilitates information exchange and acts as a catalyst for coordinated research among both established nuclear suppliers and users and prospective suppliers and users. It cannot independently conduct or finance R&D, but it engages directly with those who do — in industry, governments and other international organizations — and it can engage both established countries and new centres of innovation to help ensure that new designs meet the needs of all countries. As new manufacturers enter the business, the IAEA can help ensure that their safety culture and quality assurance are strong. The IAEA also provides an essential forum for coordinating expectations about technological developments and for promoting synergies. Examples already in place include the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and IAEA Technical Working Groups on advanced designs across the full range of technologies: water cooled reactors; metal cooled reactors; gas cooled reactors; fast reactors; and accelerator driven systems.

"Demands on the IAEA's compilation of the nuclear data fundamental to all research and innovation will also grow."

Demands on the IAEA's compilation of the nuclear data[4] fundamental to all research and innovation will also grow, as will the effort necessary to help ensure their high quality and comprehensiveness.

The underlying objective of these efforts will continue to be improvement of important nuclear power technology characteristics: increased proliferation resistance, safety, security and performance on the one hand; and decreased costs, construction times and complexity on the other. In particular, technological innovations will continue to be a key source of safety improvements.

Depending on the availability of resources and developments in Member States, it is likely that lower priority will be assigned to Agency activities in hydrogen production, nuclear fusion and uranium mining. For example, near term work on hydrogen production is expected to progress largely in established nuclear power countries (however, the IAEA can help ensure that the interests of unrepresented prospective users are not overlooked). With regard to nuclear fusion, the IAEA will focus on fostering cooperation and the involvement of countries outside the major players in the International Thermonuclear Experimental Reactor (ITER) project.

[4] Data concerning properties used in nuclear physics, for example the probability that a particular nuclear reaction will occur.

Meeting Basic Human Needs: The Role of the IAEA in Development

The IAEA is responsible for ensuring that the advantages of nuclear technology are used to benefit human well-being and sustain socioeconomic development, while also seeking to ensure that the risks associated with nuclear technology are minimized. It carries out this responsibility by assisting Member States in obtaining safe and secure access to peaceful nuclear applications for sustainable development.

Member State capacities in the nuclear field have developed significantly since the IAEA was established. A variety of disciplines and sectors have begun to work more cooperatively to deal with the greater scale of challenges to human well-being. New actors have entered the field; the private sector, for example, plays an essential role in advancing and promoting nuclear science and technology and various governmental organizations offer alternative solutions to development problems. With all these changes a central concept remains — no sustainable human development is possible without security, and no lasting security is achievable without development. The IAEA's development activities are thus central to the achievement of its overall mandate.

Today, some 115 countries benefit directly from the IAEA's technical cooperation programme. As the relevance of nuclear applications for development and meeting basic human needs increases, so too does the demand for support from the Agency. Already, existing financial and human resources are insufficient for keeping pace with the requests for support expressed by Member States, leading the Agency to investigate other implementation options, such as more regional collaboration, regional agreements, country to country support and partnerships.

> *"... no sustainable human development is possible without security, and no lasting security is achievable without development."*

In the future, demographic and environmental trends will further drive demand for IAEA services. Many Member States, in particular the least developed, are likely to require continued support. It is expected that the IAEA will prioritize, in collaboration with other key partners, issue-specific assistance in three main thematic clusters — disease prevention and control, food safety and security, and sustainable management of natural resources and ecosystems — with a lesser focus on a fourth cluster, industrial process management.

While these thematic clusters suggest increased levels of activity, the IAEA expects to reduce its activities in other areas (depending in part on the availability of resources). These include mature nuclear technologies (those that no longer require development or those in which Member States have acquired sufficient capacity), or technologies no longer considered to have a comparative advantage.

Disease prevention and control

Expanding populations, longer life spans and greater urbanization will create stress on health care systems worldwide and drive increasing demand for IAEA support in the use of nuclear technologies for diagnosis and treatment, advice on the deployment of hi-tech solutions, and safety and regulatory measures in nuclear medical practices.

In developing countries, the incidence of chronic diseases, such as cancer and cardiovascular disease, is projected to increase dramatically and radiotherapeutic and nuclear imaging techniques will become more important. Cancer control will be an important focus of activity for the IAEA in the future. Until recently, the IAEA has focused primarily on providing equipment and associated training to support cancer treatment. However, the Agency has begun efforts to provide more comprehensive support to Member States through the creation of formal partnerships with, for example, WHO to improve early detection, treatment, aftercare and palliative care, as exemplified by the existing IAEA Programme of Action for Cancer Therapy (PACT).[5]

Radiopharmaceutical production is another area where Member States might request assistance. Nuclear imaging procedures require radiopharmaceuticals which are often too expensive for low to middle income countries. The ability to produce cheap radiopharmaceuticals locally could have a significant impact in developing countries, leading to increased requests for IAEA assistance regarding best production practices, quality assurance and regulatory aspects. The use of stable isotopic techniques to develop effective nutritional interventions to address such issues as the 'double burden of malnutrition' (under-nutrition and obesity) is likely to become a higher priority for many Member States.

In contrast, as noted above, the IAEA is likely to reduce activities related to the provision of technologies that are mature or readily available through the private sector. For example, radioimmunoassay techniques used in human health (and animal production) studies are in the process of being replaced by non-radioactive, tracer based assays. Also, large radioactive sources for the treatment of cancer are increasingly being replaced by linear accelerators.

Food safety and security

Climate change and a larger world population are likely to result in increased pressure to guarantee both the quantity and quality of food. Therefore, food safety and security will receive increasing attention. Nuclear techniques improving agricultural productivity are increasingly likely to focus on improving crop varieties to enable them to grow under the harsh conditions brought about by climate change. Combined technology packages based on mutation induction and genomic screening techniques could improve plant breeding and support the development of sustainable biofuels. The IAEA will also promote the development and application of radiation and isotopic techniques for the control of transboundary diseases and pests in technology packages that offer added value to the sustainable intensification of agricultural production.

"Nuclear techniques ... are increasingly likely to focus on improving crop varieties to enable them to grow under the harsh conditions brought about by climate change."

Techniques for the diagnosis of transboundary animal diseases could become more important and focused on nuclear and nuclear related molecular technologies for early and rapid detection. The IAEA will work with countries to develop and improve diagnostic and characterization technologies for detecting different pathogens (for example, avian influenza virus) not only in diagnostic laboratories, but also in the field. It will also assist in the use of radiation to produce deactivated live disease viruses, which is a key step in providing safe animal vaccinations.

The projected expansion of international agricultural trade will require the integration of pre- and post-harvest pest control measures so that Member States can meet regulations for international agricultural export markets and, in particular, overcome pest problems related to food and food products. Along with climate change driven alterations in the geographical distribution of pests, this is likely to lead to an increased demand for the area-wide use of the radiation based sterile insect technique (SIT) to protect crops and livestock from pests. A project on fruit flies in Latin America has already resulted in significant socioeconomic benefits, allowing fruit exports. In some areas, the potential for increased Agency support could depend on the success

[5] PACT is a comprehensive, multidisciplinary alliance initiated by the IAEA in 2004 to help developing Member States deal with an emerging cancer epidemic and provides a test case for possible thematic approaches in other areas. It has built formal partnerships with organizations in different sectors, uses a variety of funding mechanisms, and offers technical assistance and advice.

of Agency projects currently under way, for example in relation to the control of tsetse flies in parts of Ethiopia.

The use of ionizing radiation for the control of food-borne microbes and pests is also expected to increase. In view of the increasing hazards arising from contamination by a wide spectrum of environmental pollutants and chemical additives, IAEA coordinated research programmes on additional screening techniques could be required. However, food irradiation as a mature technology is likely to need only minor input by the Agency.

Natural resource management and ecosystem sustainability

Nuclear techniques offer useful tools to assess and monitor natural resources and ecosystems, thereby supporting the development of efficient management strategies to preserve marine and terrestrial environments, particularly in the face of climate change. Such techniques can also be used to mitigate soil degradation, and to strengthen efforts for the conservation of water, air, oceans and land resources. Through the development and improvement of stable and radioactive tracer isotopic techniques, the IAEA will assist Member States to monitor impacts of climate change, agricultural practices and land use on the quality and quantity of natural resources.

"The IAEA will facilitate the use of isotope hydrology and other nuclear tools to support the integrated management of water resources ..."

The competition for water resources is expected to increase in the future, and the rate of consumption is likely to continue to grow faster than that of the population. The agricultural sector will remain the largest user. The IAEA will facilitate the use of isotope hydrology and other nuclear tools to support the integrated management of water resources related to ground or surface water, land resources and coastal zones. The unique data provided by these techniques could become even more valuable as climate change alters the hydrological cycle. One current example of how activities can evolve in the future is the IAEA's effort to integrate groundwater considerations into the management of the Nile River Basin.

As climate change and ecosystem sustainability become increasingly urgent problems, the IAEA could offer a package of appropriate nuclear assessment tools. In a wider context, environmental impact assessments should be integrated into the services offered by the Agency.

The Agency's future activities in the area of natural resource management and ecosystem sustainability will be based, in part, on the integration of services that are currently spread across several programmes, resulting in efficiency gains. Additionally, there will be decreases in those areas of work that can be more readily performed by the private sector (for example, assessing dam safety using nuclear technology). Reductions are also anticipated in standard monitoring exercises in water, oceans, and air and land ecosystems.

Evolving nuclear technologies to support industrial process management

The economic growth of developing countries will lead in many cases to increasing industrial activities. Radiation based techniques can help optimize industrial processes. Much of this optimization is likely to be undertaken by the private sector. Where this sector does not provide sufficient access to the relevant technology, Member States are likely to need continued IAEA support, particularly with respect to advice on best practices and supporting safety and regulatory structures. Radiation treatment, processing and diagnostic technologies aiding in the development, manufacture and analysis of advanced materials, including nanotechnology, is likely to become an area of interest for many Member States. However, IAEA support for mature technologies, such as non-destructive testing, could be phased out.

The use made of research reactors, accelerators and allied nuclear techniques may increase in response to established and new applications in health, the environment and the preservation of cultural heritage. Further, the role of research reactors and accelerators as a cornerstone of education and training in nuclear sciences is likely to remain relevant for human capacity building.

A changing context, an evolving role

In the future, the IAEA is likely to move away gradually from operational activities towards normative functions, greatly increasing the emphasis on partnerships and networking, and on the role that the Agency can play as a hub for nuclear information (for example, the IAEA's role as the central repository for collecting and maintaining nuclear data). Operational functions are likely to be increasingly decentralized. Member State cooperation is also likely to evolve, with the Agency focusing more in some areas on less or least developed countries (for example, in capacity building), and providing a more targeted delivery to middle income countries in other areas. Actual procurement by the Agency of large items of equipment may be scaled back, as it is an area where most Member States are becoming self-sufficient.

Laboratories and regional networks

The IAEA is currently the only United Nations organization that operates its own laboratories. These facilities, located in Vienna, Monaco and Seibersdorf, provide applied research, educational and analytical support in development, safety and verification. These needs arose from the complex nature of most nuclear applications and their critical safety aspects, as well as the need to perform experimental research and teach analytical techniques in fields where Member States lacked sufficient knowledge and capacity. As Member States become increasingly self-reliant, these services as well as other IAEA technical services could be outsourced to national or other international laboratories and institutions, or to IAEA Collaborating Centres.

The role of the IAEA's laboratories is thus expected to change significantly, as they move towards a more 'virtual' mode of operation in which the IAEA plays a coordinating role, based on its knowledge of networks and Member State capacities. This will allow Member States to draw on a vastly enlarged and up-to-date pool of resources. At the same time certain physical laboratory functions will be retained where independence is important, most notably in the area of analytical support for safeguarding nuclear material, the provision of reference materials for quality assurance in sciences and trade, and radiation dosimetry calibration services for radiological protection and medical applications. The laboratories will continue to focus on areas where no other actor is likely or willing to undertake work that could be of significant benefit to Member States. Importantly, it should be understood that the Agency will continue to coordinate required support (such as training) through laboratories in Member States.

"The role of the IAEA's laboratories is thus expected to change significantly, as they move towards a more 'virtual' mode of operation."

Decentralized country and regional based networks of scientific institutions are likely to become the main source for technology transfer and capacity building. The establishment of IAEA regional offices responsible for managing technical cooperation programmes with Member States could facilitate this more decentralized approach. While greater resources and time would be required initially to implement these changes, and to build formal partnerships, in the long run — potentially by 2020 — this evolution could enable the IAEA to better support regional needs, at lower cost.

Finally, the use of nuclear applications is bound to grow as nuclear technology takes advantage of the synergies and opportunities for innovation in today's interconnected world. Rising populations, longer life expectancy and environmental stress will create challenges in the fields of health, food security, natural resources and water availability. In addressing these challenges, the IAEA, through its Member States, can bring together a broad and probably unique knowledge base in nuclear technology, nuclear energy and nuclear applications.

Underpinning Nuclear Safety and Security: Preventing Nuclear Accidents and Nuclear Terrorism

The growing use of nuclear technology in Member States will bring significant benefits but will also entail risks. It will be essential to avoid accidents like those at Three Mile Island and Chernobyl, and prevent terrorists from acquiring nuclear weapons or detonating 'dirty bombs'. The growth in civil nuclear technology needs, therefore, to be complemented with an equally ambitious enhancement of global safety and security.

Safety and security share the ultimate goal of protecting people and the environment from the harmful effects of radiation, but they are different in both cause and process. Nuclear accidents are caused by human and/or technical failures or extreme natural events, and the likelihood of their occurrence can be scientifically estimated. In contrast, malicious events are intentional, much less predictable, and involve an adversary intent on evading prevention measures. That said, from the perspective of both operators and regulators, prevention measures must cover all safety and security requirements. Measures to combat illicit trafficking and nuclear proliferation are also closely interlinked but involve different constituencies. Taken together, these measures constitute a global nuclear order dedicated to ensuring that the benefits of nuclear technology will be available to all in a peaceful, safe and secure manner.

Safety and security are primarily the responsibility of the State, but recognition of the far reaching consequences of accidents or nuclear terrorist acts has strengthened global arrangements to address these risks — a process which is ongoing. The IAEA plays an important role, supporting the development and implementation of international conventions and codes of conduct and helping to establish international standards and guidelines. Most of the conventions recognize the IAEA as the competent body to assist States in their implementation.

"... the IAEA will have a role, in cooperation with organizations such as WHO and ILO and professional societies, in the education and training ... of practitioners and in informing ... patients undergoing radiation procedures."

Safety risks

The renewed interest in nuclear power, the ageing of existing installations, wider applications of radioactive sources in the medical and industrial fields, and the need to implement solutions for the disposal of nuclear waste present serious safety and public communication challenges today and will do so in the future. As an example, recent tsunamis and earthquakes have demonstrated the need to re-evaluate the safety of existing and future nuclear power plant designs against extreme natural events.

Losing control of, or misusing, radiation sources can lead to accidents, over-exposure of people, or malicious use. The IAEA will continue to have a central role in coordinating international action to strengthen the control of radioactive sources from 'cradle to grave', and to mitigate the effects of unauthorized disposal. Accidents and radiation overexposure in medical procedures, some fatal, continue to occur at an unacceptably high frequency. There is an urgent need to promote the implementation of actions to prevent accidents and to protect radiation workers, patients, the public and the environment from unnecessary exposures to radiation. In the years ahead, the IAEA will have a role, in cooperation with organizations such as WHO and ILO and professional societies, in the education and training of vast numbers of practitioners and in informing an even greater number of patients undergoing radiation procedures.

Centralized waste storage facilities in many States are ageing and their safety will need to be reassessed. Public concern over environmental protection and the long term cumulative impact of radioactive discharges of nuclear facilities is expected to increase. By 2020, the emphasis in work related to waste safety is likely to shift from analysing concepts for disposal to the evaluations of specific proposals for the geological disposal of high level waste.

With the expansion of the use of nuclear power and other nuclear techniques will come a corresponding increase in the transport of uranium, fresh and spent fuel, radioisotopes and waste. Given the emergence in recent years of denials of shipment of radioactive material, this challenge could rapidly grow in volume and complexity. The IAEA will need to play an increasing coordination role in promoting safe and secure transport.

Security threats

Comprehensive security requires a combination of prevention, detection and response measures set within a robust civil and criminal legal framework. The stakeholders include operators and users, regulators, port and airport authorities, customs, security and intelligence forces. Security measures should rest upon a realistic assessment of the threat. The security of nuclear material suitable for use in nuclear weapons has always been, and will remain, of the very highest priority. Accordingly, prevention measures, especially physical protection, must continue to be of the highest achievable level. New technology, and risk reduction programmes, will address some of the problems,[6] but the need to reach the highest levels of security will remain a long term imperative.

"The IAEA will need to play an increasing coordination role in promoting safe and secure transport."

As understanding of the potential threats involving the dispersal of radioactive materials by dirty bombs, sabotage and other means has improved, the priority given to their security has increased. This is especially true for radioactive sources, the security of which, until recent years, was largely addressed through control and inventory measures, and also for highly radioactive material produced as a result of the expanded use of nuclear energy.

International measures to help States to improve their level of protection are already in hand,[7] supported by the emerging IAEA security recommendations and guidelines, and by evaluation services and capacity building activities. Much remains to be done, in combination with safety and safeguards work. Prevention is a major long term goal for the IAEA: one which will require attention through 2020 and beyond. It will also be important to build detection capabilities at borders and elsewhere to interdict stolen or lost materials being trafficked. This includes improving technology, but the actual development of detection instruments and scientifically advanced forensic methods will be of relatively low priority for the IAEA, given the involvement of other actors. The Agency will, however, continue to have a coordinating role.

Preventing and mitigating nuclear accidents

High priority will also be given by the Agency to preventing and mitigating nuclear accidents. As noted above, States embarking on new nuclear power programmes are increasingly looking to the IAEA for help.

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[6] For example, by reducing or eliminating in civil applications the use of high enriched uranium, and utilizing separated plutonium in more proliferation resistant forms.

[7] The amended Convention on the Physical Protection of Nuclear Material, UN Security Council Resolutions 1540 and 1373 and the Code of Conduct on the Safety and Security of Radioactive Sources.

Safety depends on technology, the appropriate legal framework, an effective national regulatory body, and the existence of a safety culture throughout the government and industry. To advance these, the IAEA is likely to continue through 2020 and beyond to: publish guidance; provide training; disseminate operating experience, new knowledge and best practices; provide peer reviews; and coordinate research. As a possible new initiative, the IAEA could work together with importing countries and reactor vendor countries and companies to ensure that the safety infrastructure is in place for new power reactors.

Strong growth is expected in this area, particularly in the demand for peer reviews, as an expansion of nuclear power will call for ever greater transparency. The IAEA will not be the sole provider of any of these activities. However, it will add value where markets and governments do not provide sufficient transparency and information.

The early hours after a nuclear or radiological emergency are crucial. They can mean the difference between minor consequences and substantial health and economic effects. Early detection, notification and response is key to saving lives and managing the public response to an emergency, whatever the cause. Effective emergency preparedness and response require both national capabilities and, because radiation does not respect national boundaries, international cooperation. As the use of nuclear technology expands, so will the expectations of States for the IAEA to coordinate the international response to emergencies in accordance with roles assigned to it by international conventions. The IAEA has established an incident and emergency centre but its ability to carry out these roles is insufficient.

Enhancing safety and security

Safety and security both require continued vigilance and should always be considered as works in progress. For example, gaps exist today in the coverage of international conventions and codes of conduct and in the development and application of the normative infrastructure. And the number of countries that have subscribed to the international instruments needs to increase. These gaps need to be filled as a matter of high priority. As the expectations and demands of States increase, so will the need for the IAEA to help promote more effective and integrated approaches.

"... the Agency will continue to coordinate evaluation missions to appraise national application of IAEA safety standards and security guidelines and to provide appropriate advice."

International safety standards and security guidelines and recommendations provide practical advice to States on how to meet their international obligations.[8] They also support States in meeting their national safety and security objectives. The IAEA will give high priority to completing the currently planned series of security documents by 2010, and by 2020 the new structure of universally accepted safety standards should be in place. As each series is completed, the Agency's work on such documents will shift to maintaining their relevance, incorporating lessons learned, and developing further documents addressing any new needs and technologies. By 2020, it is expected that many of the nuclear security documents will have become, de facto or de jure, international security standards and incorporated into national security policies and regulations.

The IAEA will provide significant assistance to States to assess their safety and security needs and vulnerabilities. In this regard, the Agency will continue to coordinate evaluation missions to appraise national application of IAEA safety standards and security guidelines and to provide appropriate advice.

8 For safety, they cover such areas as legal and governmental infrastructure, emergency preparedness and response, the siting, design and operational safety of facilities, radiation, and waste and transport safety. In the area of security, guidelines cover issues such as nuclear security culture, threat analysis, facility and radioactive material security, transport security, combating illicit trafficking and detection equipment specifications.

In the future, it is possible that States may also use such missions to provide assurances of compliance with international safety standards and security guidelines. Although it has never been invoked for this purpose, the IAEA Statute already authorizes the Agency to provide for the application of safety standards, through legally binding undertakings by States. Such an evolution in the 2020 timeframe from voluntary to mandatory international peer reviews could help increase safety worldwide and help increase public confidence.

Assessments of national security needs, combined with enhanced information collection capabilities, have led to the development of integrated nuclear security support plans agreed between individual States and the IAEA. These plans already involve over 40 States. The number of States with such plans will increase substantially and, by 2020, it is forecast that 70% of these plans will have been implemented and attention turned to self-sufficiency and sustainability issues.

The training of legislators and regulators, facility operators and users, customs and other security officials will remain a high priority for both the IAEA and the requesting States. As new facilities are built and a new generation of professionals emerges, the demand for training is likely to increase.

Finally, the IAEA foresees a coordinating role in the development of new security related technologies by others and acting as a hub for receiving, disseminating and analysing information. It will give priority to the exchange and analysis of information on illicit nuclear trafficking and other unauthorized activities, and to developing new information resources and information networks. Partnerships with other international organizations, for example Interpol, OECD/NEA, WCO and WHO, will be further broadened.

Non-Proliferation, Disarmament and the IAEA

While the expansion of nuclear energy will bring greater prosperity to different parts of the world, it may also increase proliferation risks. For many States, attaining nuclear technology and know-how will be a matter of economic, scientific and technological advancement. But without appropriate control measures, nuclear material and technology could be misused to build nuclear weapons.

Proliferation risks are also being exacerbated by globalization. Covert nuclear trade networks can illegally procure sensitive technology in one part of the globe and sell it in another, concealing their clandestine shipments within the enormous volumes of legitimate global trade. Interactions and transactions between dealers and clients are being facilitated by the revolution in communication technologies and the erosion of national borders.

However, science and technology will continue to offer new ways and means of responding to proliferation concerns. The IAEA will be able to develop and make use of better equipment and advanced information and communication technologies, resulting in more effective techniques and approaches to verify that the civilian nuclear programmes of States remain peaceful. Also, in the longer term, risks may be reduced through the development of more proliferation resistant nuclear technology.

"The international community will continue to rely on the IAEA for objective and independent verification of States' nuclear programmes."

Maintaining stability and peace will become even more important in an increasingly globalized and interdependent world. In the nuclear area, the IAEA is expected to continue to play a key role in the management of global nuclear order through the practical realization of the principle 'trust but verify'. The international community will continue to rely on the IAEA for objective and independent verification of States' nuclear programmes. States parties to the NPT and nuclear-weapon-free zone treaties recognize it as the competent body to carry out that role.

During the past decade the cornerstone of the non-proliferation regime — the NPT — has been beset by concerns about compliance and growing tension between its non-proliferation and disarmament related aspects, as demonstrated by the deep divisions in meetings of the NPT States parties in recent years. However, nuclear non-proliferation and disarmament are mutually reinforcing, and the IAEA will be well positioned for the advancement of both and ready to contribute to strengthening the regime during this crucial time.

Changing the culture of verification

The IAEA performs verification through a set of activities by which it confirms that States are not using their civil nuclear programmes to build nuclear weapons. The rights and obligations of States and of the Agency are established in 'safeguards agreements', under which: States submit information to the Agency about nuclear material, facilities and activities; and the IAEA verifies nuclear material, inspects facilities and evaluates information about the States' nuclear programmes. Over 160 States have concluded such agreements with the IAEA.

To carry out its verification activities effectively, the IAEA needs to have adequate inspection authority and access to all relevant information and locations. The Agency's two main types of legal instruments are comprehensive safeguards agreements (CSAs) and additional protocols (APs).[9] Together, the two instruments enable the Agency to conclude that States are not diverting nuclear material to nuclear weapons.[10]

Yet, today, 30 NPT State parties have not even brought in force their required CSAs and some 100 States have yet to conclude an AP. By 2020, or earlier, the CSA–AP combination should, in the Secretariat's view, be the universally accepted verification standard, if verification is to be credible. It will also be important for the IAEA — the Secretariat and the Member States — to fully utilize all measures available under these legal instruments.

This new standard would not only increase transparency, but would also enable the Agency to optimize its verification activities, resulting in a reduced inspector presence and workload in the States.[11] Realizing such efficiencies will be increasingly important, especially in light of the projected expansion in the use of nuclear energy. Many additional nuclear facilities, material and activities will be subject to IAEA safeguards. For example, by 2030,[12] the overall in-field verification effort could increase only by some 10% compared with the current level if all States concluded an AP, even though the number of facilities subject to safeguards is expected to almost double by then. Without APs in all States, the in-field workload would most likely be a further 15% higher.

However, these efficiencies can be realized only if States give the IAEA the necessary legal authority — under both a CSA and an AP — so that it can confidently conclude and continuously reaffirm that they are not diverting nuclear material and have no undeclared nuclear material and activities. The process by which the IAEA evaluates State programmes is information driven and determines its inspection activity in the field. The Agency assesses all available information about a State's nuclear activities, from the declarations by States to open source information. Although field inspections are expected to increase only modestly by 2030, this 'desk evaluation' at IAEA Headquarters — representing the largest share of verification work — will require significant additional effort (see Fig. 2). Evaluating States will become more complex, given the increasing volumes of information available to the IAEA, the increasing number of States and facilities being verified, and the spread of sensitive material and technology. By 2030, the IAEA may need to increase its evaluation activities by up to 50%.

While the universalization of CSAs and APs is a key goal, it will also be important to continue tackling the limitations identified in the existing legal framework. Unaddressed, these limitations can hamper the process of assessing the nuclear programmes of States. For example, the list of equipment and materials for which States are required to provide export and import information under an AP could be expanded to reflect the evolution of nuclear technology as well as address items likely to be involved in the clandestine nuclear trade. Moreover, various voluntary reporting schemes providing relevant information not covered under existing agreements will need to be evaluated to see how the current irregular and limited reporting by States could be enhanced.

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[9] Based on IAEA document INFCIRC/153 (Corr.), approved in 1971, CSAs provide for the application of safeguards to all nuclear material in all peaceful nuclear activities in a State. All non-nuclear-weapon States party to the NPT or nuclear-weapon-free zones are required to conclude CSAs with the IAEA. Based on INCIRC/540 (Corr.), approved in 1997, APs provide for measures to strengthen the effectiveness and improve the efficiency of IAEA safeguards that cannot be implemented under the legal authority of CSAs.

[10] While a CSA provides the legal authority for the Agency to verify not only that declared nuclear material is not diverted to nuclear weapons but also that there is no undeclared nuclear material in a State, it is only for a State with both a CSA and an AP that the Agency has the practical tools to do so. The AP was developed to address these limitations after the IAEA's experiences in the 1990s in Iraq and the Democratic People's Republic of Korea highlighted the need for improving the Agency's ability to detect undeclared nuclear programmes.

[11] Such efficiencies can be gained through the implementation of 'integrated safeguards', which are the optimum combination of all measures available under CSAs and APs to achieve maximum effectiveness and efficiency, allowing measures to be applied at reduced levels at certain facilities. Integrated safeguards can be implemented only after the IAEA has drawn a broader conclusion concerning the absence of undeclared nuclear material and activities in the concerned State.

[12] This section considers changes to the verification programme in light of the 2030 projections because preparations for the future will need to take place well in advance, even before 2020.

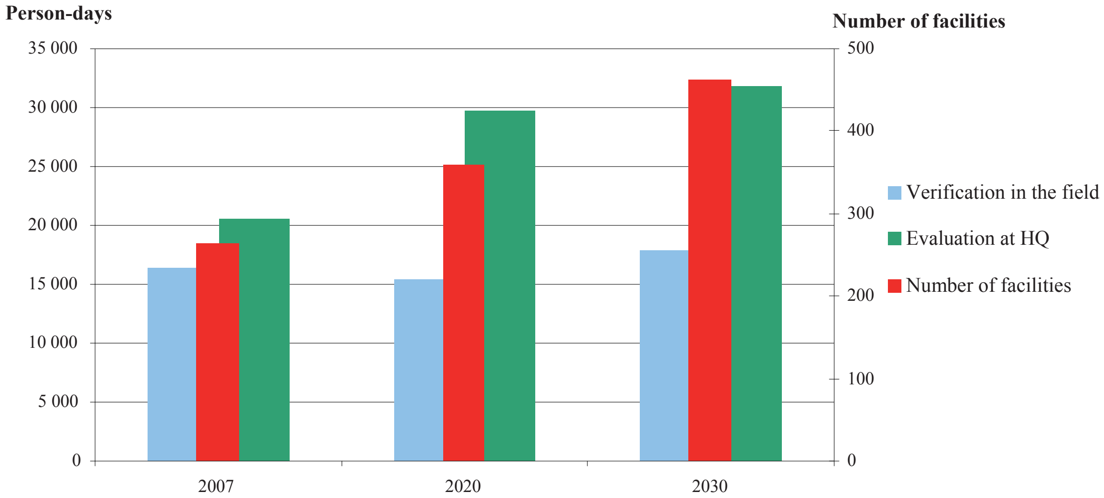

FIG. 2. Person-days for verification and evaluation and number of facilities to be verified (based on the IAEA's high projections of the number of facilities that will be subject to safeguards).

Besides expanding the legal tools, the Agency will need to move with the times when it comes to its technical capabilities. Having state-of-the-art verification technology will remain an important requirement, particularly for the detection of clandestine nuclear activities. The IAEA would benefit greatly from having the capacity to commission R&D in safeguards technology, be it in cooperation with Member States or the commercial market. It will need to strengthen existing detection capabilities, especially with regard to environmental sampling, satellite imagery and information analysis. For example, the increasing number of environmental samples taken will require the IAEA to improve its own laboratory capabilities as well as to expand its network of analytical laboratories in Member States.

The IAEA will also have to overcome technological challenges. With the volume of spent fuel projected to almost double by 2020, the IAEA will seek to review its current safeguards approaches. The increasing number of facilities approaching the end of their life cycles presents another growing verification challenge during the shutdown and decommissioning phases. In addition, new types of nuclear reactors and associated nuclear fuel cycle technologies will emerge, requiring the IAEA to begin designing dedicated safeguards approaches and techniques well in advance. The IAEA will also work with States and facility providers and operators to design and operate 'safeguards friendly' nuclear installations to facilitate efficient and effective verification.

"It is foreseen that the Agency will continue supporting States which cannot fulfil their safeguards related obligations due to lack of resources and also enhance cooperation with States with highly developed systems to fully optimize safeguards implementation."

Covert nuclear trade networks will also impose new demands. A worldwide analytical approach cross-referencing all nuclear trade relevant information will be required. To detect attempts by covert networks to acquire nuclear material and technology, the IAEA needs information from States, particularly with regard to procurement enquiries and export denials. Information on suspicious orders received, but not filled, by private companies provides valuable early information.

Even with the most sophisticated verification system, the IAEA must be able to count on the cooperation of States through State or regional systems of accounting for and control of nuclear material, systems which are required under CSAs. It is foreseen that the Agency will continue supporting States which cannot fulfil their safeguards related obligations due to lack of resources and also enhance cooperation with States with highly developed systems to fully optimize safeguards implementation.

Moreover, in view of their mutually reinforcing effect, the IAEA might even in the long term explore the possibility of integrating certain activities related to safeguards, safety and security. This could create potential synergies and efficiencies.

Towards a new framework for the nuclear fuel cycle: Non-proliferation benefits

IAEA verification has undergone a remarkable transformation in the last decade. To continue to serve the international community in a rapidly changing world, the IAEA must recognize change, adjust and take on new roles and tasks to meet new demands.

As discussed in a previous section, the projected expansion in nuclear power may result in more States opting to develop a national fuel cycle. As a result, they will also master the proliferation sensitive parts. At the front end, the principal concern is the enrichment of uranium, and at the back end it is the separation of plutonium in reprocessing plants.

While effective and universal implementation of IAEA safeguards under CSAs and APs will remain the primary technical barriers to proliferation, the new framework referenced earlier could also help minimize proliferation risks resulting from the rise in uranium enrichment capacity and spent fuel reprocessing. By providing an assured supply of nuclear fuel, the new framework would reduce the incentive for States to develop full fuel cycle capabilities at the national level, therefore reducing the number of sites where sensitive facilities are operated. Thus, multinationally controlled or owned fuel cycle installations would provide enhanced assurance to the international community that the most sensitive parts of the civilian nuclear fuel cycle are less vulnerable to misuse.

Verifying nuclear disarmament

Although the IAEA's primary role is the verification of the non-proliferation commitments of States under the NPT and nuclear-weapon-free zone treaties, its Statute provides for a possible role in assisting States in the verification of nuclear disarmament.[13] Indeed the IAEA Statute directs the Agency to conduct its activities "in conformity with policies of the United Nations furthering the establishment of safeguarded worldwide disarmament".[14]

The NPT represents a balance of rights and obligations with regard to nuclear disarmament, non-proliferation and the peaceful use of nuclear energy. While non-nuclear-weapon States pledged to forego nuclear weapons and accept IAEA safeguards on the entirety of their nuclear activities, the weapon States made a commitment to "pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament".[15] In the future, the IAEA may be called on to assist in the verification of various steps towards the achievement of that goal.

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[13] Under Article III.A.5 of the IAEA Statute, the IAEA is authorized "to apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State party, to any of that State's activities in the field of atomic energy".

[14] Article III.B.1 of the IAEA Statute.

[15] Article VI of the NPT.

For example, the nuclear weapon States may place additional nuclear material that is excess to their military needs under safeguards or convert it into forms unusable in weapons or useful for peaceful purposes, such as nuclear fuel. The IAEA is already verifying small quantities of unclassified forms of excess fissile materials. Moreover, it has developed a verification system for classified forms under the Trilateral Initiative with the Russian Federation and the USA,[16] which has been ready for implementation since 2002. However, no material has yet been made available to be placed under IAEA monitoring.

The IAEA should also be ready to break new ground by beginning to verify other nuclear disarmament activities, for which it has the necessary competence and experience. For example, a treaty banning the production of fissile material for nuclear weapons would be an important development as well as a key element of the new fuel cycle framework.[17] Should negotiations begin and conclude successfully, this could have a major impact on the IAEA if it were tasked to verify compliance. Previous estimates indicate that the cost of such verification could be very significant — comparable to the cost of current IAEA safeguards verification (€140 million per year).

"The IAEA should also be ready to break new ground by beginning to verify other nuclear disarmament activities, for which it has the necessary competence and experience."

In the future, the IAEA may also be called upon to again verify the dismantling of actual nascent nuclear weapons programmes — another area for which it has the necessary competence and experience, as demonstrated by its support in the dismantlement of the weapons programmes in South Africa, Iraq and the Libyan Arab Jamahiriya.

[16] Report on the Trilateral Initiative: IAEA verification of weapon-origin material in the Russian Federation & the United States, IAEA Bulletin **43** 3 (2001) 49.

[17] Such a treaty is commonly referred to as the Fissile Material Cut-off Treaty (FMCT), suggesting a focus on prohibiting production after an agreed cut-off date, or the Fissile Material Treaty (FMT) that would seek to address also past production (existing stocks of fissile material).

Resourcing the IAEA

The preceding sections have identified the anticipated areas of substantial increases and decreases[18] in the activities of the IAEA by 2020. Overall, for the IAEA to carry out those activities, significant additional funding will be required — even after reducing activities in areas of lower priority and realizing all possible efficiency gains.

In that context, this section first describes the Agency's current financial situation, and then considers how existing funding mechanisms, as well as new innovative sources — together with efficiency measures — might be used to address both it and future challenges. Issues faced as regards human resources are also highlighted.

The current financial situation

The IAEA was described in 2003 by the UN Secretary-General's High-level Panel on Threats, Challenges and Change as an "extraordinary bargain".[19] And in 2006, the US Office of Management and Budget gave a unique virtual 100% value-for-money rating to the US contributions to the IAEA.[20]

At the same time, however, in 2002, an independent external review[21] determined that the IAEA was showing signs of systems stress and could not sustain its achievements in the long term. The study recognized that applying the UN-wide policy of maintaining budgets at a constant level — the policy of 'zero real growth' — to the IAEA with its expanding programme requirements had resulted in the deferral of investment in systems and human resources development, and in neglected investments in infrastructure and equipment.[22] The report also concluded that this would result in a 'dilution of technical knowledge in core organizational competencies'.

"The zero real growth policy has prevailed in Member State decision making regarding the IAEA budget for much of the past two decades."

The zero real growth policy has prevailed in Member State decision making regarding the IAEA budget for much of the past two decades. Exceptionally, in 2003 — facing the possibility of a failure of the Agency's safeguards system — a 10% increase in the budget was approved, to be phased in over four years (2004–2007).[23] This increase was directed at immediate operational shortfalls, but, again, did not address the looming infrastructure deficit. Otherwise, increases during the last twenty years have been limited to responding to compelling, immediate demands such as follow-up to the accident at Chernobyl, or urgent safeguards requirements. Meanwhile, some other needs have been funded on an ad hoc basis with donations from Member States, often with restrictive or conditional clauses burdening their use, and partially from efficiency gains.

[18] Possible areas for decrease could include: hydrogen production; nuclear fusion; uranium mining; radioimmunoassay; the use of large radioactive sources for cancer treatment; food irradiation; non-destructive testing; assessing dam safety; standard environmental monitoring and radioecology; research in Agency laboratories; nuclear forensics; and the provision of equipment for border monitoring.

[19] United Nations General Assembly, A/59/565, 2 December 2004.

[20] Contributions to the IAEA, http://www.whitehouse.gov/omb/expectmore/summary/10004639.2006.html (2006).

[21] "At What Cost, Success", Mannet of Switzerland, 14 October 2002.

[22] With regard to neglected or deferred investments, the current funding deficit for infrastructure and IT projects is estimated at €80 million, with an additional €180 million in unfunded liabilities for contributions towards health insurance for qualified retirees, and other employee separation benefits.

[23] See IAEA document GC(47)/INF/7.

The pressing need to upgrade the IAEA Safeguards Analytical Laboratory (SAL) is an example of the current situation. The laboratory evaluates sensitive samples taken at nuclear facilities — analyses that must be performed in a cost effective, accurate, confidential and timely manner. SAL was built in the mid-1970s and its maintenance and the investment in its equipment have been deficient as yearly budgets were mainly used for operational costs. A sum of approximately €50 million is now needed to prevent a potential failure in this area, which could put the credibility of IAEA safeguards at risk.

Expensive technical equipment (sometimes running to tens of millions of euros) has to be installed in facilities for safeguards purposes. In the longer term, it might be considered whether part of the cost of such equipment could reasonably be borne on a routine basis by the facility under safeguards and/or the Member State concerned.

The Agency's required implementation in 2010 of the International Public Sector Accounting Standards (IPSAS) will provide at least a mechanism for the accumulation of funds for infrastructure and other investments — a mechanism that does not exist at present — and will generally improve effectiveness in the management of financial resources and information. But IPSAS itself will not alleviate the underlying funding deficit.

Funding options

Currently, two thirds of the IAEA budget — €300 million — comes from assessed contributions by Member States ('regular budget'), while the remaining third — €150 million, including funding for the technical cooperation programme — comes from voluntary contributions, again mostly from Member State governments.

It is critical that full funding for Agency activities in the areas of safety, security and safeguards be secured through assessed contributions, rather than have them rely partially — as at present — on less secure voluntary or 'extrabudgetary' contributions. In that regard, it should be noted that currently 90% of the nuclear security programme, 30% of the nuclear safety programme and 15% of the verification programme are dependent upon voluntary funding.

> *"It is critical that full funding for Agency activities in the areas of safety, security and safeguards be secured through assessed contributions, rather than have them rely partially ... on less secure voluntary or 'extrabudgetary' contributions."*

The introduction of a contingency fund financed from assessed contributions would further alleviate the uncertainty associated with the timing of receipt of Member State contributions and help respond to emergencies and unforeseen events, such as nuclear accidents or terrorist attacks, or urgent verification requests. The unanticipated request in 2007 for the Agency to conduct verification activities related to the shutdown of nuclear facilities in the Democratic People's Republic of Korea, for example, required a sudden fundraising effort to finance this unfunded activity.

The important technical cooperation activities are currently funded entirely by the voluntary Technical Cooperation Fund, and the minimum annual targets for the level of that fund, set by Member States, are not being fully met. And, despite a steady increase in the services delivered through the technical cooperation programme, there remain a significant number of approved projects for which no funds are available. The funding of this programme in a more predictable and assured manner is essential.

Voluntary funds to support a limited number of very specific projects or activities and in-kind contributions, such as equipment, services and expertise, will nonetheless continue to be necessary. However, these types of contributions reflect the donor's priority, conditions are often attached to their use, and their timing is unpredictable, thus rendering objective programmatic decision making difficult. A good practice identified internationally to address these limitations is the provision of voluntary contributions in support of broad thematic areas — rather than specific projects or activities. Such contributions are provided with very limited conditions. Contributions of this nature from a variety of sources can be pooled and can be provided on a multi-year basis to facilitate the predictability of funds.

By 2020, the IAEA will also have explored, and, wherever possible, utilized, additional and innovative funding mechanisms, as appropriate.

In this regard, private donations are playing an increasing role in funding international public goods, and will be sought in a broader and more systematic manner. The Nuclear Threat Initiative,[24] for example, has offered the Agency $50 million for a nuclear fuel bank project contingent upon it raising an additional $100 million from other donors and gaining agreement on the structure of such a bank.[25]

Endowments in the form of gifts of money or other assets, such as those common in universities and other public organizations, could also be a source of additional income.

And finally, in keeping with a growing trend in national and international public service organizations, user fees could be charged, for example in connection with the IAEA's provision of training, technical assistance, equipment, safety guidance or inspection services.[26]

Efficiency measures

The Secretariat will continue to vigorously pursue opportunities to improve its efficiency, both in its programme activities, as well as in its management practices. In the timeframe to 2020, it will redouble its efforts through an institutionalized 'quest for efficiency', adopting proven practices while keeping its focus on its core activities and those to which it can bring a high added value.

"Information and communication technology will continue to play a critical role in improving the way the IAEA delivers its programme and communicates, both internally and externally."

Information and communication technology will continue to play a critical role in improving the way the IAEA delivers its programme and communicates, both internally and externally. In particular, an enterprise resource planning system will be in place. The benefit of such an integrated information system to support programmatic activities has been demonstrated in the private and public sectors and in other international organizations and a 2006 feasibility study concluded that it would result in efficiency savings equivalent to €6 million per annum in staff time, a 25% return on investment.

The Secretariat will be using best practice tools, including a comprehensive application of quality management, and benchmarking, and it will continue its commitment to a more systematic approach to

24 A non-profit organization with a mission to strengthen global security by reducing the risk of use and preventing the spread of nuclear, biological and chemical weapons.

25 NTI Press Release, December 28, 2007. In addition, the US Congress allocated an additional $50 million on 26 December 2007.

26 The IAEA would not be unique in doing this. For example, OPCW, ITU and WIPO offset part of their budgets with such fees.

identifying, quantifying and reporting on efficiency gains. In the 2020 timeframe, a number of additional opportunities for outsourcing will be considered, including: laboratory work (where independence and confidentiality are not issues), translation, publishing and printing, conference services and procurement.

Human resources

The IAEA depends upon a specialized, high calibre and talented workforce. Over 60% of the regular budget is currently spent on staff, most of it with substantial experience in nuclear science and engineering. And with a diminishing pool of nuclear professionals on which to draw, and increasing competition from the private sector, staffing the IAEA is becoming an increasing challenge.

At the same time, there is growing complexity in the work to be done. Future safeguards inspectors, for example, will increasingly need not only to be knowledgeable about traditional and advanced fuel cycles and plant operations, but also to possess sophisticated analytical skills in the detection of early signs of weapons development.

Yet, in the face of these challenges, the Agency is constrained by the UN ‘Common System’, which governs employment rules and procedures and salary levels. If the Agency is going to be able to attract the high quality professionals on which it depends, the salary structure, benefits system and other conditions of service must become more flexible.

Concluding Remarks

The major challenges likely to face the Agency in the 2020 timeframe are: growth in the use of nuclear power, brought on by the demand for clean energy; greater demand for the use of nuclear applications in health, food and the environment; increased emphasis on maintaining a high level of safety; combating the threat of nuclear terrorism; and strengthening of the safeguards system to ensure its effectiveness, credibility and independence.

If sufficient resources are not made available, some activities which the Agency has hitherto carried out would need to be assigned lower priority, with a corresponding reduction in effort.

The provision of the necessary support for the IAEA to carry out its mandate effectively must be seen in the context of the consequences of its not being able to do so — such as increased risks of nuclear accidents, nuclear terrorism and proliferation, and reduced access by Member States to beneficial nuclear technologies and expertise to meet basic human needs, including energy.

Overall, the international community must be able to maintain its reliance on the IAEA for authoritative and objective information and impartial assessments on issues of crucial importance. For the Agency to remain an 'extraordinary bargain' and fulfil its unique role in peace and development, the continued confidence of Member States, expressed through the provision of adequate resources, will be essential through 2020 and beyond.

Abbreviations

GC	General Conference of the IAEA
INFCIRC	Information Circular (IAEA)
Interpol	International Criminal Police Organization
ILO	International Labour Organization
ITU	International Telecommunications Union
NGO	non-governmental organization
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
OECD/NEA	Nuclear Energy Agency of the OECD
OPCW	Organisation for the Prohibition of Chemical Weapons
WANO	World Association of Nuclear Operators
WCO	World Customs Organization
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WNA	World Nuclear Association