NUCLEAR ENERGY AND THE IAEA:

FOSTERING THE EFFICIENT AND SAFE USE OF NUCLEAR POWER

Foreword: Addressing the Global Energy Imbalance

Any discussion of 21st century energy trends must take into account the global energy imbalance. Roughly 1.6 billion people still lack access to modern energy services, and few aspects of development — whether related to living standards, health care or industrial productivity — can take place without the requisite energy supply. As we look to the century before us, the growth in energy demand will be substantial, and 'connecting the unconnected' will be a key to progress.

Another challenge will be sustainability; meeting these growing energy needs without creating negative side effects that could compromise the living environment of future generations.

Nuclear power is not a 'fix-all', but it will certainly be part of this mix of solutions, and the expectations for the expanding use of nuclear power are rising. In addition to the growth in demand, these expectations are driven by: energy security concerns; nuclear power's low greenhouse gas emissions; and the sustained strong performance of nuclear plants.

Each country must make its own energy choices; one size does not fit all. But for those countries interested in making nuclear power part of their sustainable development strategies, the Agency stands ready to offer a broad range of assistance programmes.

Mohamed ElBaradei
IAEA Director General
Vienna, May 2006

IAEA headquarters at Vienna International Center, Austria



"The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."

- IAEA Statute, Article II, Objectives

Fulfilling a Promise

The "Atoms for Peace" bargain underlying the IAEA's creation in 1957 presaged the central agreement of the Non-Proliferation Treaty (NPT) of 1968 — countries choosing not to develop nuclear weapons would get international support for all peaceful uses of nuclear energy.

The principal use the IAEA founders had in mind was nuclear power. Nuclear power remains the most prominent peaceful application of nuclear energy.

There are 443 nuclear power plants in 30 countries providing 16% of the world's electricity. Most are in developed countries. In 2005, France generated 78% of its electricity from nuclear power, Belgium 56%, the Republic of Korea 45%, the USA 19% and the Russian Federation 16%.

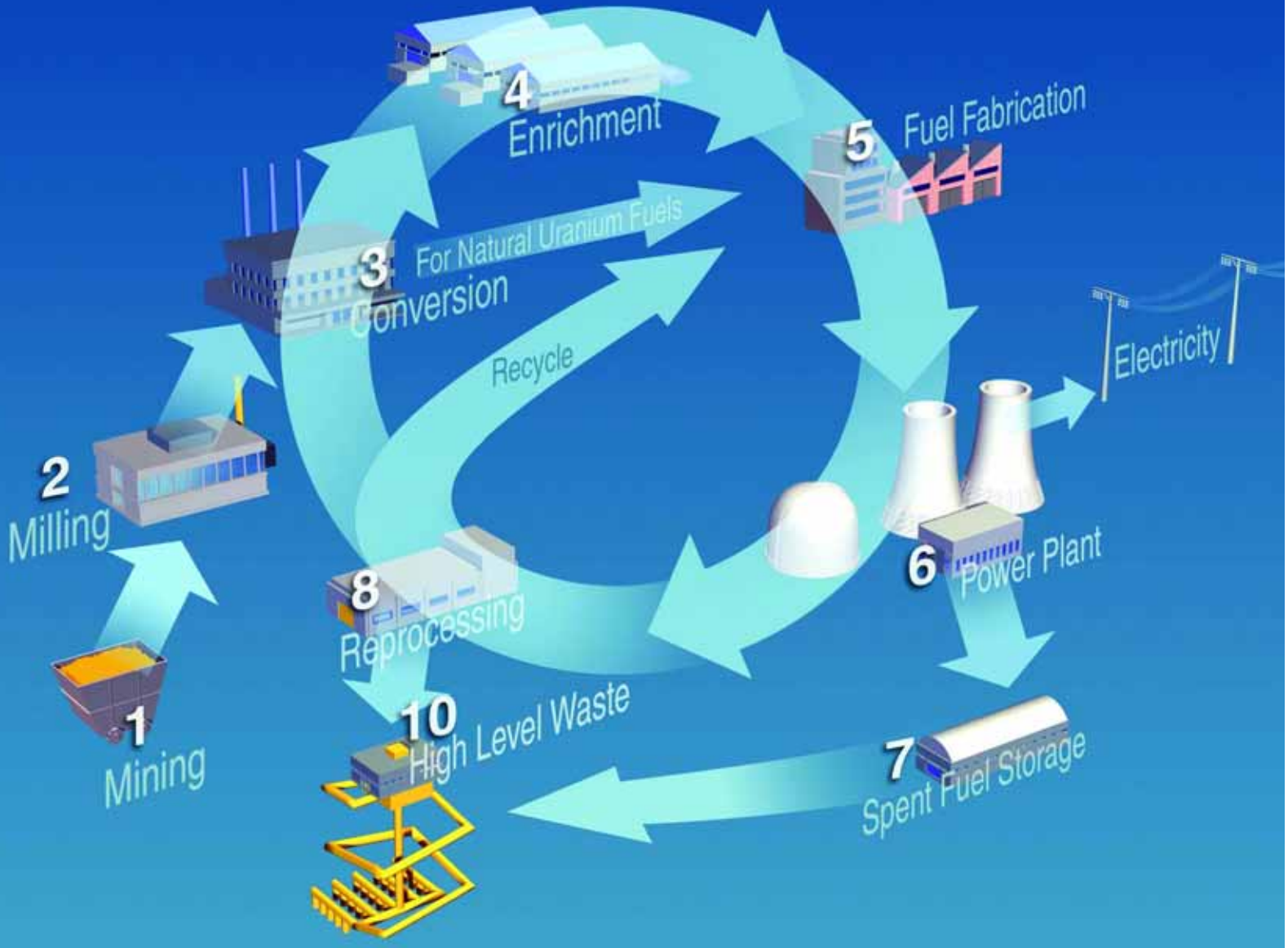
Expansion of nuclear power is centred in Asia. Of the 26 new reactors under construction, 16 are in Asia. Twenty-four of the last 34 to come on-line are in Asia.

Although China and India currently get only 2.2% and 2.8% of their electricity from nuclear power, both have burgeoning energy demands and major plans for nuclear expansion.

The Agency fosters the efficient and safe use of nuclear power by supporting interested Member States in:

- Improving the performance of nuclear power plants and the nuclear fuel cycle (see diagram next page);
- Catalysing innovation in nuclear power and fuel cycle technologies;
- Developing indigenous capabilities around the world for national energy planning;
- Deploying new nuclear power plants;
- Preserving and disseminating nuclear information and knowledge; and
- Advancing science and industry through improved operation of research reactors.

Nuclear Energy: Power for Living



Nuclear Fuel Cycle

1. Mining

The raw material for today's nuclear fuel is uranium.The largest resources are in Australia, Kazakhstan, and Canada. Thorium can also be used, but requires changes to reactors. Thorium is 3-4 times as abundant as uranium.

2. Milling

Uranium ore is crushed and chemically treated to separate the uranium. The result is 'yellow cake', a solid form of uranium oxide (U_3O_8).

3. Conversion

Less than one percent of yellow cake is uranium-235 (^{235}U), the isotope that maintains a nuclear power plant's chain reaction. To increase the concentration of ^{235}U, the yellow cake must be first converted to uranium hexafluoride gas (UF_6).

4. Enrichment

Most nuclear power plants require 'enriched' fuel with 2-5 percent ^{235}U. ^{235}U is concentrated using either porous membranes that allow ^{235}U through more easily than heavier isotopes, or spinning cylinders, 'centrifuges', where heavy isotopes are pushed out to the cylinder walls.

5. Fuel Fabrication

Enriched UF_6 is converted to uranium dioxide powder and formed into hard solid cylindrical pellets 8-15 mm in diameter. These are packed in long metal tubes, which are grouped in 'fuel assemblies'.

6. Electricity Generation

Controlled fission, or splitting, of ^{235}U atoms generates heat that is transferred in several steps to create high-pressure steam. The steam spins a turbine, which generates electricity.

7. Spent Fuel Storage

The useful life of a fuel assembly is 3-7 years. After removal, it is stored under water, which provides both cooling and radiation shielding. Later, it can also be stored dry in shielded buildings or casks.

8. Reprocessing

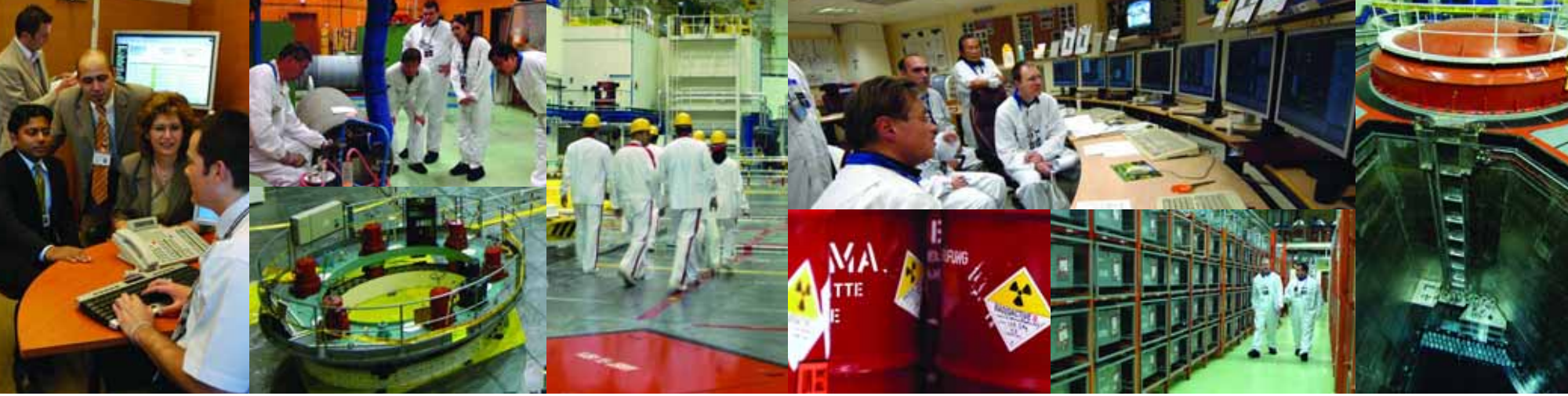
Material in spent fuel can be recycled to produce more energy. Some countries chemically reprocess spent fuel to separate the useable material from the unusable waste.

9. Decommissioning

Decommissioning follows permanent closure of a nuclear facility. It includes safe management of all materials on site, plant dismantling and site remediation for new use.

10. Waste Disposal

Waste will be packed in long-lasting containers and buried deep in geological formations chosen for their favourable geochemistry, limited water movement and proven stability over hundreds of millions of years, far longer than needed for high level waste.



Improving Performance

Nuclear power plants

The percentage of time that nuclear power plants are available to generate electricity has risen from an average of 73 percent in 1990 to 83 percent in 2004. The rest of the time they are shut down for refueling, maintenance, safety checks and improvements. The increased availability is due to advances in technology and management that improve productivity and safety.

Agency activities target improvements in quality management, maintenance, on-line monitoring, instrumentation and control, modernization programmes, outage management, corrosion control, structural integrity, staff training and knowledge management.

The Agency also helps to cost effectively schedule replacements, improvements, upgrades, licence renewals and decommissioning.

Agency assistance comes in many forms. The Agency

- Assembles expert teams to peer-review facilities to identify potential improvements;
- Maintains databanks on operating experience,
- Disseminates operating experience, new knowledge and best practices;
- Provides direct training and computer packages for distance learning;
- Publishes standards and guidelines;
- Publishes technical guidance and reference documents and
- Coordinates research among groups working on common problems.

The fuel cycle: front end

Resource exploration to fuel performance

The Agency disseminates authoritative data on uranium and thorium resources, exploration, mining and production. It assists developing countries in uranium exploration. Through published guidelines, on-site missions, technical exchanges, on-line resources and international conferences, the Agency promotes best environmental practices in uranium mining, production and mine remediation.

The reliable performance of nuclear fuel is a major determinant of cost-effectiveness and safety. The Agency provides an important forum for the exchange of information, research, practical experience and best practices on all aspects of nuclear fuel. Agency efforts focus on more demanding operational strategies, lower failure rates, greater operational flexibility and advanced fuel designs.

The fuel cycle: back end

Spent fuel storage, waste management and decommissioning

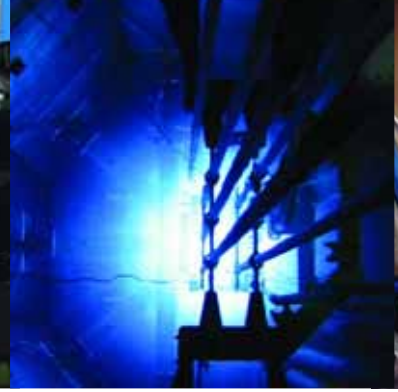
The nuclear industry has half a century's successful experience with spent fuel storage. The Agency helps Member States extend storage capacity by providing on-site evaluations, guidance and information. It maintains multiple spent fuel, waste management and fuel cycle facility databanks, and is an authoritative source of independent analyses on nuclear fuel cycle issues worldwide.

The Agency builds capacity in geological disposal through its Network of Centres of Excellence on Training and Demonstration of Disposal Technologies in Underground Research Facilities. It conducts peer-reviews through its Waste Management Assessment and Technical Review Programme (WATRP).

It directly aids countries in disposing of used radiation sources from medical and industrial applications, and provides guidance, information, best practices and planning assistance for decommissioning nuclear facilities, for site remediation, for preparing radioactive waste and for final repository design, operation and closure.

The Agency convenes review meetings under the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management to promote transparency, best practices and steady improvement.




Catalysing Innovation

The 21st century promises the most competitive, globalized markets in human history. Future expansion of nuclear power will require continued innovation.

The Agency serves as a catalyst. It helps Member States resolve scientific and technological issues related to nuclear power and to non-electric nuclear reactor applications such as seawater desalination, and heat and hydrogen production. The Agency coordinates research and promotes information exchange for current reactor lines and for innovative nuclear energy systems. These include small and medium sized reactors that may be particularly suitable for developing countries and non-electric applications.

The Agency provides a unique forum for collaboration among developing and industrialized Member States. It helps to pool R&D resources towards common goals through IAEA Technical Working Groups for water cooled reactors, gas cooled reactors and fast reactors. The Agency's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), with 24 members from developing and industrialized countries, facilitates joint international assessments of innovative nuclear energy systems.

Planning the Energy Future

Poverty eradication and sustainable development require clean affordable energy services. Expanding energy access requires planning. The Agency helps developing countries build their energy planning capabilities. The Agency develops and transfers planning models and data; it trains local experts; and it helps establish local expertise to chart national paths to sustainable development. Its energy planning tools are used in 109 countries.

The Agency helps keep the nuclear option open by being in the midst of international negotiations and studies that set the stage on which nuclear power competes, and through economic assessments of nuclear power and its environmental impacts.

It is the lead agency for two World Summit on Sustainable Development (WSSD) energy partnerships — on 'Indicators for Sustainable Energy Development' and 'Country Profiles on Sustainable Energy Development'.

Deploying New Nuclear Power Plants

For Member States embarking on a nuclear power programme, the Agency provides assistance in planning and nuclear power infrastructure development. Infrastructure includes financial and human resources, physical infrastructure, legal and regulatory frameworks, stable political and stakeholder support, non-proliferation verification and physical security.

Managing Nuclear Knowledge

Expansion of nuclear power requires continuous nuclear knowledge transfer. The Agency assists knowledge transfer and helps link established centres of competence with centres of growth. It helps preserve knowledge for countries experiencing workforce ageing and attrition.

The Agency provides guidance and offers on-site missions to Member States to help maintain the necessary skill base, workforce levels and access to accumulated knowledge. It supports networks of educational institutions. Its International Nuclear Information System (INIS), with over two million bibliographic records plus a unique collection of full text non-conventional literature, is the world's leading information system on the peaceful uses of nuclear science and technology.

Advancing Nuclear Research

There are 274 research reactors operating in 55 countries. Research reactors produce radioisotopes for industrial, medical, agricultural and environmental applications. They help train new talent for the nuclear workforce, and they foster development and innovation through testing new fuels and materials.

The Agency has developed norms of good practice for all aspects of the research reactor fuel cycle. It helps develop strategic utilisation plans covering increased commercial use, refurbishment of ageing equipment, managing growing spent fuel inventories and planning for decommissioning. It promotes regional cooperation for expanded mutual advantage.

To reduce proliferation risks, the Agency supports programmes to convert research reactors from highly enriched uranium (HEU) fuel, suitable for weapons, to low enriched uranium (LEU), unsuitable for weapons. The Agency brings together fuel developers, manufacturers and users to set guidelines for LEU fuel; it participates directly in returning HEU research reactor fuel to its country of origin; and it maintains databases essential to programmes on both fuel conversion and HEU fuel return.

IAEA

International Atomic Energy Agency

Atoms For Peace

http://www.iaea.org/
http://www.iaea.org/OurWork/ST/NE/index.html

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