

# Nuclear Power's Changing Picture

by Mohamed ElBaradei

**The world's rising demand for electricity will take a mix of energy sources.**

**E**nergy is essential for development. Nearly every aspect of development — from reducing poverty to improving health care — requires reliable access to modern energy services. When these development needs remain unaddressed, the resulting misery often leads to conflicts and violence, which in turn affect development efforts and impact on regional and global stability.

In this context, it is important to consider the global energy imbalance. Roughly 1.6 billion people live without access to electricity, and 2.4 billion rely on traditional biomass because they have no access to modern fuels.

In my view, global energy security means fulfilling the energy needs of all countries and peoples — including the one-quarter of our fellow human beings who have no access to modern energy systems. The Organisation for Economic Cooperation and Development (OECD) International Energy Agency reports that if current consumption trends and government policies continue, we will see a 53% increase in global energy consumption by 2030 — and 70% of the coming growth in demand will be from developing countries. It has also said that the increased use of nuclear power would help to meet the increase in energy demand, enhance the security of energy supplies and mitigate carbon emissions.

Naturally, nuclear energy alone is not a panacea, but it is likely in the near future to have an increasing role as part of the global energy mix. Why are we witnessing a resurgence of interest in nuclear power, and what challenges lie ahead for a country that is considering a nuclear power programme?

## The global status

There are 439 nuclear reactors in operation in 30 countries. These reactors supply about 15.2% of the world's electricity.

To date, the use of nuclear power has been concentrated in industrialized countries. In terms of new construction, however, the pattern is different; 16 of the 30 reactors now being

built are in developing countries, and most of the recent expansion has been centred in Asia. China, for example, currently has four reactors under construction, and plans a more than five-fold expansion in its nuclear generating capacity over the next 15 years. India has seven reactors under construction, and plans roughly a seven-fold increase in capacity by 2022. Japan, Pakistan and the Republic of Korea also have plans to expand their nuclear power capacity.

In the near future, we may well see additional countries in the Asia-Pacific region choosing the nuclear power option. Vietnam intends to begin construction of its first nuclear power plant in 2015. Indonesia plans to build two 1000 MW reactors in central Java. Recently, the Energy Generating Authority of Thailand announced plans to build two large nuclear plants, with construction to begin in 2015. In Malaysia, a comprehensive energy policy study — including consideration of nuclear power — is to be completed by 2010.

The resurgence of interest in nuclear power is not limited to Asia. Other countries such as Jordan and Turkey are seriously considering or planning for the introduction of nuclear power programmes, and many others, such as Argentina, Bulgaria, Kazakhstan and South Africa, are working to expand existing programmes.

## Reasons for rising interest

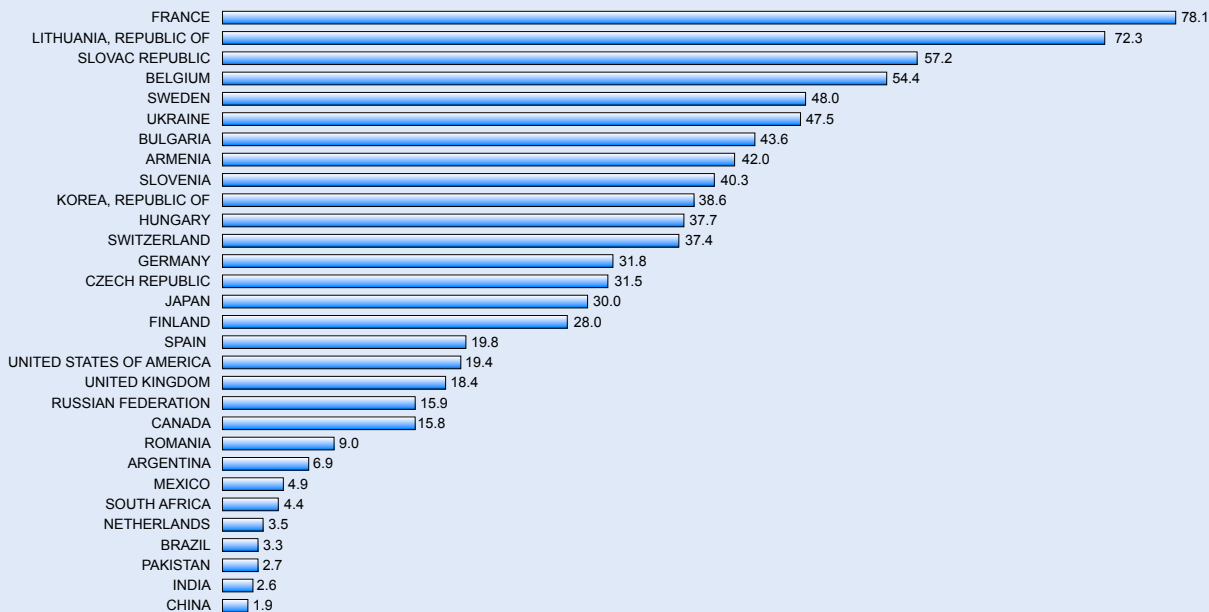
The reasons for renewed interest are several:

### *Energy diversity and energy security*

For many countries, nuclear power is a way to enhance the security and diversity of their energy supplies. This was also true in the 1970s, when concerns about energy security, triggered by disruptions in oil supply, were a major cause of nuclear expansion in countries such as France and Japan. Today, France depends on nuclear power for 78% of its electricity supply. In Japan the figure is 30%.

Energy security concerns are with us again. For some, diversifying a country's suppliers and sources of energy is an essential buffer against fluctuations in the market prices

## Nuclear Share of Electricity Generation Worldwide



Percentages for the year 2006. Source: IAEA. For the latest statistics, visit [www.iaea.org](http://www.iaea.org) and view the Power Reactor Information System (PRIS).

of fossil fuels. For others, energy security concerns may be rooted in the potential instability of political relationships with large oil and natural gas producers.

### Carbon emissions and environmental concerns

But another factor driving the interest in nuclear power is that it emits almost no greenhouse gases (GHG). The complete nuclear power chain — from mining the uranium and manufacturing the fuel to constructing and operating the reactor and disposing of the waste — emits only 1.6 grams of carbon equivalent per kW/h. This is about the same negligible emission rate as wind and hydropower and many times less than coal, oil and natural gas.

Increasing international attention is being given to the impacts of carbon emissions from fossil fuels. The 2007 G8 summit said it would work to bring the major GHG emitting economies into a new international emissions-reductions framework in the near future, and would consider a goal of cutting global emissions in half by 2050. Given its low emissions, nuclear power is seen by many as part of the solution.

### Strong performance

An important factor also driving the renewed interest in nuclear power is its strong performance record. Nuclear power is a mature technology with more than half a century of operating experience. And the past two decades have seen significant improvements in nuclear power plant reliability as well as lower operating costs and a progressively improved safety record.

## Key aspects to consider

But for nuclear power to continue to be viable as a source of energy, a number of concerns will need to be addressed.

### Nuclear safety

First, consider nuclear safety. The Chernobyl accident in 1986 was clearly a setback to nuclear power. Many lives were lost. Thousands suffered major health impacts, and there were significant environmental and social impacts. The accident was the result of an old reactor design, compounded by gross safety mismanagement. But ironically, this event also prompted major improvements in our approach to nuclear safety.

A key change was the development of a so-called international 'nuclear safety regime'. International conventions were put in place, creating legally binding norms to enhance the safety of nuclear activities. The IAEA updated its body of safety standards to reflect best industry practices. And, importantly, both the IAEA and the World Association of Nuclear Operators (WANO), created international networks to conduct peer reviews and exchange operating information to improve safety performance.

The international nuclear safety regime over the years has produced many insights on how to minimize safety risks. But we should not rest on our laurels. It is essential that existing safety standards, operational practices and regulatory oversight are adapted — and in some cases strengthened — to ensure enhanced levels of safety into the future.

## **Nuclear security**

Nuclear security has also become a major concern in recent years. The indiscriminate attacks by extremist groups in many regions have led to the re-evaluation of security in every industrial sector, including the nuclear sector. In the past five years, the IAEA, in cooperation with many nations, has worked on every continent to help countries better control their nuclear material and radiological sources and protect their nuclear facilities.

## **Management of spent fuel**

The management of spent fuel and disposal of high level radioactive waste remain a challenge for the nuclear power industry. The amount of spent nuclear fuel produced annually — about 10,000 tonnes — is actually small when contrasted with the nearly 28 billion tonnes of carbon dioxide (CO<sub>2</sub>) waste from fossil fuels that are released directly into the atmosphere and, as I have noted, are the main source of climate change concerns. Experts agree that the geological disposal of high level radioactive waste is safe and technologically feasible. But public opinion will likely remain skeptical — and nuclear waste disposal will likely remain controversial — until the first geological repositories are operational and the disposal technologies fully demonstrated.

## **Nuclear non-proliferation**

At the same time that we are seeing rising expectations for nuclear power, we are equally witnessing concerns regarding the spread of nuclear weapons and of sensitive nuclear technology.

The 2006 nuclear test by the Democratic People's Republic of Korea (DPRK) and international concern about the nature of Iran's nuclear programme are two cases in point.

In my view, we are at a crossroads. It is essential and urgent for all parties to renew their commitments to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The Treaty rests on two pillars: non-proliferation and disarmament. That is, the commitment by non-nuclear-weapon States party to the NPT not to pursue nuclear weapons; and the equal commitment by nuclear-weapon States to move towards nuclear disarmament. These commitments are mutually reinforcing.

The pace of nuclear disarmament has been slow. We still have 27,000 warheads in existence. And it is becoming painfully clear that, as long as some countries place strategic reliance on nuclear weapons, other countries will be tempted to emulate them. We cannot delude ourselves into thinking otherwise.

On the nuclear non-proliferation front, the IAEA plays a central role. Under NPT safeguards agreements, we inspect countries to verify that their peaceful nuclear programmes

are not used as a cloak to divert material to non-peaceful uses. But to be effective, it is essential that we are provided with the necessary authority, information, advanced technology, and resources.

As more countries industrialize, controlling the spread of technology is becoming increasingly difficult. Particularly sensitive are nuclear operations such as enrichment and spent fuel reprocessing — activities that are part of a peaceful nuclear programme, but also can be used to produce the high enriched uranium and plutonium used in nuclear weapons. Countries that have such operations are only a short step away from a nuclear weapons capability.

For some time, I have been advocating that we should consider a multinational approach to enrichment and reprocessing — to ensure that no one country has the capability to independently produce sensitive nuclear material. This would occur in two steps.

The first step would create a mechanism for the 'assurance of supply' of nuclear fuel, possibly including a fuel bank to be managed by the IAEA.

For countries that use nuclear fuel for electricity generation, this mechanism would serve as a supplier of last resort, thereby removing the risk of having their fuel supply interrupted for non-commercial reasons.

The second step would seek to bring any new operations for uranium enrichment and plutonium separation under multinational control. These multinational controls should also be extended to facilities that already exist — to ensure that all countries are treated equally in terms of their nuclear capabilities.

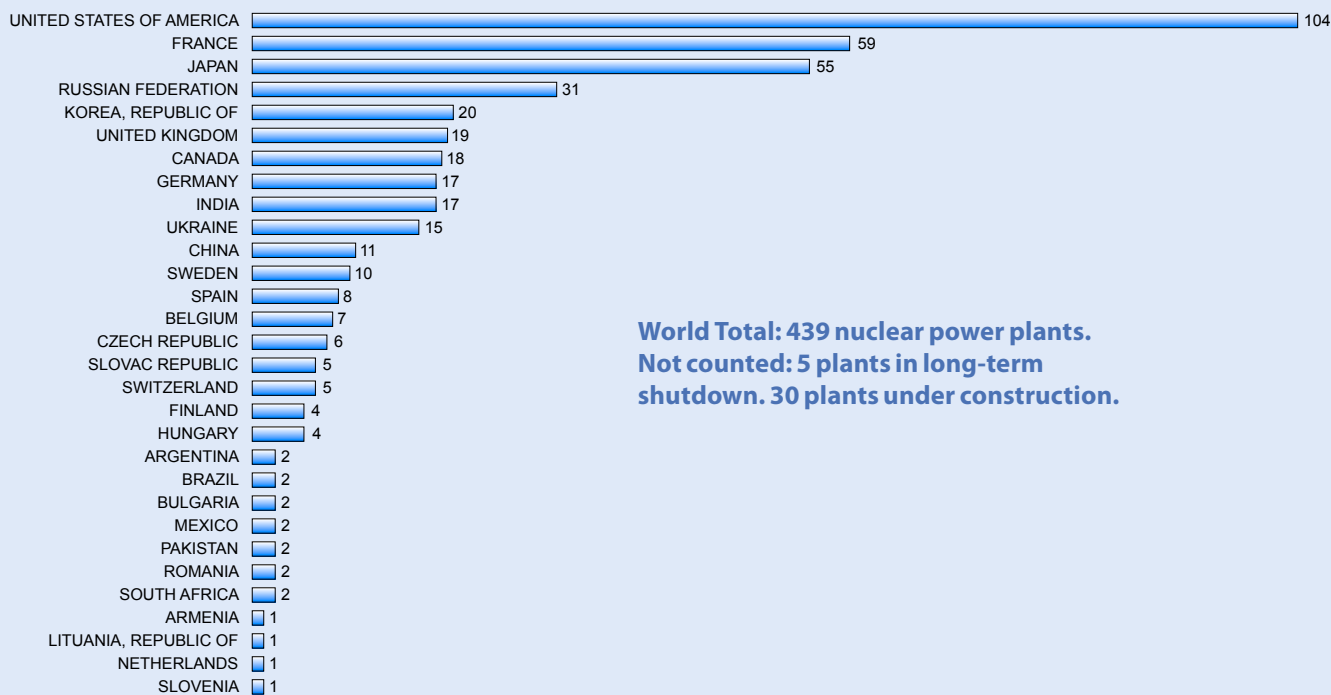
## **Technological innovation**

The future of nuclear power will also be greatly impacted by technological innovation — the development of new reactor and fuel cycle technologies. As might be expected, current nuclear Research and Development (R&D) projects are focused on enhancing nuclear safety, reducing proliferation risks, minimizing waste generation and improving economic performance.

The IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) works to ensure that the future needs of all countries, in particular developing countries, are understood and taken into account when innovative nuclear systems are evaluated and developed.

Many developing countries have been particularly interested in efforts to develop small and medium-size reactor designs. These designs allow a more incremental investment than is required for a large reactor, and provide a better match to grid capacity in many developing countries. They are more

## Nuclear Power Plants in Operation Worldwide



**World Total: 439 nuclear power plants.  
Not counted: 5 plants in long-term  
shutdown. 30 plants under construction.**

Data as of August 2007. The world total includes 6 power plants in Taiwan, China. Source: IAEA. For the latest statistics, visit [www.iaea.org](http://www.iaea.org) and view the Power Reactor Information System (PRIS).

easily adapted to applications such as district heating and seawater desalination.

### Infrastructure needs

As a sophisticated technology, nuclear power requires a correspondingly sophisticated infrastructure. For new countries considering nuclear power, it is essential to ensure that the necessary infrastructure will be available. 'Infrastructure' includes many components — from industrial infrastructure such as manufacturing facilities, to the legal and regulatory framework, to the institutional measures to ensure safety and security, to the necessary human and financial resources.

When it comes to new nuclear infrastructure, there are three important questions. How much and what sort of infrastructure is needed? What is the desired timing for acquiring it? And should a country develop this infrastructure domestically, or should some parts be imported or shared with other countries?

Naturally, each country must make its own decisions. The IAEA is, however, ready and able to provide expert assistance in this area if requested.

### Public perceptions

I would note one final aspect that will be important in determining the future of nuclear power. That aspect is public perception.

The public's perception of risk has a strong influence on a country's energy choices. As with civil aviation, bioengineering, or any other advanced technology, nuclear power does not come with absolute safety guarantees. What is important is that the risks and benefits are clearly understood.

All members of the nuclear community — scientists, operators and safety regulators — should make every effort to provide accurate and easily understood information to improve public understanding of the risks and benefits of nuclear energy. Unfortunately, misconceptions can significantly influence public acceptance of nuclear power. It is essential that the nuclear community be seen as transparent and open in its activities, to increase understanding and confidence in the safe operation of nuclear facilities.

The need to ensure adequate and reliable energy supplies is directly relevant to development, and to national and international security. As such, energy will continue to be an important part of the global agenda for the foreseeable future.

At the IAEA, we stand ready to assist countries in finding solutions that are best suited to their needs and priorities.

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