NUCLEAR POWER: PREPARING FOR THE FUTURE

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It is a pleasure for me to address this conference on nuclear power for the 21st Century. Today I will discuss a few aspects of the evolving global scenario for nuclear power. All indicators show that an increased level of emphasis on subjects such as fast growing energy demands, security of energy supply, and the risk of climate change are driving a re-consideration, in some quarters, of the need for greater investment in nuclear power.

The decisions that emerge from this debate will have long range implications, and require a degree of planning that looks at least several decades into the future. This morning I would like to offer a brief review of the current picture, and to outline a number of issues that, in my view, will be crucial in determining the contribution of nuclear power to the future global energy mix.

THE GLOBAL ENERGY IMBALANCE

But I would like to begin by placing these topics in context — the context of our current global energy imbalance. I was personally reminded of this imbalance on a recent trip to Ghana and Nigeria. Per capita electricity consumption in Ghana is only about 300 kilowatt-hours per year, and in Nigeria it's closer to 70 kilowatt-hours per year. That translates to an average availability of 8 watts — less than a normal light bulb — for each Nigerian citizen. Contrast that with France, where per capita consumption is over 7300 kilowatt-hours per year — a factor of 100 times greater.

The imbalance in energy availability in developed versus developing countries is a matter of great impact. When we consider the Millennium Development Goals proposed just five years ago — such as the eradication of poverty and hunger, universal access to fresh water, and improved health care — it is quickly evident that the availability of energy overall, and electricity in particular, is central to our ability as an international community to deliver on each of those goals.

The disparity in energy supply is directly related to the disparity in standards of living, which in turn creates disparities in opportunity and hope — and, I would contend, leads to the sort of despair and insecurity that give rise to tensions in many regions of the developing world. Here, in the "City of Light", it might be easy to forget the common estimate that approximately 1.6 billion people around the world lack access to modern energy services; but as we look to the century that lies before us, "connecting the unconnected" will be a key to progress. the expected substantial growth in energy demand.

Given this context, any discussion of the energy sector in the 21st century must begin by acknowledging the expected substantial growth in energy demand in the coming decades. This expectation is based on three factors: the drive to raise living standards in the developing world to which I have already alluded, continued population growth, and the never-ceasing expansion in consumer products and technologies that increase the quality of life but consume additional energy.

Let me illustrate. If the developing world were raised to the global average energy consumption rate — about half the standard of Eastern Europe — the net result would be a 35% increase in global energy use. If we account for the population growth predicted by 2020, the net increase would be 60%. So it should be no surprise that even the most conservative estimates predict at least a doubling of energy usage by mid-century.

THE CURRENT PICTURE: AN EMERGING FOCUS ON NUCLEAR POWER

What remains unclear, of course, is what role nuclear energy will play in meeting this increased demand. While the current outlook remains mixed, there is clearly a sense of rising expectations for nuclear power. China plans to raise its total installed nuclear electricity generating capacity from the current 6.5 gigawatts to 36 gigawatts by 2020. India plans to expand its nuclear capacity 10-fold by 2022, and 100-fold by mid-century. The Russian Federation plans to raise its nuclear capacity from the current 22 gigawatts to 40–45 gigawatts by 2020.

Elsewhere, plans remain more moderate, but it is clear that nuclear energy is regaining stature as a serious option. When Finland pours the concrete for Olkiluoto-3 later this year, it will be the first new nuclear construction in Western Europe since 1991 — and Elecricité de France has recently selected Flamanville as the site of a European Pressurized Water Reactor, with construction set for 2007.

Increased Availability, Sustained Safety Performance, Improved Economics

Much of the increase in nuclear generating capacity over the past decade has been credited not to new construction, but to the increased availability of existing plants — a change tied directly to improvements in global safety performance. To understand the current picture, it is important to understand this trend.

The accident at Chernobyl in 1986 prompted the creation of the World Association of Nuclear Operators (WANO), and revolutionized the IAEA approach to nuclear power plant safety. Both organizations created networks to conduct peer reviews, compare safety practices, and exchange vital operating information to improve safety performance. The IAEA updated its body of safety standards to reflect best industry practices, and put in place legally binding norms in the form of international safety conventions. And a more systematic analysis of risk has been used to ensure that changes made were in areas that would bring the greatest safety return.

Although the focus of this international effort was on improving safety, the secondary benefit was a steady increase in nuclear plant availability and productivity — an increase also supported by improved management, better preventive maintenance practices and technological enhancements. The result is that existing well-run nuclear power plants have become increasingly valuable assets. Although the initial capital cost of a nuclear plant is high, the operating costs have become relatively low and stable. These improvements to safety and economics have been a strong factor in decisions to extend the licences of existing plants in the United States and elsewhere, and they are providing impetus for renewed consideration of new nuclear construction.

Clearly, however, not every country shares the view that improved economics and safety performance warrant a revival of nuclear power. For example, here in Western Europe, four countries currently have nuclear phase-out policies in place; and a number of others have stated policies against nuclear power. New nuclear power plants remain the most attractive in countries and regions where energy demand growth is rapid, alternative resources are scarce, energy supply security is a priority, and nuclear power is important for reducing air pollution and greenhouse gas emissions.

SHAPING THE FUTURE: CRITICAL ISSUES

Overall, the current picture remains mixed, and projections for the future of nuclear power vary widely depending on what assumptions are made. In my view, the primary value of these projections is that they highlight the factors that will influence the future of nuclear power. I would like to examine a few such issues.

Carbon Emissions and the Growth in Demand

The first issue is the degree to which global attention remains focused on limiting greenhouse gas emissions and reducing the risk of climate change. With the projected growth in energy demand I have already mentioned, the degree to which fossil fuels are tapped to meet this demand could have a major negative environmental impact.

Nuclear power emits virtually no greenhouse gases. The complete nuclear power chain, from uranium mining to waste disposal, and including reactor and facility construction, emits only 2–6 grams of carbon per kilowatt-hour. This is about the same as wind and solar power, and one to two orders of magnitude below coal, oil and even natural gas. Worldwide, if the existing nuclear power plants were shut down and replaced with a mix of non-nuclear sources proportionate to what now exists, the result would be an increase of 600 million tonnes of carbon per year. That is approximately twice the total amount that we estimate will be avoided by the Kyoto Protocol in 2010.

Nuclear should not be viewed as being in competition with 'renewable' sources of energy, such as wind, solar and geothermal plants. But the problem is that no 'renewable' source has been demonstrated to have the capacity to provide the 'baseload' amounts of power needed to replace large fossil fuel plants. ***Security of Supply***

A second factor is the current emphasis for many countries on ensuring the security of energy supply. The January 2004 Green Paper on Europe's supply security estimated that business-as-usual would increase dependency on imported energy from its current 50% to about 70% in 2030. A similar concern drove nuclear power investment in Europe and North America during the oil crisis of the 1970s. Large uranium resources in a given country or region are not a necessary pre-condition for nuclear energy security, given the diverse global roster of stable uranium producers, and the small storage space required for a long term nuclear fuel supply.

Public Perceptions and Misconceptions: shaping national choices

A third factor concerns the influence that public perceptions — including perceptions of risk — have on a country's energy choices. Nuclear energy has long been marked by feelings of unease and concerns about safety and waste. Nuclear power was dealt a heavy blow by the tragedy of the 1986 Chernobyl accident (a blow from which the reputation of the nuclear industry has never fully recovered). Little distinction has been made, in the media or in public understanding, between the design characteristics of the Chernobyl reactor and the hundreds of other reactors in operation around the world — nor have we properly publicized the array of measures put in place since Chernobyl to offset the possibility of another severe nuclear accident.

It is important for the nuclear community to make every effort to provide comprehensible, accurate information to support that debate, to ensure that the risks and benefits of nuclear technology are clearly and fairly understood. In keeping with that effort, the IAEA performs comparative energy assessments for Member States, and works to build Member States' capacities for national energy analysis and energy planning.

Performance in Addressing Key Concerns: safety, waste disposal and security

An extremely important factor — and one over which the nuclear community has some degree of control — is the ongoing performance of the nuclear industry in addressing key concerns related to nuclear power: namely, safety, waste disposal and, more recently, security.

Nuclear Safety

As I have already mentioned, the development of strong international nuclear safety networks over the past two decades has paid off, and I feel confident in saying that nuclear safety has significantly improved. But we should not rest on our laurels. As nuclear power technology continues to spread to new countries, as new reactor designs are developed and put to use, and as the licences of existing plants are extended, it is essential that existing safety standards, operational practices and regulatory oversight are adapted — and in some cases strengthened — to ensure acceptable levels of safety into the future.

Management and Disposal of Spent Nuclear Fuel

In terms of actual implementation, the management and disposal of spent nuclear fuel remains a challenge for the nuclear power industry. When the actual amount of spent nuclear fuel produced globally every year — 12 000 tonnes — is contrasted with the 25 ***billion*** tonnes of carbon waste released directly into the atmosphere every year from fossil fuels, the amount of nuclear waste seems relatively small. In addition, most technological hurdles to spent fuel disposal or reprocessing have already been solved. 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.

In this regard, the greatest progress on deep geological disposal has been made in Finland, Sweden and the USA. Finland's Government and Parliament have approved a decision 'in principle' to build a final repository for spent fuel near Olkiluoto. Construction should start in 2011 and operation in 2020. And in the US, the President and Congress in 2002 approved proceeding with the disposal site at Yucca Mountain, where operations are planned to begin by about 2012.

For some time, I have been advocating the consideration of multinational approaches to spent fuel management and disposal. More than 50 countries have spent nuclear fuel, including fuel from research reactors, stored in temporary sites, awaiting disposal or reprocessing. Not all countries have the right geology to store waste underground and, for many countries with small nuclear programmes, the costs of such a facility would be prohibitive.

Nuclear Security

Nuclear security has also gained importance in recent years. The September 2001 terrorist attacks in the United States naturally led to the re-evaluation of security in every industrial sector, including nuclear power. Both national and international nuclear security activities have greatly expanded in scope and volume; in the past two years, we in the IAEA have worked on every continent to help countries better control their nuclear material and radiological sources, protect their nuclear facilities and strengthen border controls. Here, too, the international community is making good progress; while much remains to be done, nuclear installations around the world have strengthened security forces, added protective barriers, and taken other measures commensurate with current security risks and vulnerabilities.

Technological and Policy Innovation

Last but by no means least, the future contribution of nuclear power will be greatly impacted by innovation — the development of new reactor and fuel cycle technologies. To be successful, these innovative technologies should address concerns related to nuclear safety, proliferation and waste generation — and must be able to generate electricity at competitive prices.

Small and medium-sized reactors allow a more incremental investment, provide a better match to grid capacity in developing countries, and are more easily adapted to a broad range of industrial settings and applications — such as district heating and seawater desalination. They are of particular interest to many of our developing country Member States, and have thus been a consistent focus of Agency work.

Several projects around the world are moving towards implementation. The Russian Federation already has a licensed design available for construction: the KLT-40, a 60 megawatt reactor design that can be floated and transported by barge, takes advantage of Russian experience with nuclear powered ice-breakers and submarines, and can also be used for district heating. The Republic of Korea has decided to construct by 2008 a one-fifth-scale demonstration plant of its 330 megawatt SMART pressurized water reactor, which will also include a demonstration desalination facility. And South Africa recently approved initial funding for developing a demonstration unit of the 168 megawatt gas cooled Pebble Bed Modular Reactor (PBMR), due to be commissioned around 2010.

CONCLUSION

While it is difficult to predict with any confidence what the 21st century holds for nuclear power, the factors that will shape its future are relatively evident. It is my hope that, during this conference, we can consider how each of these factors can be addressed, to ensure that nuclear energy remains a viable source of safe, secure and environmentally benign energy.