World Energy Council
CONSEIL MONDIAL DE L'ENERGIE

The Role of Nuclear Power in Europe

Executive Summary

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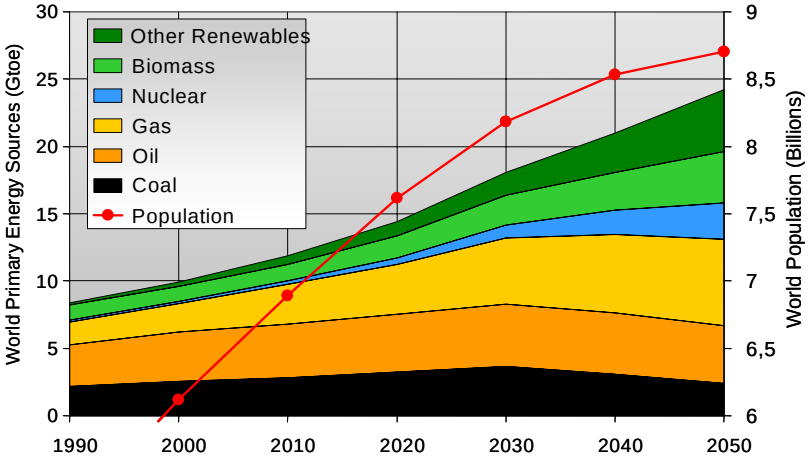
Introduction

Energy is and will remain one of the major global concerns of the 21st century and Europe is no exception. With global energy demand expected to grow strongly in the coming years, burning questions are now being raised over the future of energy supplies, the economic competitiveness of different energy sources and the associated environmental impacts.

By 2050, the world population is expected to reach close to 9 billion people. Without a doubt, global energy consumption will grow strongly and is forecast to double to some 20 Gtoe per year while in the same period electricity demand is forecast to triple. Faced with such strong demand, nations are now forced to seek new technically and economically efficient and environmentally sound ways to meet the expected growth.

IEA Scenario of energy growth for a sustainable future



Source: IEA report "Energy to 2050 – Scenario for a Sustainable Future (2003)"

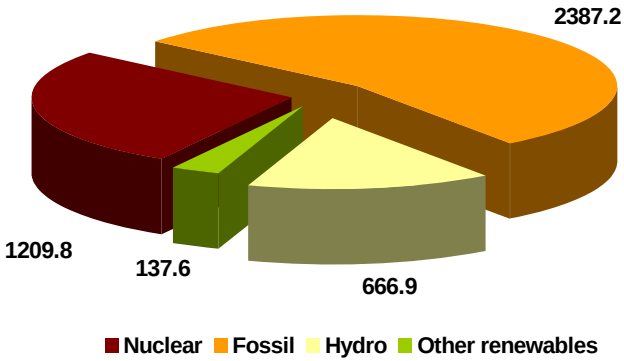
Many scenarios can be proposed for future world supply; in any case all sources of energy will have to be utilised in the best way to satisfy the needs.

In 2005, the European Regional Group of the World Energy Council decided to launch a study to clarify the conditions nuclear energy should meet to be re-integrated into the European electricity market. The findings of this study are summarised in the report *"The Role of Nuclear Power in Europe"*.

European Energy Realities

Today nuclear power accounts for nearly 30% of the total electricity supply in Europe. The main share of nuclear generating capacities is located in a handful of countries: France (63 GW), Russia (22 GW), Germany (20 GW), Ukraine (13 GW), the UK (12 GW) and Sweden (9 GW). In the aftermath of the Chernobyl accident in 1986, a number of European countries have committed to phase out their nuclear capacities. At the same time, all future scenarios suggest that energy demand is set to grow strongly all over the world, and increasing competition for energy resources accompanied by rising energy prices are expected to change the global energy scene, and Europe's role in it.

Electricity Production in Europe (TWh)



Source: WEC Study Group, 2004

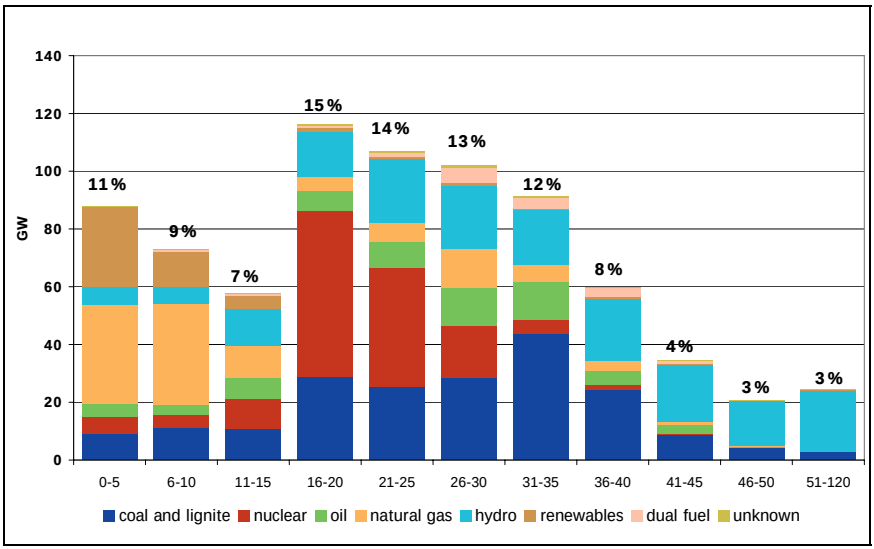
How will these changes affect the European energy sector? Is the political process on track? Europe (excluding Russia) currently

imports 50% of its energy, and this figure is expected to grow to approx. 70% by 2030. How is Europe preparing for this? The European policy makers and the energy industry currently face three major challenges:

- Ensuring security of energy supply,
- Stabilizing or reducing greenhouse gas (GHG) emissions and
- Maintaining economic competitiveness by keeping energy prices at an affordable level.

The WEC study demonstrates that many European countries are showing a keen interest in nuclear power as a way to tackle some of these challenges and also a means of introducing low-carbon energy sources into the energy mix.

Breakdown of European power generation capacity by age



Source: Utilities Database Institute, data as of December 31st, 2004

In terms of its future energy choices, Europe is today at a crossroads: more than 80% of installed capacity (currently more than 1,000 GW) will be more than 30 years old by 2020. That

means a large number of power plants will be retired over the period between 2010 and 2030. This is a major challenge but also a unique opportunity, since the choices made today will be shaping Europe's energy future for decades to come.

There is little doubt that economic and environmental factors will be the deciding forces in defining what kind of role nuclear power will play in the global energy sector in coming years.

However, as much of Europe debates the future of nuclear power, all eyes are focused on the Finnish company TVO which - together with the French company AREVA - is building the first reactor in Western European in the 21st century.

Deciding Forces: Economics

The report points out that there are solid economic reasons to support the development of nuclear power in Europe.

For existing plants the economics behind nuclear power look particularly attractive considering that planned lifetime extensions, capacity increases and licence renewals can further reduce costs.

The final costs of kWh depend on local legislation and taxes, which impact the discount rate, given that nuclear plants are highly capital intensive.

Assuming a stable political environment, clear regulatory frameworks governing the site location, decommissioning regulations and other aspects, these costs can reach 40 €/MWh. However, under specific circumstances they can be considerably lower, around 30 €/MWh for low discount rate and/or large scale/series effects, or higher, up to 55 €/MWh for a single unit order and higher discount rate.

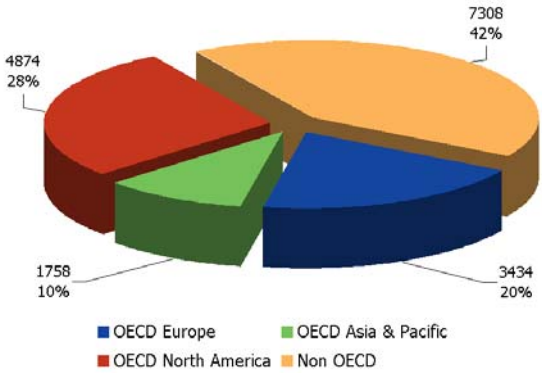
These estimates also include future expenses associated with decommissioning and waste disposal. The uncertainty about these figures will not have a significant effect on the total kWh cost.
Regardless of how competitive nuclear energy technology may be today, it will have no future if it cannot compete in the market. To achieve a strong economic performance in the future, lifetime extensions and capacity increases of plants need to be encouraged.

Deciding Forces: Environment

Nuclear power can offer environmental advantages. If carbon dioxide emissions were ever penalised, nuclear would be a particularly competitive alternative. As nuclear power generation does not produce greenhouse gases and emissions, the key sources in creating global climate change and air pollution, it would undoubtedly help tackle growing environmental concerns.

In March 2006, the European Union published the Green Paper: "A European Strategy For Sustainable, Competitive and Secure Energy" (by the Commission of the European Communities, 08/03/2006) which emphasised that Europe would not be able to make any significant impact on reducing carbon dioxide emissions without relying on nuclear energy.

World Emissions by Region (Mt CO_2)



Source: IEA, 2004

Despite the benefits, there remain considerable uncertainties as to whether nuclear power can play an important role in meeting global energy needs over the next few decades. Clearly, nuclear power will remain a controversial and much-politicised affair if the major concerns facing the nuclear industry today are not dealt with. One of the major concerns is the management and disposal of spent nuclear fuel.

Waste Management

The actual amount of spent nuclear fuel produced globally every year is approx. 12,000 tonnes. Therefore, compared to the 25 billion tonnes of GHG released annually from fossil fuels directly into the atmosphere, the amount of waste is relatively small. Were spent fuel to be reprocessed, this figure would be even lower; about 4% of the original fission products would be buried and the remaining 96% of useful uranium and plutonium recycled and reused.

Technologies for the safe management of low and intermediate level nuclear waste are well known and widely available. For high-level waste, a few countries have already made significant progress in the political process to select sites for permanent storage of high-level waste, others have only just started the process. In some countries funds are established to cover investments and operating costs for the management and final disposal of this waste.

There is, however, no single technical and financial solution suitable for every country for the management of its nuclear waste, as the operating environment is different for each country and every single power plant.

The current legal situation across Europe, whereby each country has to find its own solution for nuclear waste management, does not promote economic efficiency. The key issue here is what the public is willing to accept on their territory.

The decommissioning of old plants is reflected in the full cost accounting and this has a certain impact on waste management practices depending on the amounts of waste. Nearly all nuclear operators in Europe have allocated sufficient funds to cover future decommissioning costs, and the remaining few have agreements with local authorities who have made a commitment to take care of the waste. The report estimates that the discounted decommissioning costs for new plants due for retirement in 60 years or more is between 0.5 to 1.0 €/MWh.

Other Concerns

Given nuclear power's excellent operational safety record in Europe during the past five decades, public concern in many countries today is shifting from operational risks to nuclear waste management. The only significant nuclear event, the Chernobyl accident, occurred due to specific design flaws in one particular type of reactor, and inadequate operational practices, which together led to a nuclear slowdown in Europe for 20 years. Since then, the European operators together with the nuclear safety authorities have improved the safety standards even further and today all European plants demonstrate excellent safety performance. The development of strong international nuclear safety networks over the past two decades has contributed to the overall improvement of nuclear safety.

In addition to waste management and decommissioning, the public is also concerned with nuclear proliferation and the risk of terrorism. The report points out that emphasis placed on these concerns varies between different countries.

Security of nuclear power installations has gained priority in recent years. The September 2001 terrorist attacks in the U.S. led to the reassessment and a fresh evaluation of security in every industrial sector, including nuclear power. As a result, both national and international nuclear security activities have expanded greatly in scope and volume.

The report draws attention to the positive moves made, which include the strengthening of security forces, added protective barriers and other similar measures introduced to meet current concerns about security risks and vulnerabilities.

There is no doubt that more needs to be done in terms of the physical security of nuclear power plants, but credit needs to be given to the positive moves made so far.

The Future

Turning to technological issues, the future contribution of nuclear power to society will depend on innovation, such as the development of new reactor and fuel cycle technologies. To be successful, these technologies need to address concerns related to nuclear safety, proliferation and waste generation. They also need to be able to generate electricity at competitive prices.

The report highlights the need for added support for nuclear R&D with a special focus on Generation 3+ and Generation 4 technologies, which are expected to be available between 2030 and 2040. They are expected to increase efficiency by almost 80 times the current levels, lower costs and decrease proliferation risks.

Advanced nuclear technologies are already available on the market for use in new power plants (Generation 3 reactors). Examples of these are under construction or close to final order in China, France, Finland, Japan, Romania and Taiwan.

There is little doubt that much needs to be done in terms of investment to meet Europe's energy demand in the years ahead. The understanding of nuclear power in its role of meeting this demand has been growing in recent years.

Europe has to make some important decisions when it comes to determining the future of its nuclear industry. However, if

European countries and the European Union member states in particular, are serious about including the nuclear option in their energy mix, this decision should be straightforward.

Investment programmes could be accelerated if a more simplified and rapid process for granting construction and operational licences were available to potential investors. It is possible to simplify the investment process even further in order to allow stable, consistent and predictable market rules and this would also go a long way to ensure an investor friendly environment.

There is also a need to open up the internal energy markets throughout the entire European Union. Steps may have been taken over the last 10 years to remove barriers to entry for new suppliers but there is still an urgent need for a single competitive market.

Conclusions

The report highlights the need for added support for nuclear R&D with a special focus on Generation 4 technologies, which are estimated to be available on the market between 2030 and 2040.

They are expected to make nuclear power sustainable while reducing by almost 100 times the need for natural uranium and the production of long lived radioactive waste. They are also expected to extend its application to non-electricity products such as hydrogen, synthetic hydrocarbon fuels and process heat for the industry.

The key to creating a new generation of nuclear power plants in Europe is winning over public opinion. Nuclear energy has long been viewed with unease and there is, without doubt, concern over safety, proliferation and waste. More accessible and accurate information is needed to ensure that consumers understand that nuclear power is one realistic option for electricity production in Europe today.

Future success of nuclear power in the electricity market will be defined by the following key conditions:

- Stability, consistency and predictability of market rules to ensure investor friendly environment
- Independence and transparency of safety regulations
- Agreement on a common technically feasible, economically efficient and publicly acceptable framework for waste disposal
- A simple and rapid process for granting construction and operational licences
- Standardisation and scale effects for reactor manufacturers
- Support for nuclear R&D, and in particular for Generation 4 technologies. This to secure a sustainable generation of electricity in a possible context of rising uranium prices and electricity by-products such as hydrogen, synthetic hydrocarbon fuels and high temperature process heat for other industrial applications.
- Active involvement of all stakeholders in the consultation and implementation processes
- Equitable distribution of risks and rewards between all involved.

European countries, and the European Union member states in particular, must seriously consider including the nuclear option in their energy mix. This implies improving public awareness about energy issues, providing factual information and conducting comprehensive and efficient communication campaigns. The European members of the World Energy Council (WEC) are ready and willing to work together with all stakeholders to ensure a facts-based, balanced and unbiased approach to the assessment of the nuclear option as a part of WEC's strategy of keeping all energy sources open.

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