COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 10.1.2007
COM(2006) 844 final

COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT

Nuclear Illustrative Programme

Presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and Social Committee

{SEC(2006) 1717}
{SEC(2006) 1718}
{SEC(2007) 12}

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1. INTRODUCTION

Title Two, Chapter IV, Article 40 of the Euratom Treaty states that the Commission shall "*periodically publish illustrative programmes indicating in particular nuclear energy production targets and all the types of investment required for their attainment*." Since 1958 four such illustrative programmes and one update have been published[1].

This Nuclear Illustrative Programme describes the current status and potential future scenarios for the nuclear sector in the EU, within a broader energy strategy. It provides a basis for discussing the nuclear option in the context of the ongoing EU energy policy debate. The basis for a European energy policy was set out by the European Commission in the recent Green Paper[2] and in the Strategic Energy Review[3]. In this context, the Nuclear Illustrative Programme also aims at providing a factual analysis of the role of nuclear energy in meeting the growing concerns about security of energy supply and CO_2 emission reductions, while ensuring that nuclear safety and security are paramount in the decision-making process. Independent of the energy policy choices made by Member States, consistent action in the field of nuclear safety, decommissioning and waste management is necessary.

Nuclear power stations currently generate approximately one third of the electricity and 15% of the energy consumed in the European Union (EU)[4]. Nuclear power is currently one of the largest sources of carbon dioxide (CO_2) free energy in Europe.

2. THE GLOBAL ENERGY MARKET

2.1. Market drivers

World energy demand is expected to rise by 60% by 2030. Oil consumption, for example, has increased by 24% over the last 10 years, with global demand projected to grow by 1.6% per year[5].

The EU's dependence on imports is increasing. Based on current trends, in the next 20 to 30 years, around 65% of the Union's energy requirements, up from 50% today, will be met by imports, some from regions that raise concerns about political stability[6]. Reserves of basic energy sources are concentrated in a few countries. Approximately half of the gas consumed in the EU comes from Russia, Norway and Algeria. On current trends, world gas consumption would increase by 92% over the next 25 years[4].

Oil and gas prices have nearly doubled over the last two years, with electricity prices following. Despite high prices, global demand for energy continues to rise. In 2004, global demand rose by 4.3%, mostly in the developing countries. China alone accounted for 75% of the additional demand for coal. Energy demand per head in Asia, Africa and South America is presently only a fraction of energy demand in the EU. However, the emerging economies of

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1. In 1966, 1972, 1984, 1990 and lastly almost ten years ago in 1997.
2. A European Strategy for Sustainable, Competitive and Secure Energy - COM(2006) 105, 8.3.2006.
3. COM(2007) 1, 10.1.2007
4. Annex 1: See Figures 1 and 2 showing electricity and energy consumption in the EU.
5. International Energy Agency (IEA): World Energy Outlook 2006.
6. Annex 1: See Figure 3 showing forecast energy production and consumption.

China and India alone will certainly increase their demand for energy and have an impact on this balance in the near future.

Within the EU, despite constant efforts to improve efficiency, energy demand has continued to rise by 0.8% per year. The latest estimates predict an annual increase in EU electricity demand of 1.5% on a business as usual scenario. As a result, unless action is taken on the basis of the Strategic Energy Review, greenhouse gas emissions could increase by a further 5% by 2012, in direct conflict with the Kyoto target of a reduction of 8% in the same time frame.

Reliance on fossil fuels implies increased CO_2 and other emissions harmful to the environment. The world climate is getting warmer. According to the Intergovernmental Panel on Climate Change, greenhouse gas emissions have already made the world 0.6° C warmer[7].

2.2. Global prospects and the EU-27 market

In 2005, the EU is the biggest nuclear electricity generator[8] in the world (944.2 TWh(e)). It has a mature nuclear industry spanning the entire fuel cycle, with its own technological base and expertise. Attention has focused on the safety and security of nuclear installations and protection of the public. The recent liberalisation of electricity markets has significantly changed the investment scenarios compared with the 1970s and 1980s when most nuclear plants were constructed.

The Community has strengthened its international relations with agreements that facilitate trade in nuclear materials and technology, instrumental to a policy of diversification of supply and closer cooperation on technology transfer and business with non-Community countries[9]. At the same time, the EU has continued to foster research and development on nuclear safety, reduction and treatment of radioactive waste, final repositories and innovative nuclear technology. In May 2006 Euratom became a full member of the Generation IV Forum (GIF), studying potential future reactor designs that will make nuclear energy generation safer and more economic, improve security, reduce non-proliferation concerns and limit waste generation.

Established and emerging economies in Asia, such as Japan, South Korea, China and India, along with Russia and the USA are planning future construction of nuclear generation capacity, ensuring that nuclear power plays a significant role in meeting their increasing energy requirements. The international situation calls for constant attention to policies consistent with nuclear developments in other regions of the world, given the potential geopolitical implications for global security, health, industry and public opinion.

In the EU Finland and France decided to construct new nuclear reactors. Other EU countries, including the Netherlands, Poland, Sweden, the Czech Republic, Lithuania (in collaboration with Estonia and Latvia), Slovakia and the United Kingdom along with Bulgaria and Romania have re-opened the debate about their nuclear power policy, which could lead either to extending the rating and operating life of existing plants or to debating their replacement or

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7 www.IPCC.ch: Intergovernmental Panel on Climate Change – 2001 Report.

8 IAEA (International Atomic Energy Agency) source, 2005.

9 Agreements have been concluded with Australia, Canada, the USA and, more recently, with Japan, Kazakhstan and Ukraine.

planning to build new installations. Germany, Spain and Belgium are continuing their nuclear phase-out policies for the time being.

2.3. The Green Paper on a European strategy for sustainable, competitive and secure energy and the role of nuclear energy

The era of cheap energy is probably over, mainly due to strong world demand and insufficient investment in production, distribution and transmission capacity over the last few decades. In this context, the Strategic Energy Review and the 2006 Green Paper on secure, competitive and sustainable energy highlight the need for substantial investment over the next 20 years in the EU to replace ageing electricity generation capacity. They also call for a more sustainable, efficient and diverse energy mix.

While each Member State and energy utility chooses its own energy mix, individual national decisions relating to nuclear energy can have an impact on other States in terms of trade flows of electricity, the EU's overall dependence on imported fossil fuels and CO_2 emissions but also on competitiveness and the environment.

The future of nuclear energy in the EU depends primarily on its economic merits, its capacity to deliver cost-efficient and reliable electricity to help meet the Lisbon goals, its contribution to the shared energy policy objectives, its safety, its environmental impact and its social acceptability. Nuclear energy generation has a role to play in the response to the Strategic Energy Review and, in particular, to the main priorities identified in the Green Paper[10]: security of supply, competitiveness and sustainability. At the same time, nuclear safety, decommissioning nuclear reactors at the end of their active life, management, transport and final disposal of radioactive waste together with non-proliferation are important issues that must continue to be actively addressed.

3. EU INVESTMENT IN THE NUCLEAR DOMAIN

3.1. Nuclear power plants, worldwide and in the EU

Today 443[11] commercial nuclear power reactors are operating in 31 countries worldwide, with total capacity of over 368 GWe. They supply 15% of the world's electricity. In addition, 56 countries are operating a total of 284 research reactors for scientific purposes. A further 220 nuclear reactors power military and naval vessels. Globally, 28 nuclear power reactors are under construction, with another 35 firmly planned, equivalent to 6% and 10% of existing capacity respectively[12].

Few nuclear power plants have been built after the 1980s, but those operating are producing up to 20% more electricity due to power up-ratings and higher availability factors (i.e. shorter stoppages for fuel re-loading and fewer incidents). From 1990 to 2004 world capacity rose by 39 GWe (12%, due both to net addition of plants and up-rating of some existing installations) and electricity production increased by 718 billion kWh (38%). Ageing power plants are

10 The Green Paper identifies six priorities: competitiveness and the internal energy market, diversification of the internal energy mix, solidarity in the Community, sustainable development, innovation and technology, and external policies.

11 IEA World Energy Outlook 2006.

12 Annex 1, Table 1 and Figure 4: List of reactors, electricity generation and uranium requirements.

scheduled to be shut down in the next 10 to 20 years, which will reduce nuclear energy's share of total electricity generation[13]. The International Energy Agency in its 2006 World Energy Outlook's reference scenario – i.e. if present policies continue unchanged – shows that the nuclear energy share will decline from the current 15% to below 8% by 2030.

One quarter of the world's reactors have load factors[14] of more than 90%, and almost two thirds above 75%. These figures suggest near-maximum utilisation, given that most reactors have to shut down every 18 to 24 months for re-fuelling.

In EU-27[15] a total of 152 nuclear reactors are in operation in 15 Member States. The average age of nuclear power plants (NPPs) is approaching 25 years[16]. In France, which has the largest fleet (59) of nuclear reactors accounting for nearly 80% of its electricity generation, and Lithuania, with only one NPP yet accounting for 70%, the average age is around 20 years. The UK fleet of 23 NPPs has an average age approaching 30 years, while in Germany the average age of their fleet of 17 operational NPPs is 25 years.

Since nuclear power provides one third of Europe's electricity and the typical initial design life of an NPP is 40 years, decisions are required on extension of the life of some plants, where safely possible, or on new investment to meet expected demand and to replace ageing infrastructure over the next 20 years. Taking into account the current EU energy mix, if the planned phase-out policy in some EU Member States is maintained, without extending plant lifetime and/or new construction, nuclear energy's share of electricity production will be significantly reduced. Considering that it typically takes ten years to construct a new NPP[17], should the intention be to replace existing nuclear plants by new ones, decisions are required, even if it were merely to maintain nuclear energy's current share of electricity production.

3.2. Investment notifications

Under Article 41 of the Euratom Treaty, investment projects related to the nuclear fuel cycle in the EU must be notified to the Commission prior to conclusion of contracts with suppliers or, if the work is to be carried out by the undertaking with its own resources, three months before the work begins.

Since 1997 a total of 19 projects have been notified to the Commission. Ten were for installations in France, seven of them on replacement of steam generators for NPPs, one on construction of a treatment and storage facility for radioactive waste (CEDRA) at Cadarache, one on construction of a new uranium enrichment plant (Georges Besse II) at Tricastin using centrifuge technology and the last on construction of a new EPR NPP at the Flamanville site.

In 2004 Finland notified the Commission of its plans for a new NPP at Olkiluoto, the first new NPP to be built in the EU for more than a decade. Upgrades and additional capacity at the three uranium enrichment plants (Urenco) in Germany, the Netherlands and the United Kingdom, construction of an installation for vitrified high-active waste (VEK) in Karlsruhe,

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13 Annex 1: See Figure 5 for a comparison of two possible scenarios.

14 "Load factor" means the ratio between the average load and the peak load over a specified period of time.

15 Annex 2: Country-by-country information on current nuclear fuel cycle activities.

16 Annex 1: See Figures 6 and 7 showing NPPs by age and age distribution by country.

17 The Olkiluoto NPP project in Finland was submitted in 2000 and received Government approval in 2002 and licensing approval in 2004. Construction started in 2005. Operation is expected to start by 2010.

Germany and replacement of steam generators at the Tihange NPP in Belgium complete the list.

3.3. Development and investment prospects

This section summarises the situation in the various countries that currently use nuclear energy. Further details are given in Annex II.

In mid-2004 **Belgium** announced a new national energy policy study on plans to phase out nuclear power up to 2030, with the first NPP closing in around 2015. Existing legislation calls for the closure of NPPs after 40 years of commercial operation, but exceptions can be made on the grounds of security of supply. In June 2006 the Federal Government decided on Dessel as the site for a surface disposal facility for low- and intermediate-level short-lived waste, to come into operation between 2015 and 2020.

In **Bulgaria** Kozloduy NPP Plc operated four nuclear reactors until the end of 2006. Two units were shut down to meet commitments given in the accession negotiations. Decommissioning of these units is being supported by EU funds. In order to make up for the closure of these units and satisfy the increasing electricity requirements in the region, two additional units at the Belene site are at an advanced design stage.

In 2003 Ceske Energeticke Zavody (CEZ) which operates the **Czech Republic**'s two nuclear power stations - Dukovany and Temelin - began an ambitious upgrade programme. Besides improving competitiveness and safety, the aim of the upgrade is to extend the plants' operating licences from 30 to 40 years. Despite plans in 2005 to close the Czech Republic's remaining uranium mine (Dolni Rozinka), which previously had significant uranium production, rising uranium prices are prompting the authorities to consider extending its operation.

The construction licence for **Finland**'s fifth nuclear plant, a 1600 MWe European pressurised water reactor (EPR) sited at Olkiluoto, was issued to Teollisuuden Voima Oy (TVO) in February 2005. Construction has already started, with operation originally planned to start in 2009-10. According to TVO, due to construction delays, the start up is postponed until 2010-11. The operating units Olkiluoto 1 and Olkiluoto 2 have been upgraded to 860 MW with an operating lifetime of 60 years.

Posiva Oy is constructing an underground characterisation facility (Onkalo) in the bedrock of Olkiluoto to acquire the information needed for the construction licence application for a deep repository that will be submitted to the Finnish Government in 2012. The repository will not require monitoring after closure. The Government decided, however, that retrievability was a prerequisite. There are plans to expand the repositories for low- and intermediate-level waste at Olkiluoto and Loviisa - where radioactive waste is placed in caverns and silos excavated in underground rock near the power stations - so that they can take decommissioning waste. The estimated costs of the repository and other waste management activities are included in the price of nuclear-generated electricity, collected from the generators and deposited in the State Nuclear Waste Management Fund.

Before the **French** Government put together its energy bill, a national energy debate was started in 2003. The debate concluded that nuclear power should continue to play a key role in the French energy mix. Two issues considered in the debate were the need to replace the existing fleet of nuclear power plants, starting in around 2020, and global warming. The new legislation not only keeps the nuclear option open, but also includes commitments to reduce greenhouse gas emissions. Once this legislation had been passed, the Government agreed to a request from Electricité de France (EdF) to build an EPR, the second in the EU, which will come into operation in 2012.

Germany has a phasing-out law ("Atomausstiegsgesetz"), under which the nuclear power generators and the Federal Government reached an agreement on the total nuclear power to be produced which is effectively limited to 32 years, based on estimated energy production quotas. The operators also agreed to stop transfers of spent fuel for reprocessing from 2005 onwards. In order to avoid transport to the interim storage installations in Gorleben, construction of on-site storage facilities was required at several plants. Two NPPs have closed - Stade in 2003 and Obrigheim in 2005 - leaving 17 units in operation. The permit to begin decommissioning the Mülheim-Kärlich plant was issued in July 2004. The final stage of expansion of the Urenco enrichment plant in Gronau has been approved, and the licence has been granted for a capacity increase at the Advanced Nuclear Fuels fuel fabrication plant in Lingen.

The four Paks units in **Hungary**, all second-generation VVER-440/213 reactors, were supplied by Russia's Atomenergoexport. A subsequent modernisation programme increased their power ratings. In the last five years extensive work has been done to prepare for potential extension of their operating licences for another 20 years. Paks also plans to increase each unit's electrical power by a further 10%. A Central Nuclear Fund has been set up to finance waste management and decommissioning at the Paks site. Investigations to find a suitable location for a new repository for low- and intermediate-level waste identified a site at Bátaapáti. In 2005 the local community voted in favour of the project.

Having agreed, as a condition for accession to the EU, to close down its two Russian-designed nuclear reactors at Ignalina, which were not considered economically upgradeable, **Lithuania** has decided to remain a nuclear country. In March 2006 a Memorandum of Understanding was signed with Estonia and Latvia on preparations for the construction of a new nuclear reactor. As a result of a feasibility study, intended to promote activities in favour of energy security in the Baltic region, the Governments of the three Baltic States agreed, in principle, to construction of a new NPP in Lithuania. The Lithuanian Government is expected to adopt legislation in 2007 to accommodate that decision.

The **Dutch** Government and Elektriciteits Produktiemaatschappij Zuid (EPZ), the owner of the Borssele plant, agreed another extension to its operating life. It will continue generating until 2033, provided the plant remains safe and economically viable. The Government intends to review the national laws and regulations to clarify the conditions under which new nuclear installations could be built in the future, giving special consideration to the issue of radioactive waste and measures to prevent terrorist attacks.

Romania is operating one nuclear power plant (Cernavoda 1). A second unit is under construction and should become operational in 2007. Preparatory work for two additional units will start in 2007. The plan is to double electricity production by 2009 and triple it by 2015.

In February 2005 the **Slovak** Minister for Economic Affairs authorised the sale of 66% of Slovenské Elektrárne, the country's nuclear operator, to **Italy**'s Enel S.p.A. As a condition for accession to the EU, Slovakia agreed to close down two of its six Russian-designed reactors - Bohunice 1 and 2 - which were not considered economically upgradeable.

Slovenia shares ownership of the Krsko nuclear power plant with Croatia. In 1990 uranium mining activities were stopped at the Zirovski VRH mine, which is now being decommissioned.

In **Spain**, the present policy of the Government in relation to nuclear energy is the progressive reduction of its participation in the power generation, without compromising at any moment the security of electricity supply. In April 2006, the Jose Cabrera (Zorita) plant was definitively shut-down after 38 years of operation. This one was the smallest and the oldest nuclear power plant of the Spanish park. Dismantling the plant will be undertaken from 2009. The main strategy established in the VI General Plan for Radioactive Wastes, approved by the Government on 23 June 2006, is based on the availability of a centralised temporary storage facility by the year 2010.

The operators of **Sweden**'s 10 nuclear power reactors have all announced modernisation programmes, including major power uprating. In response to these plans, the safety authority has issued new regulations on retrofitting the ageing reactors to meet modern safety standards. The Swedish Nuclear Fuel and Waste Management Company (SKB) set up by the NPP operators expects to submit a permit application in 2006 for a waste encapsulation plant, due to be located next to the existing interim storage facility in Oskarshamn. A permit application for the deep repository itself is scheduled to be submitted in 2008.

On 1 April 2006 the **United Kingdom**'s Nuclear Decommissioning Authority (NDA) took over ownership of most of the civil nuclear sites and responsibility for dealing with the country's waste legacy. This included all the public-sector civil nuclear liabilities held by the UK Atomic Energy Authority (UKAEA) and most of those held by British Nuclear Fuels plc (BNFL), together with BNFL's related assets. The UK operates a total of 39 reactors and 5 fuel reprocessing plants, plus other fuel cycle and research facilities on 20 sites, including the elderly Magnox reactors which should all be closed by 2010.

When the NDA came into existence, BNFL and the UKAEA continued to operate most of their former facilities under contract to the NDA. The plan, however, is that this arrangement is to be only temporary. Starting in 2008, the NDA will put site management contracts out to tender, with BNFL and the UKAEA having to compete against other companies, including American undertakings, for the jobs. The UK energy review of July 2006 stated that nuclear energy has a role to play in the future UK mix for electricity generation alongside other low-carbon generation options.

4. THE IMPACT OF NUCLEAR ENERGY ON SECURITY OF SUPPLY, COMPETITIVENESS AND ENVIRONMENTAL PROTECTION

This section analyses the role of nuclear energy in relation to the three main priorities of the 2006 Green Paper, namely: security of energy supply, competitiveness against other forms of energy generation, and contribution to limiting greenhouse gas emissions.

4.1. The role of nuclear energy in security of supply

Before liberalisation of the energy sector, it was the role of governments to take energy security into account when planning their energy systems, by trying to put together a diversified and secure portfolio of supply sources. Since legislation on liberalisation has been enacted, the role of governments has evolved towards creating the appropriate framework for competition. On liberalised markets, investment decisions are taken by investors and not by governments.

Nuclear energy can contribute to diversification and long-term security of energy supply for the following reasons:

– **The limited importance of the raw material – natural uranium - and its availability**

Nuclear plants are largely insensitive to changes in the cost of fuel, unlike other types of generating plants. Nuclear fuel, including uranium mining, enrichment and fuel fabrication represents approximately 10-15 % of the total cost of generating electricity. Furthermore, maintaining strategic stockpiles, covering several years of consumption, is easily manageable without placing a significant financial burden on users.

No uranium shortages are foreseen in the near future. The rising uranium price has increased exploration and production but had little impact on nuclear electricity costs[18]. Looking ten years ahead, the market is expected to grow slightly without important impact to generation costs[19]. Reasonably assured and recoverable known uranium resources at competitive prices can sustain the requirements of the nuclear industry for at least the next 85 years[20] at current levels of consumption.

Primary production (new mining) of uranium has been lower than reactor requirements since 1985. Secondary sources (stocks, recycled fuel and down-blending of highly enriched uranium from military stockpiles) have made up for any shortfalls. By 2020 secondary sources are expected to be depleted. Consequently, more exploration is required. European companies, such as Areva, co-own mining facilities in Canada and Niger. Finland, Slovakia and Romania are investigating uranium mining.

The Euratom Treaty requires that all users in the Community receive *a regular and equitable supply of ores and nuclear fuels*. It establishes a common supply policy based on the principle of equal access to sources of supply, while prohibiting practices designed to secure a privileged position for certain users. Implementation of these provisions falls within the remit of the Euratom Supply Agency (ESA)[21]. The ESA's mandate extends to ensuring that imports and exports to and from the Community are in line with EU policies on security of supply and that the interest of the users is protected.

– **The geopolitical distribution of uranium resources, producers and suppliers**

The geopolitical distribution of uranium resources is diverse[22], with most of them coming from politically stable regions of the world. Australia and Canada currently supply 45% of the EU uranium requirements.

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[18] "Uranium 2005: Resources, Production and Demand", Nuclear Energy Agency.

[19] See Annex 1, figure 8 for impact on electricity generation for a 50% increase in price of fuel for various sources.

[20] "Forty Years of Uranium Resources Production and Demand in Perspective – The Red Book Retrospective", OECD, 2006.

[21] The Euratom Treaty gives the ESA the right of option to acquire ores, source materials and special fissile materials produced in the Community and an exclusive right to conclude contracts for the supply of such materials from inside or outside the Community. In order to be valid, supply contracts must be submitted to the ESA for conclusion.

[22] Annex 1: See Figure 9. Geopolitical distribution of imported gas and uranium resources.

– **Production capabilities**[23]

The various steps of the fuel cycle display different degrees of security of supply. Some services, such as fabrication and transport, are provided by a wide range of suppliers, ensuring both security and competitive prices. For others, e.g. enrichment, the number of suppliers is more limited, yet more than 70% of EU-25's requirements are met by EU suppliers.

The international safeguards aiming at preventing proliferation of nuclear weapons place specific constraints on nuclear fuel markets in the form of declaration, control and verification of peaceful use of nuclear materials. The framework created under the Euratom Treaty and the International Atomic Energy Agency (IAEA) provides a well-defined set of rules. Within this framework, nuclear materials for peaceful uses can be traded freely between countries and operators.

4.2. Nuclear power and competitiveness

Cost and investment risk are important issues when considering construction of nuclear reactors. Nowadays a new nuclear plant involves an investment in the range of € 2 to 3.5 billion (for 1000 MWe to 1600 MWe respectively). Today, given the Kyoto targets, public policy has sound and urgent reasons for placing a sizeable premium on clean technologies. One key question is whether nuclear energy requires such policy intervention in order to be economically competitive. Investment in new nuclear facilities requires at least a stable legislative and political framework given the time lag between the initial investment and sizeable returns. As liberalised markets cannot guarantee long-term stability of prices, the IEA indicates that for the private sector to invest in new nuclear projects, governments may need to take measures reducing investment risks.

– **Nuclear electricity's competitiveness on the current energy market**

The total revenue and costs over the lifetime of an NPP should be compared with the return provided by alternative sources over the same period. However, predicting revenue and costs over this time frame is very difficult, due to the volatility in the cost of oil and gas and of electricity prices. Given the lack of new plant construction in the EU and USA for more than a decade, no proven cost data are available yet for new generation NPPs.

Analysis by the International Energy Agency (IEA)[24] and the Nuclear Energy Agency (NEA)[25], based on data from more than 130 different types of electricity-generating plants, including coal, gas, nuclear, wind, solar and biomass, from experts in 19 OECD and 3 non-OECD countries, indicates that in most industrialised countries new nuclear power plants offer an economical way to generate base-load electricity with gas and coal prices at a certain level. The industry confirms this view[26]. According to the IEA and NEA, nuclear electricity is a competitive alternative, with costs and competitiveness depending on the project[27]. The

23 Annex 1: See Figures 10.1 and 10.2. Availability of uranium resources.
24 International Energy Agency, World Energy Outlook 2006, p. 43.
25 Projected Costs of Generating Electricity (2005) – Nuclear Energy Agency Study, March 2005.
26 The New Economics of Nuclear Power – World Nuclear Association, December 2005: http://www.world-nuclear.org/economics.pdf.
27 Annex 1: See Figure 11a and 11b. OECD estimates of relative competitiveness of electricity production.

WNA report validates these findings and notes that the data were collected prior to the price increases for fossil fuels, which further reinforces the point.

Nuclear power has traditionally shown a combination of higher construction and lower operating costs than fossil-fuel-based energy production, which exhibits lower capital costs but higher and potentially fluctuating fuel and, hence, operating costs.

– The economic competitiveness of nuclear power depends on several factors, with construction times, capital costs, waste disposal, decommissioning and the operational capacity factor playing a key role.

– Licensing procedures have been simplified. Although rigorous safety and quality standards are being and have to be maintained, predictable technical parameters and timescales, from design to certification through construction to operation, and lower regulatory costs have reduced overall financing costs.

– Operating costs have fallen steadily over the last 20 years, as capacity factors have increased. The low marginal cost of nuclear power[27] has encouraged nuclear plant owners to apply for extended operating licences. Although uranium prices have substantially risen since 2004, the impact on electricity costs has been relatively minor as the cost of uranium is only a small fraction (approximately 5%) of the total kWh cost.

– In several EU countries the nuclear industry levies electricity surcharges to manage and dispose of the waste generated and to fund decommissioning. The financial management method and availability of the funds vary between Member States[28].

– Generating utilities around the world are planning to extend reactor operating lifetimes[29]. Sweden has approved 10-year extensions, with a 20-year increase possible, provided nuclear safety norms are observed.

– The spectacular price increases in other fuels have also added to the economic competitiveness of nuclear power under these circumstances.

The IEA concluded its 2006 analysis[30] by saying that “new nuclear power plants could produce electricity at a cost of less than 5 US cents per kWh, if construction and operating risks are appropriately managed by plant vendors and power companies. At this cost, nuclear power would be cheaper than gas-based electricity if gas prices are above $4.70 per MBtu. Nuclear power would still be more expensive than conventional coal-fired plants at coal prices of less than $70 per tonne. The breakeven cost of nuclear power would be lower when CO_2 prices are taken into account."

– **Role of state aid**

New nuclear plants are generally being built without subsidies, which is an indication that nuclear energy is increasingly perceived as competitive. This trend marks a change from past practice in a number of EU countries. In Finland, for instance, the new nuclear plant is being

[28] C(2006) 3672 final adopted on 24.10.2006.

[29] The US Nuclear Regulatory Commission recently granted 30 plants a 20-year extension, effectively prolonging the lifetime of their reactors to 60 years.

[30] World Energy Outlook, 2006, p. 43.

financed by private sources[31]. Similarly, the UK Government announced that it would be up to the private sector to initiate, fund, construct and operate new nuclear plants.

4.3. Economic aspects of nuclear power plants

Uncertainty about future electricity prices, market structure and conditions and about future energy and climate change policies poses a major risk to long-term investment in the energy sector. This is particularly important for nuclear energy, due to the high capital investment associated with construction of a new NPP and the relatively long period before any such investment starts to show a profit. It is therefore important to try to establish firm policy frameworks so that the conditions are clear and predictable for new investments.

Construction of the new NPP in Finland, although not requiring government subsidies, depends on secure long-term investment, which will be achieved by shareholder agreement ensuring a fixed energy price to the owners/investors, which are essentially shareholders from the paper industry.

Another key issue for the economic future of nuclear power is to understand how its commercial returns relate to electricity market structures[32]. Investors prefer shorter payback periods, making investments with lower construction costs and a short lead time more attractive. Nuclear lead times (five years in the most optimistic scenario) are, for engineering and licensing reasons, much longer than for combined cycle gas turbines (CCGT) or renewable energy sources which have lead times of only two years or less.

Construction costs for nuclear plant are two to four times greater than for a CCGT. Of the three major components of nuclear generation costs – capital, fuel, and operation and maintenance – the capital costs account for approximately 60% of the total, compared with only around 20% of the total costs for a CCGT.

The economic risks of a nuclear power plant are linked to the major capital investment at the beginning and require quasi-faultless operation during the first 15 to 20 years of its 40-60 year lifetime to pay back the initial investment. In addition, decommissioning and waste management mean that financial assets must be made available for 50 to 100 years after the shutdown of the reactor.

The lack of recent experience with new construction makes it difficult to estimate the precise costs for the latest generation of reactors. In the past, disputes about licensing, local opposition and cooling water sources have delayed construction and completion of nuclear plants both in the USA and Europe[33]. As the same factors have also caused delays in more recent energy system investments, for example in inter-connectors, similar delays are likely to occur in construction of new nuclear plants.

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31 The procedure for clearing the investment under Articles 41-43 of the Euratom Treaty was fulfilled properly and did not give rise to any objection. Regarding the export credit guarantee awarded for part of the project, which is in conformity with OECD export credit rules, the Commission has opened a procedure to determine whether this guarantee constitutes State aid within the meaning of Article 87(1) of the EC Treaty, and, if it does, whether the aid is compatible with the common market. This procedure is pending at the time of writing.

32 International Energy Agency (2005): "Projected costs of generating electricity, 2005 update", OECD publication, Paris.

33 Ludwigson, J. et al. (2004): "Buying an option to build: regulatory uncertainty and the development of new electricity generation", IAEE Newsletter, Second Quarter 2004, pp. 17-21.

The larger size of nuclear plants exposes investors to greater downstream risks, as for the next decade only large-scale plants (> 500 MW) should be available. On liberalised electricity markets, uncertainties about electricity prices encourage construction of small-scale modular units, as the timing of entry is critical to the returns on an investment. For engineering reasons, economies of scale dominate nuclear plants and reducing unit size does not appear economic with current technologies[34].

Certain financial and environmental risks still remain with governments in some Member States, such as responsibility for the facilities for long-term waste disposal and management. Although funds may be accumulated by operators during the plant's operating life, and as such paid for by the private sector and consumers, gaps may still exist between the funds available and those actually required. It will be for governments and generating companies together to develop innovative mechanisms to tackle outstanding issues and future challenges. It remains crucial that sufficient savings are set aside to finance decommissioning and waste management.

Building a large number of reactors with similar design (fleet approach) has potential advantages. Hence, it could also be attractive for private investors to cooperate in order to benefit from such economies of scale. Nuclear suppliers have indicated that savings on subsequent plants could be between 10% to 40% of the cost of the first plant, which provides a significant incentive for a fleet approach. The projected savings are due to the following factors, inter alia:

– First-of-a-kind (prototype) costs related to a new design.

– A fleet of plants of the same design allows the licensing costs to be spread.

– The fleet design concept would allow development of a single solution on decommissioning.

– The limited number of professionals could be used more efficiently, avoiding potential expertise bottlenecks.

– If a commitment were made to purchase a number of reactors, more favourable turnkey contracts could be offered[35].

The fleet approach, however, is not devoid of commercial risk, for example if it were to prove necessary to redesign the plant as a result of an accident or other generic malfunction.

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34 Gollier, C. et al. (2005) “Choice of nuclear power investments under price uncertainty: valuing modularity”, Energy Economics 27(4): 667-685. The benefit of one large nuclear power plant project stemming from increasing returns to scale are compared with the benefit of a sequence of smaller (300 MWe), modular, nuclear power units on the same site. The benefit of modularity in terms of profitability is equivalent to a reduction of the cost of electricity by only one thousandth of a euro per kWh.

35 According to EDF, its project for construction of a new EPR reactor at Flamanville is expected to cost around €3 billion to build with the initial cost of energy production around €43/MWh, potentially subsequently dropping to €35/MWh based on a contract to build a series of 10 NPPs. These costs are similar to those expected for Olkiluoto in Finland.

4.4. Nuclear power and climate change

The path forward on climate policy lies primarily in near-term emission reductions driven by the targets set by the Kyoto Protocol[36]. Nuclear-generated electricity provides large-scale, base-load supply to support energy-intensive industries and daily domestic requirements with limited emissions. Nuclear power plants have met 38% of the increased global electricity demand since 1973. Assuming that otherwise this capacity would have burnt fossil fuel, nuclear energy has significantly contributed to mitigating emissions of CO_2, the principal greenhouse gas (GHG)[37]. Generation of one million kilowatt-hours of electricity from coal releases 230 metric tonnes of carbon into the atmosphere, from oil 190 metric tonnes and from natural gas 150 metric tonnes. Under normal operating conditions a nuclear power plant generates the same kilowatts essentially carbon-free. Emissions due to extraction and fabrication activities for the different types of fuel are not considered in this comparison.

In 2000 the NEA[38] investigated the role of nuclear power in alleviating the risk of global climate change and provided a quantitative basis for assessing the reduction of GHG emissions following alternative nuclear development paths. The analysis covers the economic, financial, industrial and potential environmental effects of three alternative nuclear power development scenarios ("nuclear variants"): continued nuclear growth, a nuclear phase-out or a period of stagnation followed by a nuclear revival. Each of the three variants would pose challenges to the nuclear sector, but all of them would be feasible in terms of construction rate, financing, site selection, land requirements and natural resources. The NEA concluded that nuclear power is an available option for alleviating the risk of global climate change and that keeping the nuclear option open would also foster further development of non-electrical applications, such as heat, drinking water and hydrogen production, further enhancing nuclear power's contribution to reducing GHG emissions. Consequently, the role of nuclear power should continue to be taken into account in the discussions on the EU Emission Trading Scheme.

A study[39] contracted by the Commission provides in depth projections on energy requirements and the consequences, based on various scenarios on the choice of electricity generation for the EU until 2030. The study shows that, in the medium term, a sustainable choice for the energy mix would be a combination of renewable sources of energy and investment in nuclear electricity generation, combined with efforts to improve energy efficiency.

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36 The Kyoto Protocol is an amendment to the United Nations Framework Convention on Climate Change. It was opened for signature on 11 December 1997 and came into force on 16 February 2005. By February 2006, 162 countries, including the EU Member States, were parties to the Protocol.

37 According to the International Nuclear Forum, in 1995 electricity utilities' emissions of CO_2 worldwide were 32% lower than they would have been if fossil fuels had been used instead of nuclear energy. Emissions of sulphur dioxide and nitrogen oxide were 35% and 31% lower, respectively.

38 The OECD NEA is an intergovernmental body with the objective of assisting its member countries (28 members, including all the EU Member States with nuclear programmes) in maintaining and further developing, through international cooperation, the scientific, technological and legal basis required for safe, environment-friendly and economical use of nuclear energy for peaceful purposes.

39 "European Energy and Transport Scenarios on Key Drivers." Commission publication (September 2004) produced by the National Technical University of Athens, E3M-Lab, Greece. It shows the results of application of the PRIMES model to investigate alternative energy futures for EU-25, as distinct from the baseline provided by the effects of current trends and policies. The study was taken as the basis for the Commission publication "European Energy and Transport - Trends to 2030".

Nuclear power is therefore one of the options available for reducing CO_2 emissions. Nuclear power is presently the largest source of CO_2-free energy in Europe and forms part of the Commission's carbon reduction scenario. The IEA's 2006 World Energy Outlook mentions, in the case of the EU, “extension of the life of nuclear plants” (148 Mt of CO_2 emissions avoided) along with increased use of renewables in power generation (141 Mt of CO_2 emissions avoided). Keeping the nuclear option open in order to achieve this potential will require a number of decisions and measures by governments and industry.

5. CONDITIONS FOR ACCEPTABILITY OF NUCLEAR POWER

5.1. Public opinion and participation

A factor to be taken into account, which influences the debate on the future of nuclear power, is the issue of public opinion because of its impact on the political decisions to be taken and of the legitimate right of populations to be involved. Concerns about the safety of nuclear power plants, management of radioactive waste, security, proliferation and terrorism have all had an influence on public opinion.

The 2005 Eurobarometer survey showed that the EU public is not well informed on nuclear issues, including possible benefits in terms of mitigating climate change and the risks associated with the different levels of radioactive waste. It also found that out of a majority of citizens having questions about nuclear, 40% of opponents of nuclear energy would change their mind if solutions to nuclear waste issues were found. Consequently, these issues need to be solved if nuclear energy is to be considered acceptable.

Public opinion and perception of nuclear power is paramount to the future of nuclear policy. It is essential that the public has access to reliable information and can participate in a transparent decision-making process. The EU will explore the way to increase access to information, possibly by creating a database accessible to citizens. The EU is fully committed to safeguards, non-proliferation and security of nuclear materials, improving the security of nuclear installations, enhancing detection capabilities, safe management and transport of radioactive sources, decommissioning and radiological protection of workers and the general public. The Commission will therefore step up its cooperation with the IAEA, Member States and operators to enhance their effectiveness and ensure the health, safety and security of the public.

5.2. Nuclear safety

From the outset the importance of nuclear safety was recognised by the European Community, as stated in the Euratom Treaty, and accordingly by the Council[40]. Until now, the safety and reliability record of EU nuclear power plants is excellent. Two nuclear accidents, at Three Mile Island (1979) in the USA and Chernobyl (1986) in Ukraine, triggered international efforts to raise safety standards. Afterwards, the industry came under intense scrutiny leading to improvement of nuclear safety worldwide. Major lessons were learned for all nuclear installations. A Council Resolution on the technological problems of nuclear

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[40] Council Resolution of 22 July 1975 on the technological problems of nuclear safety aiming at progressive harmonisation of safety requirements and criteria in order to provide an equivalent and satisfactory degree of protection of the population against radiation risks with no lowering of the safety level already attained.

safety, published in 1992, reaffirmed the objectives of the 1975 Resolution and extended it to non-Community countries, notably in Central and Eastern Europe and the Republics of the former Soviet Union[41].

Liability for nuclear accidents in the EU-15 Member States is governed by the Paris Convention of 1960, which created a harmonised international system on liability for nuclear accidents, currently limiting the liability to operators in case of nuclear accidents to around $700 million. The Vienna Convention, another arrangement on the same subject but linked with the Paris Convention by a Common Protocol of 1988 (creating a joint regime with mutual recognition of the two Conventions), is applicable in the majority of the ten new Member States. The Commission is aiming at harmonising the nuclear liability rules within the Community. An impact assessment will be started to this end in 2007.

Nuclear safety is still a central issue in the context of the recent enlargements of the EU. Four nuclear reactors (Ignalina 1 and 2 in Lithuania and Bohunice 1 and 2 in Slovakia) with first-generation Soviet-design reactors are being shut down in predetermined stages in compliance with the 2004 Accession Treaty[42]. The EU is providing financial assistance, subject to certain conditions, to various projects on decommissioning and replacement of electricity generation capacity. Similar arrangements are in place for four of the six reactors at Kozloduy, two of which are already closed and another two were closed by the end of 2006 as part of Bulgaria's EU Accession Treaty. The Commission has adopted two proposals for regulations[43] which provide for continued financial assistance to Lithuania and Slovakia until 2013, guaranteeing at least the same level of funding as agreed for the period 2004-2006.

Furthermore, the Community has acceded to the Convention on Nuclear Safety[44] and to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[45]. A revised declaration of competences for the Nuclear Safety Convention was deposited with the IAEA in May 2004[46]. The Conventions aim at enhancing national measures and international cooperation related to safety.

Outside the Community the EU has made a substantial contribution to improving nuclear safety in the CIS countries through the TACIS nuclear safety programme, to which it allocated some €1.3 billion over the period 1991-2006. This assistance is to be continued from the new Instrument for Nuclear Safety and Cooperation, which is no longer limited to the CIS but, in principle, allows assistance to other countries.

Euratom loans have been provided to Kozloduy 5 and 6 in Bulgaria (€212.5 million in 2000), Cernavoda 2 in Romania (€223.5 million in 2004) and Khmelnitzky 2 and Rovno 4 in Ukraine ($83 million in 2004) to improve their safety standards and/or construction.

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41 Council Resolution of 18 June 1992 (OJ C 172, 8.7.1992, p. 2).
42 OJ L 236 of 23.9.3003
43 COM(2004) 624, 29.9.2004.
44 Commission Decision 1999/819/Euratom of 16 November 1999 (OJ L 318, 11.12.1999, p. 20).
45 2005/510/Euratom: Commission Decision of 14 June 2005 (OJ L 185, 16.7.2005, p. 33).
46 In December 2002 the Court of Justice of the European Communities annulled the third paragraph of the Declaration attached to the Council Decision of 7 December 1998 approving the accession of Euratom to the Nuclear Safety Convention, on the grounds that it failed to state that the Community was competent in the fields covered by Articles 7, 14, 16(1) and (3) and 17 to 19 of the Convention.

5.3. Disposal of radioactive waste

In the EU as a whole, some 40 000 m^3 of radioactive waste is generated each year. The vast majority of this radioactive waste originates from day-to-day activities at NPPs and other nuclear installations and is classified as low-level and short-lived. Spent nuclear fuel produces some 500 m^3 of high-level waste per year, in the form of either irradiated fuel or vitrified waste from reprocessing.

In the case of low-level and short-lived waste, strategies are implemented on industrial scale in nearly all EU Member States with a nuclear power programme. A total of some 2 million m^3 of such waste have been disposed of in the EU so far, most of it in surface or near-surface facilities. In the case of high-level and long-lived waste, even though many of the steps of a management strategy are in place, no country has yet implemented the proposed final solution. Deep disposal in a stable rock formation is the preferred option by nuclear operators, whereas others prefer near-surface storage in order to make surveillance and potential recovery easier in the future if required. Some of the main factors affecting progress on this final step are socio-political rather than technical. To this end there has been progress in Finland, where a disposal site has been chosen with the agreement of the local population and the endorsement of the Finnish parliament. The Finnish Law excludes any possibility of exporting or importing nuclear waste from or to Finland. There have also been big advances towards site selection in Sweden and France. However, in most countries site selection is the central issue delaying the disposal option.

Additional techniques for dealing with waste, aimed principally at reducing either the volume or the long-lived component, are being developed in research programmes. These are collectively referred to as “partitioning and transmutation”. Although they would offer the possibility of reducing the long-lived toxicity of such wastes, they can never totally eliminate the need for isolating them from the environment (e.g. in a deep geological repository). This “concentrate and confine” approach makes it possible to minimise the environmental impact.

In several cases, the estimated shares of waste management and decommissioning costs are added to the price of electricity in the EU and deposited in special funds. However, because of the difficulty of predicting future costs, financing schemes need to be kept under review to ensure that adequate funding will be available when it is needed. Management of these funds varies between Member States.

The key to progress is greater public acceptance and involvement in the decision-making process. Waste is fundamentally an environmental and health issue; as such, management and disposal of radioactive waste have to be subject to the same scrutiny applied to all projects which could have an impact on humans and their environment.

Safety also remains at the heart of the Community (Euratom) research effort in various fields. There is a recognised high level of nuclear safety in the operation of the current park of nuclear installations in Europe. Maintaining this level and raising it where possible are subject to concerted and long-term research and development (R&D). The Euratom research Framework Programme is instrumental in this effort.

5.4. Decommissioning

Decommissioning is the final phase in the life cycle of a nuclear installation. It is part of a general strategy of environmental restoration after the end of the industrial activities.

At present over 110 nuclear facilities within the Union are at various stages of decommissioning. It is forecast that at least one third of the 152 NPPs currently operating in the enlarged European Union will need to be decommissioned by 2025 (without taking into account any possible extension of the working life of NPPs). Decommissioning is a technically complex operation requiring considerable funding. The amount needed to rehabilitate the site of a nuclear plant is currently estimated to be around 10 to 15% of the initial investment cost for each reactor decommissioned.

When the conditions for the internal market in electricity were set[47], decommissioning funding schemes were discussed between the European Parliament, the Council and the Commission. The resultant inter-institutional statement[48] highlighted the need for adequate financial resources for decommissioning and waste management activities to be available for the purpose for which they were set aside and to be managed with full transparency. The Commission later proposed two draft directives on nuclear safety and financing of decommissioning and spent fuel management, not yet adopted by Council.

In order to ensure adequate financial resources, in October 2006 the Commission adopted a Recommendation which pays special attention to construction of new nuclear plants[49]. It proposes establishment of national bodies, independent in their decision-making from the contributors to the decommissioning funds. While segregated funds, either externally or internally managed, with appropriate controls on use are the preferred option for all existing installations, they are clearly recommended for any new plant. Operators should bear the real decommissioning costs in their entirety, even beyond existing estimates.

5.5. Radiological protection

The Health and Safety Chapter of the Euratom Treaty has given birth to a considerable body of Community legislation on health protection for workers and members of the public. The basic safety standards were updated in 1996 and supplemented by a new Directive on protection of patients in medical applications[50] (for therapy and diagnostics). Medical uses of radiation sources are becoming increasingly important, with new technologies administering ever-increasing doses to the patient. Big savings in exposure of the population could be achieved in medicine and in relation to natural radiation sources (radon in dwellings or industries processing ores with high uranium or thorium content).

By contrast, exposure of workers in the nuclear industry has been showing a marked downward trend, fostered by the regulatory requirement that all doses should be “as low as reasonably achievable” (ALARA). Also, discharges of radioactive effluent (both airborne and liquid) from nuclear industries, in particular from reprocessing plants, have decreased drastically over the last few decades[51].

Research conducted under the Community's Framework Programme has deepened understanding of the biological effects of radiation and confirmed the precautionary approach adopted internationally. While, in normal operation, nuclear installations can therefore truly

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47 Directive 2003/54/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC.

48 OJ L 176, 15.7.2003.

49 JO L 330, 28.11.2006.

50 Directives 96/29/Euratom and 97/43/Euratom.

51 See, for example, “Radioactivity in food and the environment”, UK Environment Agency et alia, October 2006, ISSN 1365-6414.

be regarded as safe, the possibility of a major accident is not being ignored: Community legislation adopted in the aftermath of the Chernobyl accident has brought significant progress in emergency preparedness, information exchange and controls on food.

Measures to enhance a tighter control of radioactive sources so as to avoid misuse, loss or eliminate risks to exposure of the public due to radiological or nuclear terrorism are also being supported by the Commission.

6. ACTION AT EU LEVEL

6.1. The regulatory framework (Euratom Treaty)

The Euratom Treaty is a self contained Treaty that gives the Community wide ranging competences. Indeed, Article 2 requires the Community : to promote research, to establish uniform safety standards for the protection of workers and the general public, to facilitate investments, to ensure regular and equitable supplies of ores and nuclear fuels, to make sure that nuclear materials are not diverted for purposes other than those for which they are intended, to exercise its right of ownership in respect of special fissile materials, to ensure the creation of a common nuclear market in the relevant areas, and to foster the peaceful use of nuclear energy by fostering relations with third countries and international organisations.

The Treaty (Articles 31 and 32) provides a legal basis for Community initiatives on nuclear safety. This legal basis was endorsed by the Court of Justice in December 2002[52]. Under Article 35 of the Treaty, Member States are required to establish facilities to monitor radioactivity levels released into the environment and ensure that they comply with the basic safety standards. The Commission carried out 26 on-the-spot verifications between January 1999 and June 2006. Since 2004 priority has been given to EU-10 countries (Ignalina NPP (LT) and Temelin NPP (CZ)) and to installations like the Sellafield (UK) and La Hague (FR) reprocessing plants.

Article 37 of the Treaty also places an obligation on Member States to provide the Commission with general information relating to any plans for disposal of radioactive waste so that it can evaluate whether such plans would affect the environment of another EU country. A total of 66 submissions, mainly by France, Germany and the UK, have been made in the last six years. Some 23 of them concerned decommissioning and dismantling and another 23 concerned changes to an existing facility. All the opinions released by the Commission concluded that the disposal of radioactive waste was not likely to result in significant contamination in terms of health on the territory of another Member State.

Euratom safeguards, as provided for under Articles 77 to 79, and the extensive powers bestowed on the Commission under Articles 81 to 83 are fundamental to safe and secure use of nuclear materials and mandatory for continued use and development of the nuclear industry. The Commission's over 150 inspectors submitted over 3,400 detailed reports over the period 2004-2005. As a result, the Commission issued over 200 requests for clarifications or corrective actions on non-conformity, discrepancies and shortcomings to varying degrees in the operators’ nuclear accountancy systems. No evidence was found to suggest that nuclear

52 European Court of Justice ruling for Case C29/99 on 10.12.2002.

materials were diverted from their intended use. However, as underlined above, system weaknesses were detected and corrections were implemented by the operators concerned[53].

6.2. Commission proposals on nuclear safety

Greater harmonisation of safety requirements for nuclear installations in the EU is a prerequisite for the future development of nuclear energy. At various times in the past the Commission put forward proposals for directives to set up a Community framework for the safety of nuclear installations and the management of nuclear waste (known at the time as the "Nuclear package"). Although not yet adopted, those proposals have set in motion a process leading to greater awareness of the need to establish a Community framework linking the work of national safety authorities. As part of the ongoing work, the Council prepared a report that puts forward recommendations that will allow the discussion to restart.

At technical level, the Western Europe Nuclear Regulators Association (WENRA)[54] is contributing significantly to the harmonisation efforts by establishing “safety reference levels”, 88% of which have already been implemented. Building on the existing work and bringing it within the Community framework would add value to the national approaches. Based on the technical consensus reached to date by WENRA, a debate on the roles of each player involved in nuclear safety should be restarted.

6.3. European programme for critical infrastructure protection

The security and economy of the European Union as well as the well-being of its citizens depends on certain critical infrastructure and the services they provide. In order to improve the protection of such infrastructure, including nuclear installations, and to prevent their destruction or disruption, the Commission is putting forward a European Programme for Critical Infrastructure Protection (EPCIP).

6.4. Euratom research

At present, European research in the nuclear field comes under the Seventh Euratom Framework Programme (FP7). In particular, key political and societal concerns, such as management of radioactive waste and safety of existing reactors, plus longer-term energy-related issues, such as innovative fuel cycles and reactors, are addressed. Education and training together with research infrastructure are crucial cross-cutting areas receiving support. These research activities help to structure and catalyse the R&D programmes in the individual Member States, contributing to establishment of the “European Research Area” (ERA) in the field of nuclear fission. The ERA was launched by the Commission in 2000 to ensure closer coordination of research activities and to enhance convergence of policies at national and EU levels. It is an integral part of the Lisbon agenda aiming at building a more dynamic and competitive Europe. This Community research strategy started in the Euratom FP6, and will be consolidated during the Euratom FP7, especially by establishing technology platforms aiming at fully implementing the ERA in nuclear science and technology.

Preservation of expertise in radiological protection and nuclear technology in both the nuclear industry and medicine is fundamental to the EU, as are safety and environmental protection

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[53] COM(2006) 395.

[54] Report available at www.wenra.org together with the policy statement of the national safety authorities on nuclear safety (December 2005).

notably through efforts in nuclear fission and innovative reactor technologies. It is important that this effort be sustained. In collaboration with global initiatives such as GIF, the current Euratom research in this field is principally into the viability of proposed innovative systems and fuel cycles. Thereby, it contributes to the debate regarding future energy supply and helps strategic decisions regarding energy systems and carriers.

6.5. The way forward

As announced in the Green Paper on sustainable, competitive and secure energy, the Commission has carried out a Strategic Energy Review which offers a European framework for national decisions on the energy mix. The review also facilitates a transparent and objective debate on the future role of nuclear energy in the EU energy mix for the Member States concerned.

In order to finalise and improve the proposals already made, the discussion should notably focus on:

– recognising common nuclear safety reference levels for implementation in the EU, building on the extensive expertise of Member States' national nuclear safety authorities;

– setting up a High Level Group on Nuclear Safety and Security with the mandate of progressively developing common understanding and, eventually, additional European rules on nuclear security and safety;

– ensuring that Member States put in place national plans for management of radioactive waste;

– during the early phase of FP7, establishing technology platforms to ensure closer coordination of research in national, industrial and Community programmes in the fields of sustainable nuclear fission and geological disposal;

– monitoring the recommendation on harmonisation of national approaches to management of decommissioning funds to ensure that adequate resources are made available;

– simplifying and harmonising licensing procedures, based on closer coordination between national regulatory authorities, aiming at maintaining the highest safety standards;

– ensuring greater availability of Euratom loans, provided the ceilings are updated in line with the needs of the market as already proposed by the Commission;

– developing a harmonised liability scheme and mechanisms to ensure the availability of funds in the event of damage caused by a nuclear accident;

– giving new impetus to international cooperation, notably through closer collaboration with the IAEA, the NEA, bilateral agreements with non-EU countries and renewed assistance to neighbouring countries.

7. CONCLUSIONS

Nuclear power already contributes significantly to the EU's energy mix, thereby mitigating concerns about potential shortfalls in the security of supply of electricity. Nuclear electricity production costs' sensitivity to fluctuations in the costs of imports of the basic energy sources (uranium) is limited and, as underlined by the International Energy Agency, it is an economically viable generation option, provided environmental and societal concerns are appropriately taken into account.

Nuclear energy, essentially free of CO_2 emissions, makes an important contribution to mitigation of global climate change as a result of greenhouse gas emissions.

It is for Member States to decide whether to use nuclear energy or not. For those EU countries that choose to continue or to start making use of nuclear energy generation, Member States' Governments need to take the necessary decisions. A significant number of NPPs are indeed due to close down within the next 20 years. Construction of new plants and/or extension of the current operating lifetimes of existing reactors will be required if the Member States choose to maintain the current share of nuclear power in the overall energy mix.

Globally, demand for nuclear generation is expanding. The EU is a leading industrial actor in nuclear energy. This creates business opportunities for European companies and brings potential advantages to the EU economy, thereby contributing to the Lisbon agenda. Therefore, at least an adequate investment environment and legislative framework is needed to develop this potential if need be.

The Community must enhance its cooperation with international bodies, such as the IAEA and the NEA, and remain consistent with all international obligations, including on non-proliferation of nuclear materials and technology, protection of the health and safety of workers and of the general public, nuclear safety and the environment.

The Community considers nuclear safety paramount in Member States' decision on whether to continue to use nuclear energy. For those Member States that choose to go down the nuclear path, acceptability by the public will also be an important factor. The Community has a key role to play in ensuring that the nuclear industry develops in a safe and secure manner. In that respect, the Commission considers it a priority that the Community adopt a legal framework on nuclear safety, facilitating harmonisation and compliance with internationally acceptable standards and ensuring the availability of adequate funds for decommissioning NPPs at the end of their life and national policy plans on management of radioactive waste.

Development of nuclear energy will need to be governed in line with the rest of EU energy policy in accordance with the principle of subsidiarity, should be based on the technology's own competitiveness and should be one component of the energy mix. There are clearly impacts for the EU as a whole from the decisions which individual member states take in the area of nuclear energy, although the choice of national energy mix use is a matter for each Member State. In order to provide a more regular updated picture of the situation in the EU, the Commission will – in accordance with Article 40 of the Euratom Treaty – increase the frequency of publication of the Nuclear Illustrative Programmes.