Nuclear Energy in the European Union – Before and After Enlargement

Antony Froggatt

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The political changes in 1989 increased public and political concerns over the dangers of nuclear power in Eastern Europe. These concerns led to the closure of all operating reactors in former Eastern Germany following unification, and increased international efforts to close similar reactors in the current accession countries. These attempts only reached fruition as a result of the negotiations for accession to the EU, and the first VVER 440-230 reactors were closed in Bulgaria in 2003. A total of eight reactors in three countries are scheduled for closure by 2010. However, the closure dates finally agreed will still enable RBMK design reactors to operate in the EU, in Lithuania. In addition, for the first time reactors in existing Member States will/may be closed for safety reasons effectively at the request of the EU.

The enlarged EU will have 161 nuclear reactors in operation and will be the world's largest producer of nuclear electricity, generating around 32% of the Union's electricity. Accession countries largely mirror the EU's lack of new orders, as only Slovakia officially has any reactors under-construction, and so enlargement will not bring additional optimism for new construction. This lack of new orders is resulting in the ageing of the EU 25's reactor fleet, which has an average age of 22 years, up by 7 years in a decade. The current lack of new orders is predicted to result in a significant decline in the percentage contribution that nuclear power generation plays in the EU during the period 2015-2025.

In part as a result of EU enlargement and in part due to this ageing trend, the European Commission has prepared two new Directives, one on nuclear safety and the other on radioactive waste management. When the former was launched the Commission claimed it was needed to maintain high standards after enlargement, as the current acquis communautaire does not include nuclear safety standards for reactors. Consequently, the Directive would see the Union setting legislation on nuclear safety standards for the first time. However, before the draft legislation reached the European Council or Parliament it was weakened and now proposes to set only general principles and obligations. Even this is unacceptable to some Member States and it may be rejected. Annexed to the safety Directive is proposed legislation requiring nuclear utilities establish separate legal entities for their waste management and decommissioning funds. This is intended to both reduce market distortions within the utility sector and to increase the likelihood that funds would be available when required. This legislation is strongly opposed by the French and German Governments.

The second Directive proposes to set EU-wide requirements for the sitting and operation of nuclear waste disposal facilities. This approach fails to take into account the variations in the developments of waste management programmes in Member States or different strategies being adopted.

Also in 2004 all Member States, including new Members, will have to transpose the revised electricity market Directive into national law. This will accelerate market opening, requiring full competition for domestic consumers by July 2007. Furthermore, it increases unbundling requirements and requires energy utilities to publish information on the generation mix and environmental impact of generation. The intended increase in competition is supposed to result in lower prices for consumers and thus lead to lower revenues to operators. These trends may further hinder the construction of new reactors within the Union.

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Prepared for Eurosafe 2003

Antony Froggatt

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Summary

2004 will be a key milestone for the European Union's political and economic development, with the expansion of its membership from 15 to 25 countries. In comparison the changes in the nuclear sector seem small - but they are nevertheless significant.

The political changes in 1989 increased public and political concerns over the dangers of nuclear power in Eastern Europe. These concerns led to the closure of all operating reactors in former Eastern Germany following unification, and increased international efforts to close similar reactors in the current accession countries. These attempts only reached fruition as a result of the negotiations for accession to the EU, and the first VVER 440-230 reactors were closed in Bulgaria in 2003. A total of eight reactors in three countries are scheduled for closure by 2010. However, the closure dates finally agreed will still enable RBMK design reactors to operate in the EU, in Lithuania. In addition, for the first time reactors in existing Member States will/may be closed for safety reasons effectively at the request of the EU.

The enlarged EU will have 156 nuclear reactors in operation and will be the world's largest producer of nuclear electricity, generating around 32% of the Union's electricity. Accession countries largely mirror the EU's lack of new orders, as only Slovakia officially has any reactors under-construction, and so enlargement will not bring additional optimism for new construction. This lack of new orders is resulting in the ageing of the EU 25's reactor fleet, which has an average age of 22 years, up by 7 years in a decade. The current lack of new orders is predicted to result in a significant decline in the percentage contribution that nuclear power generation plays in the EU during the period 2015-2025.

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Annexed to the safety Directive is proposed legislation requiring nuclear utilities to establish separate legal entities for their waste management and decommissioning funds. This is intended to both reduce market distortions within the utility sector and to increase the likelihood that funds would be available when required. This legislation is strongly opposed by the French and German Governments. The second Directive proposes to set EU-wide requirements for the siting and operation of nuclear waste disposal facilities. This approach fails to take into account the variations in the developments of waste management programmes in Member States or different strategies being adopted.

Also in 2004 all Member States, including new Members, will have to transpose the revised electricity market Directive into national law. This will accelerate market opening, requiring full competition for domestic consumers by July 2007. Furthermore, it increases unbundling requirements and requires energy utilities to publish information on the generation mix and environmental impact of generation. The intended increase in competition is supposed to result in lower prices for consumers and thus lead to lower revenues to operators. These trends may further hinder the construction of new reactors within the Union.

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Nuclear Power and the European Union

Nuclear power has been a fundamental part of the European Union institutions virtually since its founding. The Euratom Treaty, set up to assist with the development of nuclear power, is one of the founding three Treaties, along with the European Coal and Steel Community and EC Treaty. The Euratom Treaty was first signed by six countries, Belgium, France, Germany (Federal Republic), Italy, Luxembourg and the Netherlands. Now there are fifteen Members with a further ten set to join in May 2004.

Through the Euratom Treaty the European Union helps in the development of nuclear power –via its loan facility and research and development programmes -, regulates the uranium market, and oversees the Union's non-proliferation programme. It is proposed to increase its regulatory function for the civil nuclear industry.

Despite its diverse role and the introduction of the EU's electricity market rules, the Euratom Treaty remains apart from other EU legislation and is largely unchanged since its conception in 1957. Consequently, there is no co-decision with the European Parliament on Euratom legislation and Euratom has its own research and development programme. The separate status of the Euratom Treaty reinforces the view held by many that nuclear power is given special status within the European Union. This position has been strengthened by the decision by the European Convention not to include a review of the functions of the Euratom Treaty within the new EU Constitution. Rather it is proposed to keep the Treaty functionally intact and as a separate legal personality included as a protocol to the new Constitution. However, there is no consensus that this is the right approach to take and in September 2003 the European Parliament called for the revision of the Euratom Treaty in a separate Inter-Governmental Conference. How and if the current Inter Governmental Conference addresses Euratom reform remains to be seen, but early indications are that the larger Member States are determined not to revisit this most complex and controversial of issues.

The proposed Constitution for the EU also contains for the first time a suggestion that an energy chapter be included. This proposed wording is: -

In establishing an internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim to:
(a) ensure the functioning of the energy market,
(b) ensure security of energy supply in the Union, and
(c) promote energy efficiency and saving and the development of new and renewable forms of energy.

The inclusion of the development of 'new and renewable' forms of energy raises the possibility of promoting new nuclear, fusion and fission or 'clean coal' in addition to renewable energy sources. How this will translate into specific policy or research programmes will have to be determined, as will the relationship between the Euratom Treaty and the EU's energy chapter.

Role of Nuclear Power in the Electricity Sector

The commercial use of nuclear power was pioneered in current Member States of the EU; in 1957 reactors in the UK produced commercial electricity for the first time. Since then the industry has expanded considerably and an enlarged EU will have 156 operating commercial reactors representing over one third of the world total. The enlarged European Union will be the largest producer of nuclear power in the world, producing some 8% more nuclear power than North America, nearly three times more than Japan and seven times more than Russia. There are only four countries in the world that produce more than 50% of their power from nuclear reactors and these will all be in the EU in 2004. A summary of the statistics for Member States can be seen in the table that follows.

Table 1: Summary of Current Reactor Status in Prospective and Current EU Countries – Status September 2003

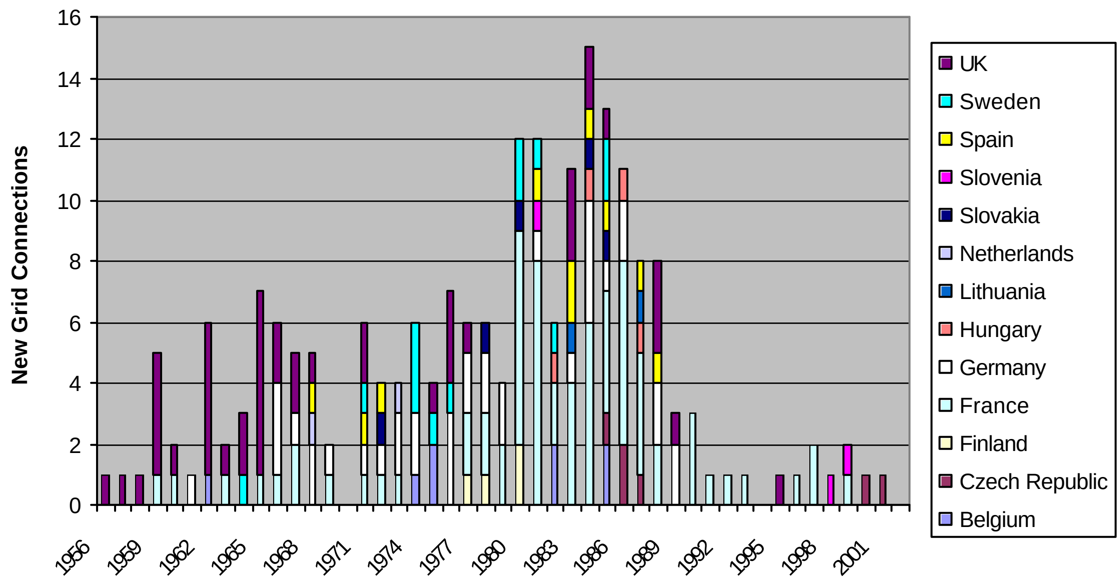
Country	Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
Belgium	7	0	1	1962	44 737	57.3
Czech Republic	6	0	0	1985	18 738	24.5
Finland	4	0	0	1977	21 443	29.8
France	59	0	11	1959	415 500	80.0
Germany	19	0	17	1961	162 250	29.9
Hungary	4	0	0	1982	12 787	36.1
Italy	0	0	4	1963	0	0
Lithuania	2	0	0	1983	12 900	80.1
Netherlands	1	0	1	1968	3 687	4.0
Slovakia	6	2	1	1972	17 953	54.6
Slovenia	1	0	0	1981	5 308	40.7
Spain	9	0	1	1968	60 284	25.8
Sweden	11	0	2	1964	65 574	45.7
UK	27	0	18	1957	81 976	22.4

Source: IAEA PRIS Database, September 2003

As noted the UK was the first country to commercially develop nuclear power, this was shortly followed by the US, whose first reactor was connected to the grid in 1960, then France, Germany, Belgium, Italy, Russia and Sweden. The graph below shows the development of an enlarged EU's nuclear construction programme since the early days and shows some key points, including: -

- The dominance of the UK in the early years, due to construction of the Magnox fleet.
- The vast construction programme in France in the 1980s.
- The less rapid but yet consistent construction programme in Germany.
- The effective collapse of new connections since 1990.

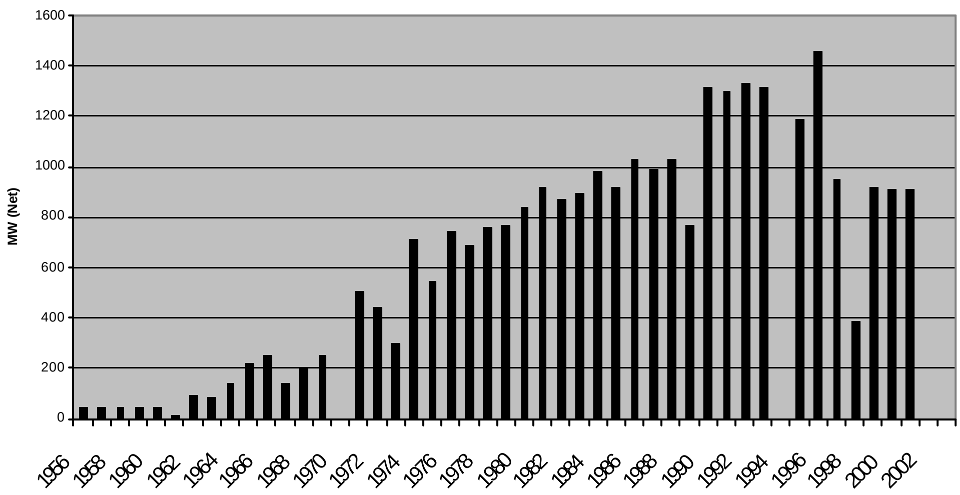
Historical Development of New Reactors in an Enlarged EU



Source: IAEA PRIS Database, September 2003

The previous graph doesn't reflect the contribution to electricity production of nuclear power in the EU as it doesn't differentiate between reactor sizes. Over the 50 years of commercial operation reactors have increased in size 20 fold. This is demonstrated in the following graph. The apparent 'downsizing' of reactors completed in the 1990s is largely due to the completion figures being dominated by accession countries, who have built smaller reactors. Should Europe's reactor construction programme restart it may well follow this path with, the Generation IV reactors likely to be of smaller size than those most recently constructed in the EU. However, the European Pressurized Water Reactor (EPR) currently under development in France is 1.6 GW, and if deployed would continue the trend of larger reactors.

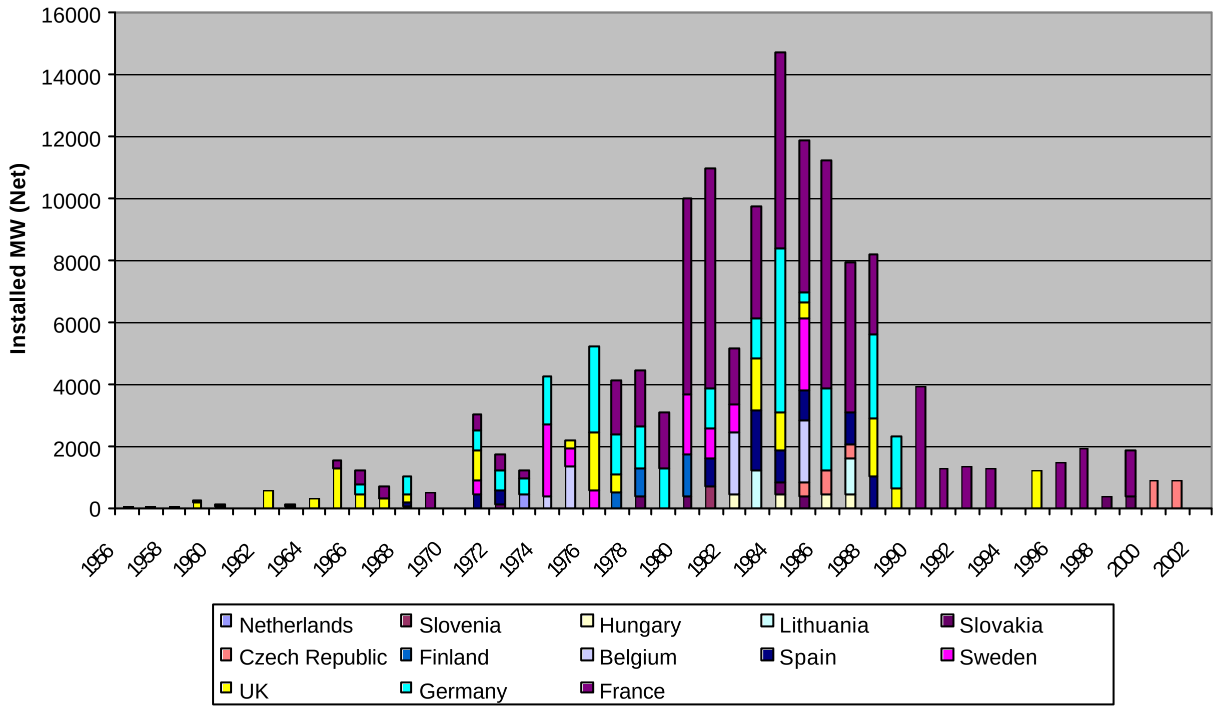
Average Installed Capacity of New Reactors in an Enlarged EU



Source: IAEA PRIS Database, September 2003

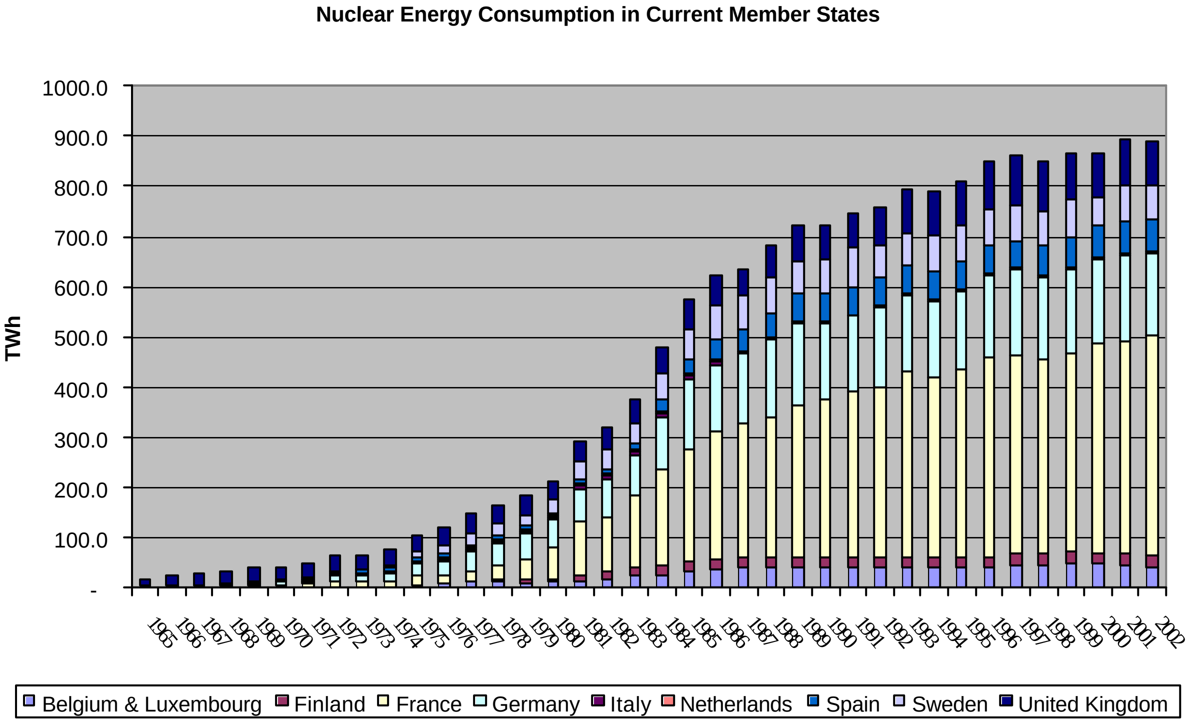
The graph below combines the number of new reactors with the increase in size and shows a slightly different view of the development of new build in Europe. This shows the domination of a few nuclear programmes in Member States. France accounts for one third of the reactors but has 45% of the installed nuclear capacity, while Germany has 18% and UK 10% of installed capacity.

Historical Development of New Nuclear Capacity in an Enlarged EU



Source: IAEA PRIS Database, September 2003

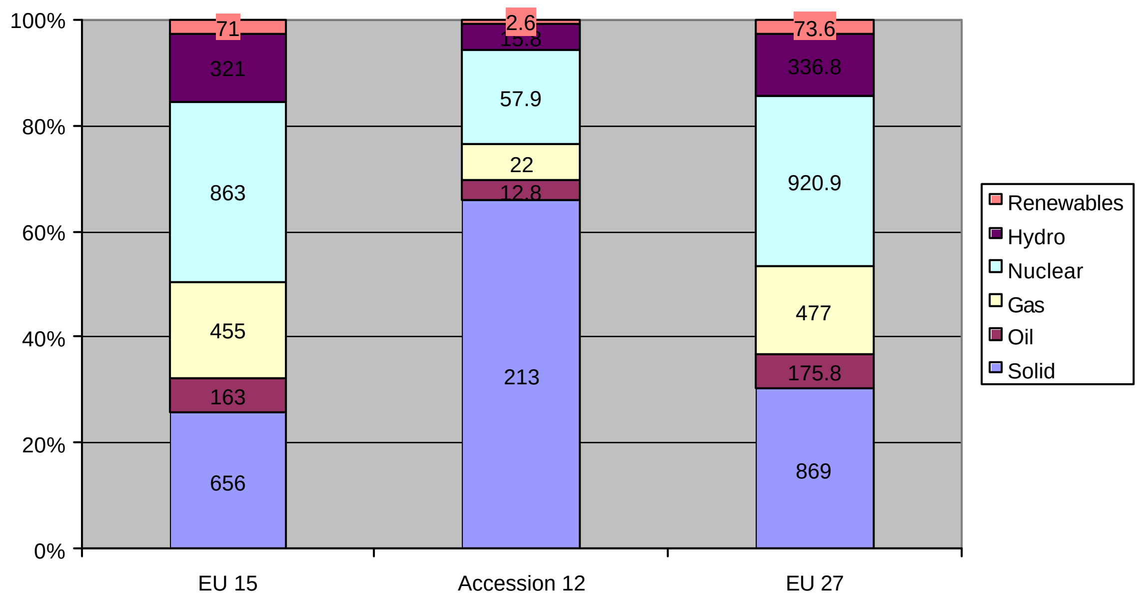
How this construction is transformed into electricity production is less easy to demonstrate for an enlarged EU, due to lack of historical data for some accession countries. Therefore, the graph following only demonstrates the annual consumption of nuclear electricity in current Member States. Clearly shown is the rapid development in the 1980s: during this decade there was a 250% increase in nuclear electricity consumption – mainly due to the French programme, while during the 1990s only a 16% increase was achieved.



Source: BP Statistic Review of Energy, June 2003

The production of nuclear electricity within the EU Member States increased from 12% in 1980 to 33% in 1988. However, since then nuclear electricity has not significantly increased its share of total production. In 2002 it was 35%, with the other major fuel, solid fuel coal around 25%, natural gas 20% and hydro 12%. In Accession countries nuclear power gives a much smaller contribution of 15%, with solid fuel around 40%, hydro 32% and natural gas 10%. In an EU 25 or 27, nuclear power will contribute around 32% to the total electricity production, with solid fuel contributing 30%, natural gas 17%, hydro 11% and wind energy less than 1% (all based on 2000 data). The graph following shows these contributions.

2002 Percentage Mix for Electricity Generation in Current and Prospective Member States of the EU



Sources: IEA, European Commission, Eurostat (the figures included in the graphic are actual production in TWh)

Over Capacity of Generation

Despite the introduction of market liberalisation and the subsequent uncertainties over price within the EU and accession countries there remains overcapacity. As the table shows within EU Member States there is an excess of around 80 GW of installed capacity over and above a 15% reserve capacity. The table[1] below shows the current overcapacity within each current Member State.

Table 4: Capacity Margins in EU Countries in 2002

Member State	Capacity (GW)	Peak demand (GW)	Capacity Margin (%)
Austria	17.5	9	94
Belgium	15.5	13	19
Denmark	12.1	6.3	92
Finland	16.6	13.2	26
France	115	77	49
Germany	117	85	38
Greece	12	8.8	36
Ireland	5	4.2	19
Italy	74	51	45
Luxembourg	1.5	0.9	67
Netherlands	20	17	18
Portugal	9.9	7.5	32
Spain	45	37	22
Sweden	30.8	26	18
UK	73	61	20
EU-15	564.9	416.9	36

[1]British Government Submission to European Commission in evidence for restructuring plans for British Energy, July 2003.

Over and above the excess capacity in the EU, some countries are experiencing a growing separation between maximum and minimum load demand. This is particularly evident in France. Research by energy analysts at WISE-Paris has shown that between 1978-2003 the margin between maximum and minimum load demand has increased by 20 GW[2]. This failure to curb peak electricity demand has helped to hide the true extent of overcapacity.

The enlargement of the EU will add to overcapacity, as the decline in energy consumption in Central and Eastern Europe (CEE) over the early part of the 1990s have meant that in most countries current demand is only reaching 1990 levels in 2000. On average, overcapacity in CEE countries is around 60%. Some countries, such as Lithuania have over 250% over –capacity, while even Poland has 43% with 10 GW of capacity above peak demand. However, this will change in some countries with the closure of power stations for environmental or economic reasons. Despite these closure plans an increasing volume of electricity is being imported from countries in the former Central electricity region (Czech Republic, Hungary, Poland and Slovakia) into the EU.

In addition to the current over capacity, approximately 90 GW of new capacity is under-construction or in the planning stage across Europe, according to the energy newsletter Platts, the majority of which is for new combined gas cycle turbines plants (80%), with the only nuclear project included being for the fifth reactor in Finland.

Closures of Reactors as a Requirement for Accession

In July 1997 the European Commission published Agenda 2000, which laid out their proposal for the enlargement of the European Union. This document made clear both the importance that the Commission placed upon nuclear safety and the timetable in which action should be taken. It stated that that nuclear safety must be '*urgently and effectively addressed*'.

The issue was further emphasised following the unification of Germany: all VVER 440 reactors were abandoned, both those of the 230 and 213 designs, as were plans to complete the VVER 1000 reactors at Stendal. For a number of years the international community – largely the G7 and EU – deemed that some designs of Soviet reactors were non-upgradeable, as they had such significant design deficiencies that it would not be economic to attempt to bring these up to a 'western standards'. The reactors in question were the RBMKs and the VVER 440-230s designs. Within accession countries, there were eight such reactors: Bohunice V-1 (Slovakia); Ignalina 1 and 2 (Lithuania) and Kozloduy 1-4 (Bulgaria). Agenda 2000 repeated the call for the closure of these reactors.

Following negotiations with the countries concerned, the December 1999 Helsinki Summit, agreed a programme for the closure of all the reactors in question. The table below shows both the proposed closure dates set out in Agenda 2000, and the revised dates agreed at Helsinki. On average the Helsinki agreement grants reactors an additional operational life of 5 years. The closure dates put forward will therefore still enable RBMK reactors to operate within the EU, in Lithuania. In addition, for the first time reactors in existing Member States will/may be closed for safety reasons effectively at the request of the EU.

[2] http://www.wise-paris.org/english/ourgraphs/ELE/FRA/ELE.FRA.11.G.PointePuiss.en.html

Table 2: Reactors to be Closed with Enlargement of the EU

Nuclear Power Plant	Reactor	Agreements Noted Agenda 2000	Accession Partnership Agreements
Kozloduy: Bulgaria.	Unit 1 and 2 Units 3 and 4	Spring 1997 End 1998	2003 2006
Ignalina: Lithuania.	Unit 1 Unit 2	1998 2002	2005 2009
Bohunce-V1: Slovakia	Units 1 and 2	2000	2006-8

The first date for the closure of Units 1 and 2 at Kozloduy has been met as both reactors were closed on the 31st December 2002. However, there still remains some uncertainty that all others will be fully adhered too.

New Build

As table 1 shows there are currently no reactors under construction in EU Member States and according to the IAEA only Slovakia has reactors under construction in those accession countries due to join the EU in 2004. The table below summarises the current situation in current and future Member States regarding new construction. Within the current EU only Finland has any firm plans for the construction of new nuclear capacity, with France the only other country with the potential to order any more reactors in the next few years. All other States have effectively ruled out new construction on the short to medium term. In new Member States, Slovakia officially has two reactors under construction and Romania, set to join in 2008, has one reactor being built. There are other less concrete plans - namely lack of financial details and technical information - for further construction also in Bulgaria, Lithuania and Romania.

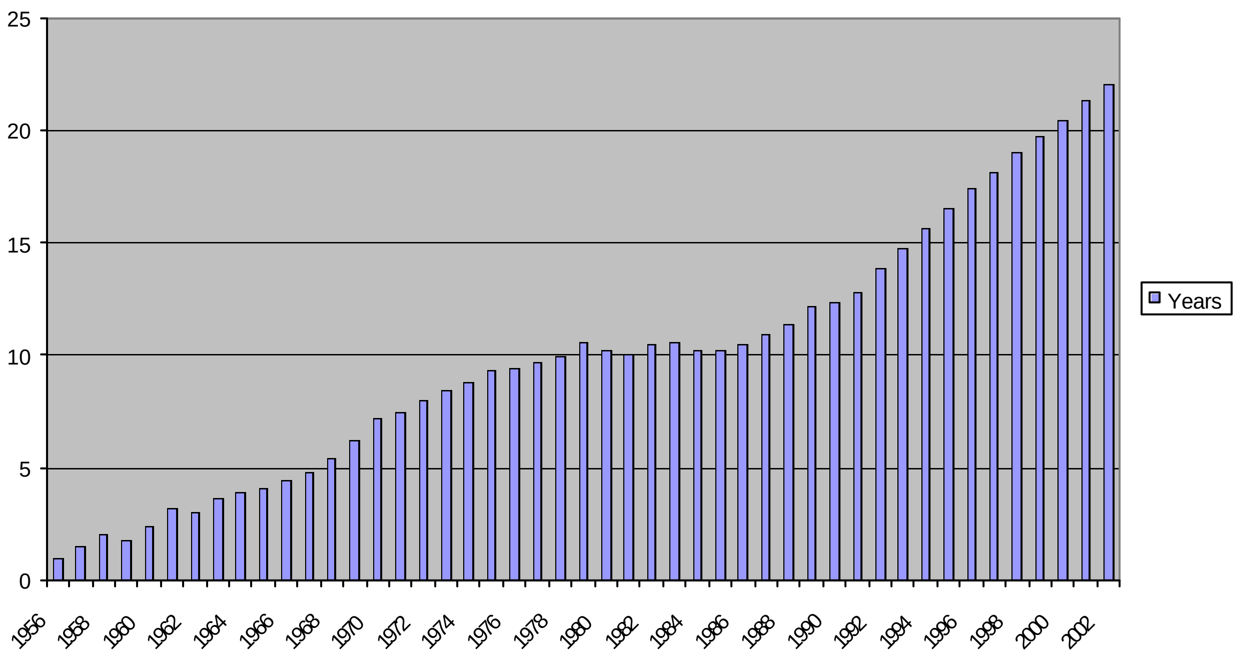
Table 3: Policy for Existing Reactors and New Build in an Enlarged EU

Country	Status on New Build
Belgium	The 1999 phase-out legislation, which finally became law in 2003, both requires the closure of reactors after 40 years of operation and a prohibition on the construction of new reactors. Following the elections in May 2003 and a change in Government it is possible that this legislation will be overturned, as could occur in any Government. However, this is unlikely as the major parties, the Socialists and Liberals, remain the same and even if it were overturned it might well be insufficient to encourage utilities to construction more reactors as a new Government could reintroduce the legislation restricting their operation.
Czech Republic	Reports in the Czech press note that Industry and Trade Minister Jiri Rusnok has suggested that the Republic might need to build three 600 MW or further reactors at Temelin reactors to help compensate for a projected decline in coal resources over the next 10-20 years and to prevent the country needing to import electricity. The State utility CEZ has said that they will decide on new power sources in 2004.
Finland	The utility TVO has applied to build a fifth reactor; this proposal was approved first by the Government and then by the Parliament in May 2002. The utility is now considering bids from a number of companies and is expected to award a tender at the end of 2003, although it is thought likely it will be the EPR. If it proceeds this will be the first reactor commissioned and built in the EU since 1986 and the first globally in a fully liberalised market.
France	By the end of 2003 the French Government is expected to have concluded their public and Parliamentary debate on the future direction for the country's energy policy. While many expected that they will propose the construction of a new prototype EPR – the industry minister Nicole Fontaine announced her desire to see the EPR build as soon as possible - others have called for a delay in the decision on the ordering of new reactors.
Germany	In 2000 the Government and nuclear utilities signed an agreement that restricts the operation of existing reactors to an operating life for the equivalent of approximately 32 years for each unit and prohibits the construction of new reactors.
Hungary	In 1999 the owners of Paks proposed to extend the facility and received a number of bids. However, at the time a gas-fired power station was chosen to meet the medium term increase in power needs. No other plans have been put forward.
Lithuania	Numerous press reports have suggested that additional nuclear units would be considered as a replacement for the Ignalina RBMK units scheduled for closure by 2010. In May 2003 the French company Areva signed a memorandum with the Government on the potential for new build, however, no further information is available.
Netherlands	The decision to close the Borssele reactors in 2003 has been overturned and it may now continue until 2013, the end of its nominal 40 years operational life. No Government plans exist for the construction of further reactors.
Slovakia	According to the IAEA units 3 and 4 of the Mochovce station are under construction. However, serious doubts remain on the likelihood of this proposal at the current time.
Slovenia	There are no plans for the further construction of nuclear reactors.
Spain	A report on the country's energy infrastructure, by the Finance Ministry in 2002 recommended that no new nuclear power reactors to be constructed until at least 2010.
Sweden	The current nuclear debate focuses on the closure of Barseback 2 and not on the construction of new reactors.
UK	The Government White Paper on Energy Policy published in February 2003 stated that there were no plans to build more nuclear power stations.
Post 2004 new EU Members	
Bulgaria	By the end of 2003 the Government is scheduled to produce a technical and economic proposal for the completion of the Belene nuclear power plant.
Romania	Unit 2 of the Cernavoda power plant is under construction and awaiting approval for a Euratom Loan for financial arrangements to be completed. Plans are also being developed to enable to completion of the remaining three units by 2020.

Reactor Ageing

The lack of construction means that Europe's reactor fleet is getting older. The graph below demonstrates this trend and shows that the average age of the reactors is 22 years. Given particularly long lead times for new build this trend must cause concern to those looking to the long-term future of the industry.

Average Age of Operating Reactors in an Enlarged EU



Given, at least on the short to medium term, a lack of new orders within the EU, the only way that nuclear utilities will be able to retain their share of rising electricity demand is to both increase the output from the existing stations and to increase their operating lives. These trends are global and are already clearly seen in North America and Western Europe. However, both measures are restricted by technical constraints.

Between 1997 and 2000 there was an increase in global output of nearly 300 TWh, equivalent to approximately 40 reactors, but in that period the net increase in reactor numbers was only three. Part of this is due to larger reactors being commissioned i.e. small reactors are being replaced by larger ones, but also by power upgrades and general increases in load factors. According to the World Nuclear Association, currently two thirds of the world's nuclear reactors now have load factors in excess of 80%, compared to only 25% in 1990. Between 1998 and 2002 the global average for load factors increased from 75.5% to 78.7%.

The International Energy Agency noted in 2001, *"If there are no changes in policy towards nuclear power, plant lifetime is the single most important determinant of nuclear electricity production in the coming decades"*[3]. Most forecasting models are based on an operational life for reactors of around 30-40 years. However, there are a number of proposals to extend these to fifty or even sixty years. The exchanging of components, such as steam generators or vessel heads, is now routine and undertaken in relatively short time periods. However, two components, the reactor vessel and

[3] Nuclear Power in the OECD, International Energy Agency, 2001, page 300.

containment system, are unlikely ever to be considered for exchange and from a technical rather than economic perspective are the life limiting factors for the reactors.

In the United States the life extension process is advanced: around 30% of the country's reactors will have operated for a minimum of 40 years by 2015, with the first four power plants reaching their 40 year life by 2006. Consequently, a significant number of reactors have or are in the process of applying for a life extension licence. To date, 16 units have been granted a licence, with a further 12 under consideration and another 30 expected in the next three years.

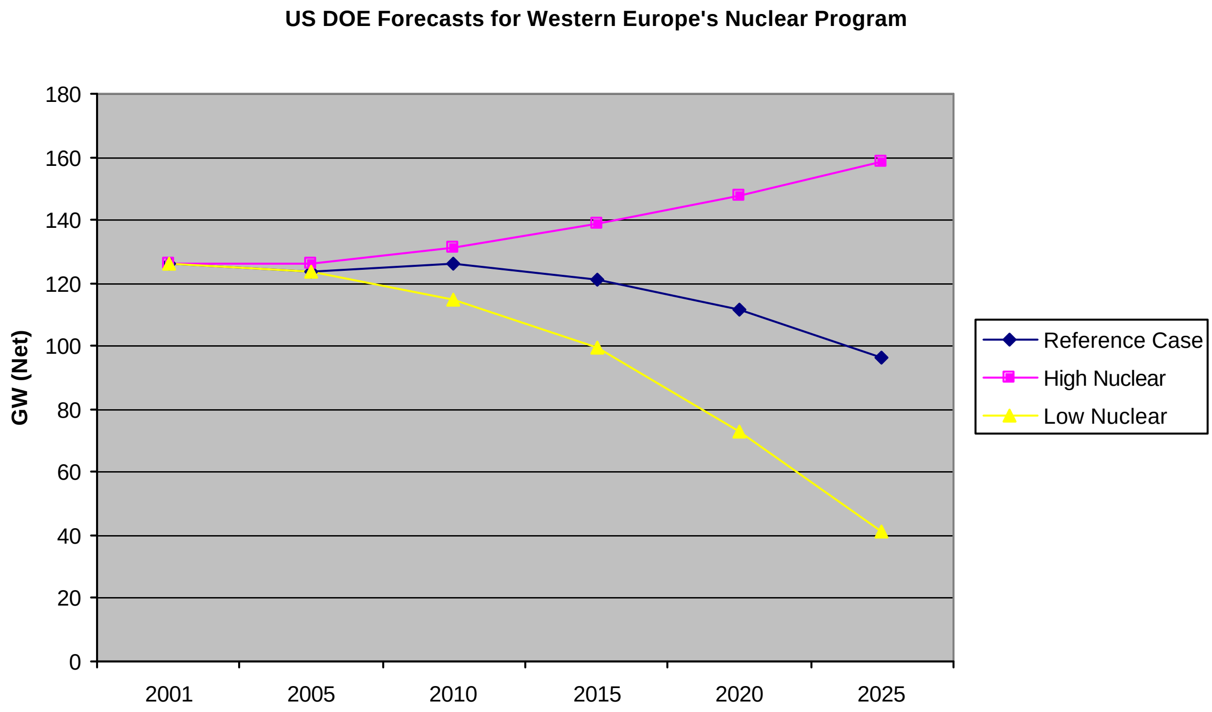
In Europe the trend is also underway. In the UK, which has the oldest reactors fleet some the Magnox stations have been given regulatory approval to potentially operate for 50 years. In those EU countries without phase-out plans, such as France and Spain, calls to increase the operating life of the reactors are growing. In 2003 Electricité de France (EdF) modified its accountancy methodology for its decommissioning funds to formally anticipate that the reactors would operate for an additional 10 years – up to a 40 year life.

The economic advantages of Plant Life Extension (PLEX) are clear as they avoid large upfront construction costs and assume that adequate funds have been set-aside during the 'expected' operational life, decommissioning costs. Some estimates put the cost of increasing the operating life of the reactors as low as between €10-50 per installed kW. However, as with any power station, ageing of components can have a significant impact on the economics of a facility as increased unreliability and greater maintenance costs can lead to the closure of stations. This is especially true in a market with less price certainty, where even limited investment risks might need to be avoided.

What Future Nuclear Power?

The US Department of Energy's most recent forecasts for nuclear power in Europe suggest a wide range of possible outcomes for nuclear power in Western Europe. Under the DOE high scenario nuclear power will significantly increase as countries once again start ordering new reactors as well as operating the existing ones for longer. This would result in an installed capacity of around 160 GW by 2025. Assuming an operational life of 45 years, just to maintain the current 120 GW of installed capacity will require the additional of 2.6 GW per year. Therefore around 80 new reactors will have to be built between 2010-2025 to reach the 160 GW target - nearly five GW per year. Given that between 1990-2010 it is likely that only around 10 GW in total (0.5 GW per year) will have been added, this scenario will require a mammoth shift in economic, political and public thinking.

The reference scenario predicts only relatively small new build and some life extension. This results in a decline in the EU nuclear capacity by around 20% over the next two decades. The low nuclear scenario sees the rapid decline in installed capacity as reactors are closed on the basis of current life expectancies. As a consequence by 2025 the total programme is only 40GW (see graph below).

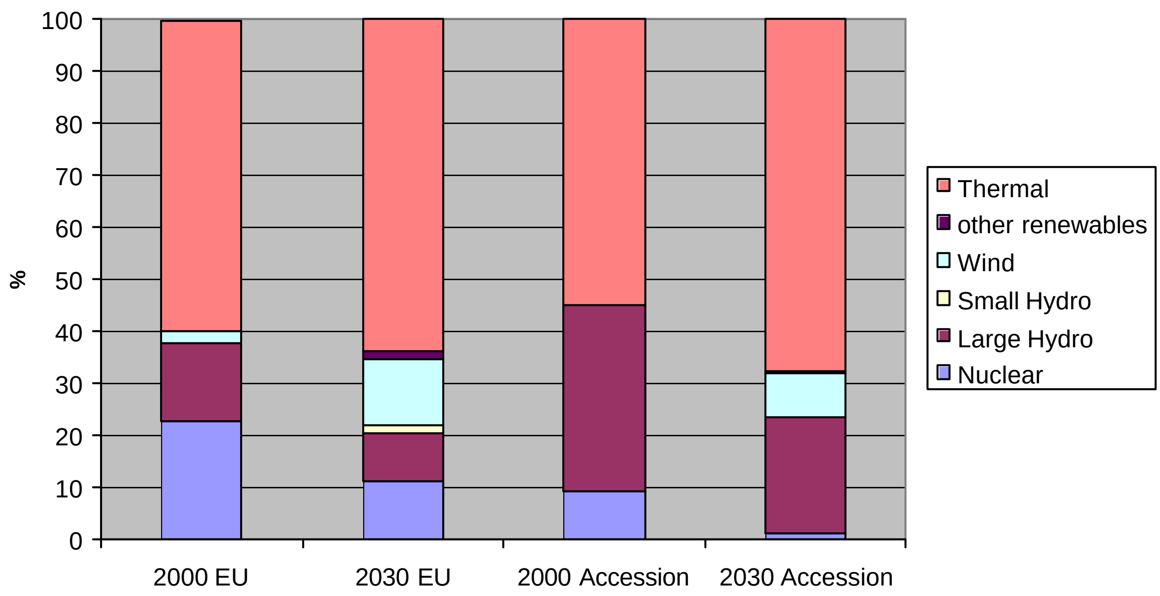


Source: US Department of Energy, 2003

The European Commission has also recently published forecasts for the future of the power sector[4]. The graph below shows how the Commission expects the installed capacity of the power sector to change in both the current Member States of the EU and in accession countries. In both cases, the installed capacity of nuclear, in percentage terms, halves over the period 2000-30, while wind energy is significantly increasing. Wind is expected to have a higher installed capacity, although not TWh production, than nuclear power by 2030. Despite this increase the use of fossil fuels is predicted to continue to dominate and to increase both their share of total production and percentage of installed capacity.

[4] European Energy and Transport Trends to 2030, European Commission January 2003, ISBN 92-8944444-4

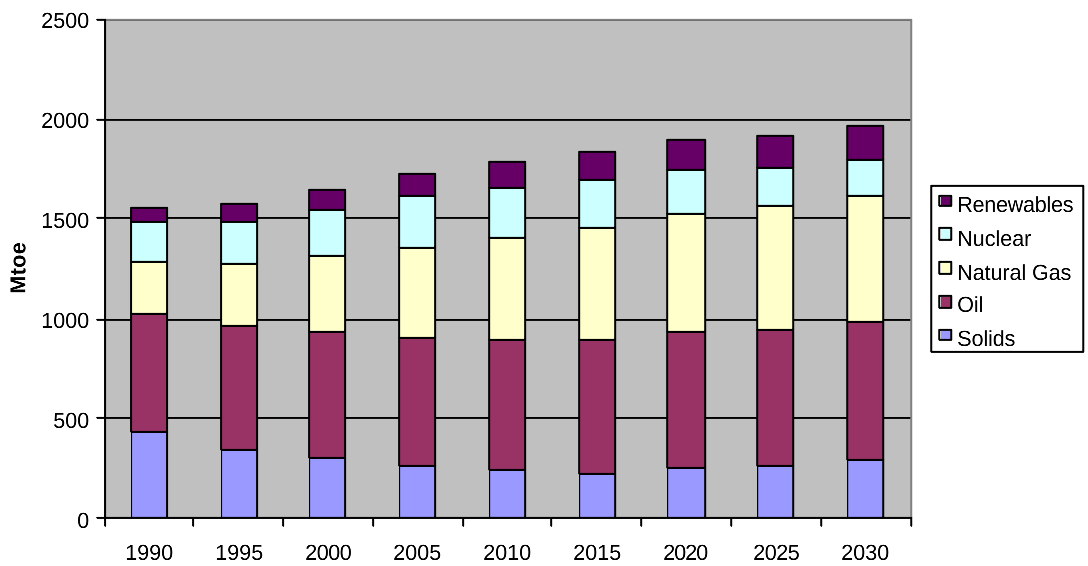
Power Generation Capacity in EU and Accession Countries 2000 and 2030



Source: European Commission, 2003 b

The Commission analysis further shows that energy produced by renewable energy in 2030 will still not equal that of nuclear power, despite the change in fortunes of the respective technologies. Between 1990 and 2030 the renewable share in energy production will increase from 4.5% to 8.6%, while nuclear power declines from 12.6% to 9.4% over the same period. Despite the rise of renewables, the report predict that Europe will fail to meet the targets of the EU's renewable energy Directive, as it is only anticipated to contribute around 6% of energy needs by 2010, rather than the 12% envisaged.

Gross Energy Consumption by Source in an Enlarged EU



Source: European Commission, 2003 b

Furthermore, it is predicted that the EU's total Co2 emissions will by 2030 have increased by around 14% over 1990 emissions.

Liberalisation of the EU Electricity Market

Member States will have to transpose the revised EU electricity market Directive into national legislation by July 2004.

The revised Directive was introduced primarily for four reasons:

- To increase the homogeneity of the market:
    - In order to be adopted the first Directive left a number of options to be decided on a Member States level, e.g. mechanism for access to the grid, these options have been reduced
    - The first Directive only required a relatively small (30%) percentage of the consumer market to be open to competition. However, a significant minority of Member States (Austria, Finland, Germany, Sweden and UK) have already 100% market opening with others scheduled to follow.
- The increased use of natural gas in the power sector led to calls for the harmonization of the gas and electricity market Directives.
- The European Council declaration in Lisbon in March 2000 called for the speeding up of liberalisation in a number of areas including the gas and electricity sectors.
- The desire to create a single EU electricity market, rather than fifteen independently liberalised markets.

The revised Directive seeks to address these issues by:

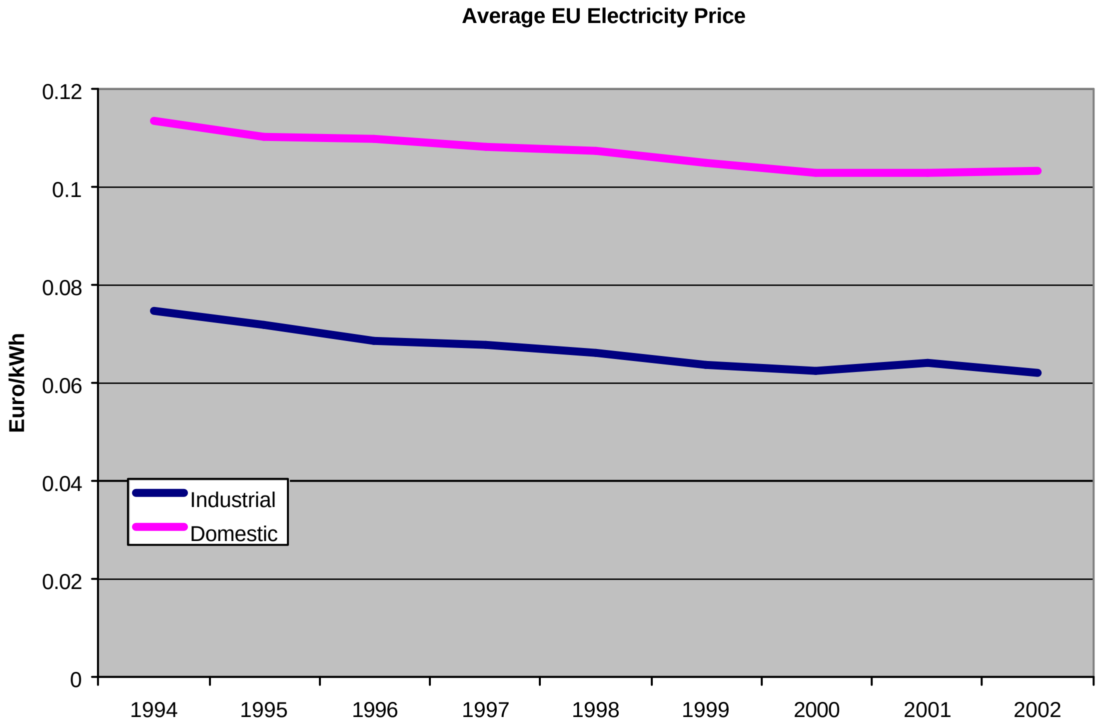
- Ensuring that all non-domestic consumers can choose their electricity supplier by mid 2004 and all domestic by mid 2007.
- Increasing unbundling between the different sector of the industry including requiring the legal separation of network activities from generation and supply.
- Strengthening the powers of the national regulators.
- Requiring the publication of network tariffs.
- Introducing monitoring of security of supply and market concentration.
- Mandating electricity labelling for the generation mix and some emissions and nuclear waste.
- Reinforcing public service obligations.

The impact that this will have will be seen over the coming years. But what is clear is that liberalisation has already had a considerable impact on the market in two main areas:

Prices:

The introduction of liberalisation to the electricity market is supposed to increase competition, stimulate innovation and encourage transparency. This is meant to lead to a decrease in electricity prices, which is beneficial to the competitiveness of the EU's industrial sector as a whole.

It is well documented that throughout the EU over the last decade there has been a fall in electricity prices for both industrial and domestic consumers. Figures recently published by Eurostat confirm this. The graph below shows that since 1994 prices for domestic consumers have fallen by around 10%, while they fell 20% for industrial consumers.



Source: Eurostat, 2003

How much this is due to liberalisation and how much to a drop in the price of the dominant fuel source, natural gas, is difficult to say. Although retail prices have fallen across the EU, the wholesale price for electricity has fallen much further in some countries. In the UK, the introduction of a new electricity trading regime in 2001 resulted in the decrease in the wholesale price of electricity by around 18% in its first year of operation. However, over the same time period the price of electricity to domestic consumers fell by only 2.5%, according to the UK body EnergyWatch.

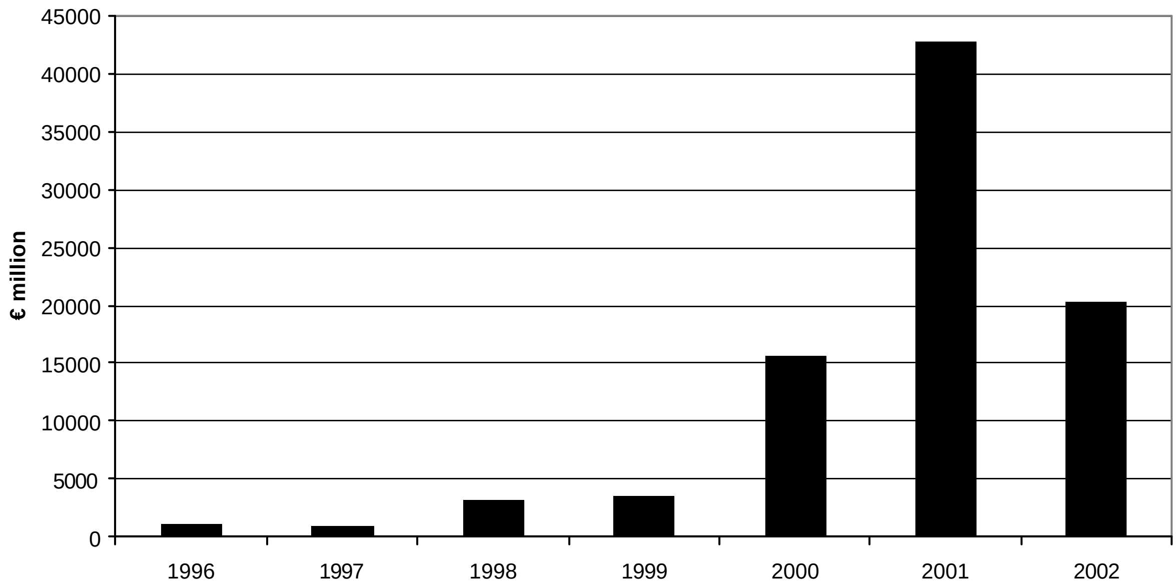
Although the Directive required some unbundling, in particular from the network suppliers, those generation companies that have retained a retail arm have been able to shield themselves from the excessive decline of wholesale electricity prices. This is particularly noticeable in the UK, where the larger generators who do not have their own retail companies have been sold or are making losses. The most obvious case in question is British Energy – the private nuclear generator – which does not have a retail division. Over the last two years the company's share price has collapsed and its profit margin disappeared. It was only saved from bankruptcy by first a Government loan of €1 billion and then a restructuring package which will see Government meeting part of the companies waste management costs, approximately €5 billion. The restructuring package has yet to be approved by the European Commission and an outright rejection of the proposal or significant conditions for its approval may still result in the company being taken back into public ownership.

Market Concentration:

As with the introduction of liberalisation in other markets there has been a growth in mergers and acquitions and subsequent increase in market concentration in the electricity market. This issue, and the problems that it may cause for market actors, is recognised in the latest version of the electricity market Directive, with measures proposed to monitor and counter its development.

European nuclear utilities are heavily involved in European and Global acquitions, with E.on, RWE and EdF the most active players in the EU market. The technical problems associated with the storage of electricity and the need for its constant availability make price control particularly difficult in the electricity sector, which raises fears in some quarters of the impact of market dominance on the smooth functioning of the market.

Combined European Acquisions of EdF, Eon, RWE, Enel, Vattenfall, Endesa and Electrabel, 1996-2002



Source: EdF Annual report, 2003

The continued expansion of the larger utilities is expected to continue, as many see Europe as a priority zone for development – in particular with recent problems in Latin America. The market leader, EdF, wish to see 50% of their revenue coming from outside France by 2005, up from 12% in 1998. Consequently, some commentators predict that within a decade only a handful of companies will dominate the European energy market.

Similar consolidation has been seen in the fuel cycle arena, in particular with the formation of Areva from Cogema (a reprocessing plant operator), Framatome (the nuclear vendor) and the French Atomic Energy Commission (CEA). However, more international consolidation is expected as well as a greater convergence of reactors designs. It is accepted that for vendors to break even they need to sell some five to ten reactors for each reactor design. Given the scarcity of new orders, consolidation from the five to seven major reactor designs to two or three is likely to occur.

EU Nuclear Package

In April 2002, the European Commissioner responsible for Energy, Vice-President Loyola de Palacio made an announcement in the European Parliament, in which she stated that the time had come to introduce 'common nuclear safety standards' into the EU. Over the next months the Commission prepared two Directives that were eventually given provisional approval by the college of the Commission in November 2002. These were Euratom Directives on: -

- Setting out basic obligations and general principles on the safety of nuclear installation.
- On the management of spent nuclear fuel and radioactive waste.

The Directive on safety principles contains an annex on the management of decommissioning funds, which had originally been proposed as a separate Directive, but was included on the advice of the Commission's legal services.

The Commission took Chapter III of the Euratom Treaty, Health and Safety, as the legal justification for introducing the Directives. This requires – under Article 31 – obtaining the opinion of an expert group, prior to the formal adoption by the Commission (this group is known as the Article 31 expert group). Consequently, the November 2002 Directives were only a draft and were re-published in January 2003, following the opinion from the Article 31 group.

Nuclear Safety Principles

Accompanying the launch of the Directives was a Communication and a Memo setting out the basic rational for the Directives. In its introductory paragraph on the safety principles Directive it states[5]: -

> *This directive will introduce common safety standards and monitoring mechanisms, which will guarantee that common legally, enforceable methods and criteria will be applied throughout the enlarged Union.*

The text of the November 2002 draft Directive stated that that this was to be a Framework Directive and that the introduction of commons safety standards which occur at a later date:

> *Recital 10: In order to attain the Community objectives regarding radioprotection mentioned above, it is essential as a first stage to define the basic obligations and general principles on the safety of nuclear installations in this* ***framework Directive. The establishment of common standards and control mechanisms will at a later stage to complement this in order to guarantee a high level of safety which takes account of technological changes.***

Following comments from the Article 31 Expert Group the Commission redrafted the Directives which were then released in January 2003. On the fundamental point of the introduction of nuclear safety standards a key shift had taken place, with recital 10 being changed to remove any reference to the introduction of a framework Directive. Thus there will be no additional Directives introducing common standards and control mechanism. There has been no explanation for this fundamental change in approach. In September 2003, the Commission stated that[6]: -

[5] Memo: Towards a Community approach to nuclear safety, European Commission Directorate-General for Energy and Transport, November 2002.

> *The proposal for a Directive setting out basic obligations and general principles on the safety of nuclear installations, approved by the Commission on 30 January 2003, is not a framework directive entailing the drafting and implementation of sub-directives under it.*

Therefore the intention to introduce common nuclear safety standards was withdrawn in the January 2003 draft and the legislation would have only required:

- Each Member State must ensure it has a safety authority, which is independent from bodies that promote or utilise nuclear energy.
- The safety authority shall regulate and supervise safety of nuclear installations and grant the necessary licences.
- Each Member State shall require the operator to run the facility in accordance with 'common safety standards' and give priority to nuclear safety.
- Ensure that the regulator carries out nuclear safety inspections.
- Each Member State shall take the appropriate steps to ensure adequate financial resources are available to support the safety of facilities.
- Establish procedures for reducing accidents and incidents and that adequate notification is occurring.

In order to verify that these activities take place the Commission will oversee verification missions. Experts from Member States, probably two per mission, will visit the safety authorities in Member States and on the basis of a pre-arranged schedule will verify their activities. The results of these missions will apparently not be made public in full and there are no mechanism laid out for ensuring that any action is taken as a result, even in cases of non-compliance.

On the Member State level, within the European Parliament, and in the nuclear industry there appears very little support for this legislation. The main criticisms are: -

- The Directive will require additional reporting e.g. bureaucracy.
- International regimes, such as the IAEA's Nuclear Safety Convention, already cover large parts of the requirements of the Directive and all Member States and accession countries with nuclear facilities are party to this convention.
- The verification missions will require national inspectors to undertake additional work, thus adding to their workload.
- There will be no inspections at the facilities themselves but rather at the safety authorities and these will all be pre-planned, therefore no surprise visits.
- There are no compliance mechanisms or sanctions in the case of non-compliance and no timetables for the introduction of measures.
- The results of the verification missions will not be made public.

Decommissioning Funds

Annexed to the safety principles Directive is legislation on the management of decommissioning funds. This legislation was introduced as a compromise to the European Parliament who tried to require the segregation of decommissioning and waste management funds within the revision of the electricity market Directive in 2002. The Parliament argued that as some nuclear utilities were not required to have segregated funds they had an economic advantage, especially in the current climate of market acquitions. Between 2000-2, three quarters of all market acquisitions in the European energy market were made by utilities that did not have segregated decommissioning and waste management funds. The European Commission and Council agreed that this was an important issue that must be addressed, but proposed that it be dealt with under the Euratom Treaty rather than in the electricity market Directive.

The draft legislation proposes that funds to pay for decommissioning must be created from contributions from nuclear operators. These funds must be sufficient and available to cover the costs relating to decommissioning and spent fuel management. The funds may not be used for any other purpose and that they must be established with 'their own legal personalities'. However, the draft Directive then added, '*If exceptional or duly justified reasons make such legal separation impossible, the fund could continue to be managed by the operator*'.

Currently there are only two countries in the current EU – France and Germany - that allow their utilities to build up and retain control of their own provisions for decommissioning. The importance that both place upon allowing non-segregated funds for their utilities was demonstrated at the 18th September 2003 French-German Initiative on Growth, at which the final communiqué signed by President Chirac and Chancellor Schroeder stated that decommissioning of nuclear facilities would be achieved without the creation of a separate fund. In all other Member States the funds are managed by the national waste management organisation or in segregated funds with an independent review of investments. Therefore it is clear that the potential exemption from the requirement for segregated funds was inserted to allow French and German utilities to continue their current financial practices.

Nuclear Waste Management

In April 2002 the Commission published a Eurobarometer poll on nuclear waste, to coincide with the announcement of the intention to the Directive[7]. This concluded that over two-thirds of citizens are worried about radioactive waste from their own country or other Member States. The poll also concluded that around 80% of the population felt that the generation producing nuclear waste should be responsible for it.

The Directive proposes to set EU wide schedules for the construction and operation of nuclear waste facilities. Furthermore, it suggests that the preferred method of disposal is in deep geological repositories and it encourages and/or sanctions the construction of waste sites for multiple Member States to use either inside or outside the European Union. Finally it suggests an accelerated research and development program, co-ordinated by the EU.

The dates proposed for the construction of the nuclear facilities should be mentioned but there is general agreement –even now by the Commission – that they are unrealistic. The dates proposed are: -

- Authorisation for the development of appropriate disposal sites should be granted no later than 2008.
- Authorisation for the operation of sites to dispose of low level radioactive waste should be completed by 2013.
- Authorisation for the operation of sites to dispose of high-level radioactive waste should be completed by 2018.

However, many question the need to the establishment of universal or country specific timetables for waste management and what additional benefits approval on a EU level will bring. The creation

[7] Eurobarometer 56.2, European and Radioactive Waste, 19th April 2002

of a universal EU date will aid communication to the public at large that radioactive waste is being actively addressed, but there are some fundamental problems with both universal and country specific binding dates: -

- It decreases the likelihood that late in the site investigation phase that an unsuitable candidate or design will be abandoned, as occurred in the UK in 1997, as a fixed timetable would require an alternative proposal at a similar stage of investigation.
- Communities close to the proposed site may consequently have increased concerns over the processes and the balanced nature of the consultation process.
- Setting a single timetable across the EU, which takes no account of the history or size of a nuclear programme or the current status of research and development programmes lacks any purpose other than public communication.

The Directive also suggests that deep geological disposal should be the only possible disposal route for high level radioactive waste, by declaring that there is '*broad international consensus amongst technical experts that disposal by isolation deep in stable geological formations is the most suitable management option*' and that on or near to surface storage is not a suitable alternative to disposal. Legislation in a number of Member States requires that different disposal options are considered, to ensure the right technical approach is taken to increase public confidence. The narrowing of options across the EU would appear illogical at the current stage of investigation of HLW disposal.

Both the proposed introduction of timetables and the pre-selection of a disposal option suggest that the Commission is trying to address the unresolved issues of, in particular, high level waste disposal in a short timescale This type of approach was confirmed by Commission official responsible for this issue stated to the European Parliament in September 2003, the Directive must primarily be a 'clear signal to public opinion' that the time for studies is over. In some Member States there appears to be a more measured approach, with longer-term timetables on consultation and investigation being proposed to review, or at least not rule out, different options for HLW disposal or storage.

The Way Ahead

At the time of publication the Commission has stated that both Directives needed to be put in place by May 2004 in time for the entry of accession countries into the EU. This date would appear both ambitious and unnecessarily hasty, rather more reasoned debate is required. Since January 2003 discussions have taken place within the Council's Atomic Questions Working Group and within the European Parliament. Coming out of these discussions are a variety of proposals on how to proceed:

Non-binding legislation: In September a non-paper produced by the Swedish, Finnish and UK Governments was circulated within the Atomic Questions Working Group. The Belgium and Germany Governments have since also supported the approach. This non-paper proposed replacing both Directives with non-binding legislation such as Council recommendations. Under Article 31 of Euratom, new legislation must be adopted by qualified majority voting and the five countries that have proposed this non-binding legislation would be able to block the introduction of the Directives.

Redrafted Directives: Since January 2003 a number of revised versions of the Directive have been produced. These seem to have removed many of the requirements of the initial Directives:

- Safety: verification of the functioning of the regulators will now be replaced by reviews of activities. Even the definition of Common safety standards, has been proposed to be replaced by Common safety principles.
- Decommissioning: The annex will be removed as will any requirement for funds to have their own legal status.
- Radioactive Waste: The proposal for a universal date for the operation of a high level waste repository has been removed and the dates for the siting and operation of other waste facilities extended until 2018.

The European Parliament is consulted, but not given co-decision under Article 31 of the Euratom Treaty. The Directives will be debated in the ITRE (Industry, Trade, Research and Energy) Committee at the end of November with a plenary vote scheduled for December. Some within the Parliament would like to see the introduction of legally binding 'state of the art' standards, as would some EU Governments, while others are more supportive on the non-legislative approached proposed.

Conclusion

In the coming years it is possible that there will be new reactors ordered within the EU. Amongst current Members this will most likely be in Finland and France, for new Members in Slovakia, and Romania in future Members. However, even if all of these projects are achieved it will not reverse the trend of the ageing of Europe's reactor fleet. It is quite clear that from an industrial sector perspective the EU's nuclear programme is stagnated and has been for a number of years - and is likely to remain so for at least a decade. This will mean that a whole generation of politicians and industrialists will have presided over a sector without any significant growth. This lack of new orders also has a great impact on reactor constructors: the engineering base created to manufacture reactors constantly needs new orders and is failing to achieve them.

Over the past decade the average age of the reactor fleet has increased by nearly seven years in the EU. This rate of increase raises serious concerns about the viability of the nuclear sector. Assuming that a 1 GW reactor operates for 45 years, then 2.6 GW of new nuclear capacity must be introduced each year within an enlarged EU just to retain current capacity. On average, it is expected that between 1990 and 2010 0.5 GW will have been introduced. As the European Commission points out, within two years 70% of the EU's reactors will be older than 20 years old, roughly half their operational life. Without significant life extensions a large wave of reactors closures will begin in around 10 years time.

In most of the current accession countries the use of nuclear power is more widespread and the reactors are younger than in existing Member States. Furthermore, there are currently more plans for new construction than in Western Europe. However, how these plans will fare in a more liberalised electricity market is not clear, and some of the current completion plans are likely to be scaled back as private financing is asked to play the pivotal role in the construction of new power station.

The enlargement of the EU has highlighted a key issue for the Union: the requirement for nuclear safety standards. Since the political changes in 1989, increased attention has been placed upon the safety of reactors in accession countries. This has resulted in the shutdown of all the reactors in former Eastern Germany and two reactors in Bulgaria, with the closure of another six agreed in principle by the end of the decade. Although these closure dates have slipped and may well, without sufficient international assistance and political will, be delayed further, it is widely recognised as the first major action by the EU on nuclear safety standards. Despite this, the EU will have RBMK and VVER 440-230 reactors operating in its Member States for the first time in 2004. The second step, the introduction of common nuclear safety standards is far less advanced and the outcome is far from certain.

While the EU is expanding its membership, it is also increasing its harmonisation of energy laws within existing countries. 2004 will see not only the accession of ten new members but also the introduction of legislation on the national level for the revised electricity market Directive. This is intended to increase competition between electricity generators and suppliers resulting in increased innovation and lower prices. Some believe that the conditions in a liberalised market will stop the nuclear industry. While this may over state the case, it is clear that long lead times, regulatory uncertainties and price fluctuations dampen enthusiasm for investment in nuclear technology. These are some of the reasons why so far no reactor has been ordered and subsequently built in a fully liberalised energy market.

The revised electricity market rules are unlikely to have a major impact on the EU's nuclear utilities although increasing unbundling requirements, stricter monitoring of accounts and electricity labelling for consumers will undoubtedly affect the decisions of some consumers and regulators. However, for accession countries the impact will be greater as they strive to conform to the full requirements of the both 1996 and 2003 Directives.

The European Commission is responding to both the public concern on waste and safety by proposing new Directives on these issues. The safety principles draft Directive has not been well received by the industry or Member States, as they see the proposed legislation is seen as bringing increased bureaucracy with little or no benefits in nuclear safety. Similarly, NGOs are sceptical about its usefulness, seeing it as a communication tool rather than a mechanism to increase safety.

However, the increasing average age of the EU's reactors, and the apparent intention to continue to extend the operating lives of Europe's reactors, does require additional measures to allow the public to understand the techniques, risks and benefits involved. Unless this occurs, public distrust will continue.

Similarly, the waste Directive with its binding targets, proposed regardless of national situation and existing research and development, is too blunt an instrument for this delicate process. The establishment of binding targets will automatically increase distrust about the process of site selection and construction. Binding targets may be used to justify curtailing public review and scientific rigour when both are essential for the viability of the proposals.

Finally, on the EU level, the introduction of the EU Constitution has highlighted the problems caused by the Euratom Treaty and the lack of an EU energy policy. The new Constitution was established to streamline the institutions for an EU of 25 Members. Many complex and controversial issues have been addressed, but not, so far, the Euratom Treaty. It is remarkable that the Treaty has remained unchanged and isolated for so long. This may be because many see it as complex but irrelevant, or it may be that it remains fundamental to the well being of Europe's nuclear industry. Whatever the reason it remains a symbol of the old nuclear industry, one that was protected from public scrutiny. The introduction of an energy chapter in the EU is likely to further highlight the unusual status of the Euratom Treaty.

The enlargement of the EU to include many new countries with different systems and designs of nuclear power plants has created challenges. Some of these have been dealt with, such as the closure of some reactors, but questions remain as to the progress of others, in particular the question of a common EU safety standard. But what cannot be questioned is that without a rapid reversal in the public, political and industrial faith in nuclear power, it is being gradually phased out. If or how this trend should be revised is a debate that is long overdue.

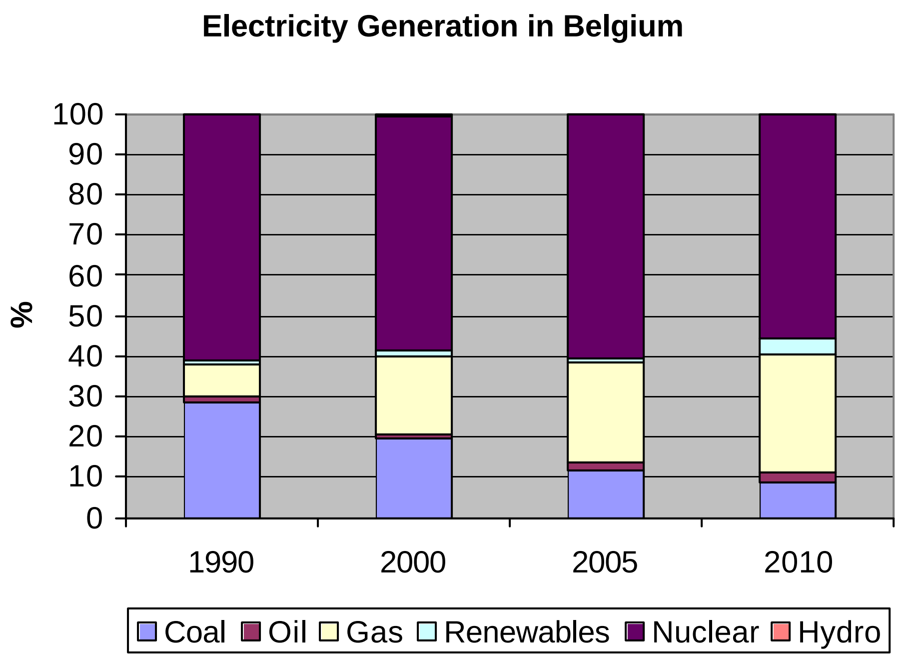
Belgium

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
7	0	1	1962	44 737	57.3

Source: IAEA PRIS Database, September 2003

In January 2003, the Belgium Senate voted to phase out the current fleet of nuclear power stations after 40 years of operation; the first will stop generation in 2015, the last in 2025.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
FBFC International	Fuel fabrication (LWR)	1961	500	t HM/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	Interim storage, pending final disposal site	Storage of vitrified waste, no further reprocessing contracts
Interim	CILVA facility at Dessel	Belgoprocess site and NPPS
Final		Research: Deep Geological disposal in clay at Hades in Mol

Source: European Commission, 2003

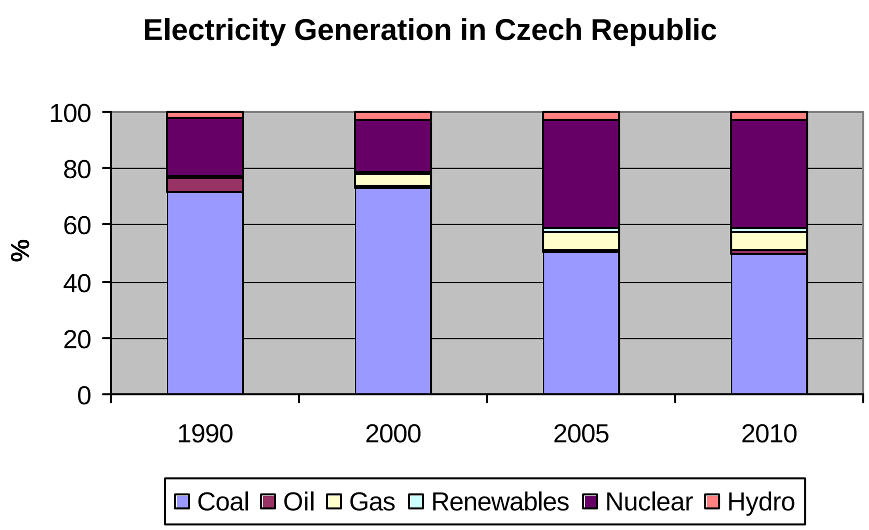
Czech Republic

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
6	0	0	1985	18 738	24.5

Source: IAEA PRIS Database, September 2003

In 2002 the second unit of the Temelin nuclear power plant was connected to the grid 17 years after construction had started. The reactors were in part financed by support from the US and Belgium Governments and was the first Western funded completion project involving part built Soviet designed reactors.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
Rozna- Geam	Uranium Ore Processing	1957	370	THM/a

Source: IAEA, September 2003

This facility is the only operational fuel cycle facility in accession countries.

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	Treatment and disposal of all waste and disposal in one site.	Spent fuel stored on and away from reactor sites, deep geological disposal by 2065
Interim	Dukovany NPP	Dukovany
Final	Dukovany, Kostime, Richard and Bratrstvi	

Source: European Commission, 2003

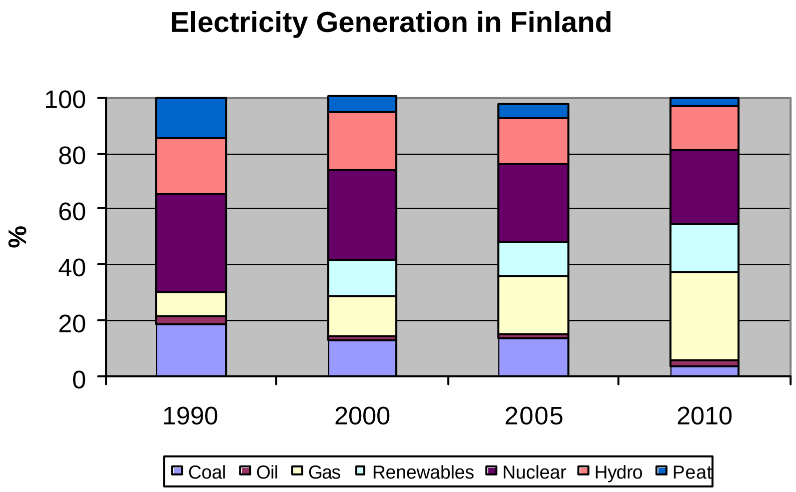
Finland

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
4	0	0	1977	21 443	29.8

Source: IAEA PRIS Database, September 2003

Finland is the only current Member State of the EU with firm plans to build more nuclear capacity. In May 2002 the Parliament agreed to the construction of a fifth reactors. By the end of 2003 the utility TVO is expected to have chosen a reactors design with the reactor due to be operational by 2009. Currently TVO is thought to be considering four bids, the European Pressurised Water Reactor (EPR), the SWR 1000, the VVER 91/99 and GE's Advanced BWR, however, reports suggest that the EPR is the most likely chose. If completed it will be the first reactor both ordered and built in the EU since 1986 and the first in a fully liberalised electricity market.



Source: IEA 2003

Fuel Cycle Facilities

Finland has no operating fuel cycle facilities

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	Disposal in near surface repositories at reactors sites	Parliament in 2001 agreed strategy for final disposal in deep geological site.
Interim	Loviisa and Olkiluoto nuclear power plants	Away from reactor storage at NPPs.
Final	Loviisa and Olkiluoto nuclear power plants	Olkiluoto chosen as potential site, target operational date around 2020

Source: European Commission, 2003

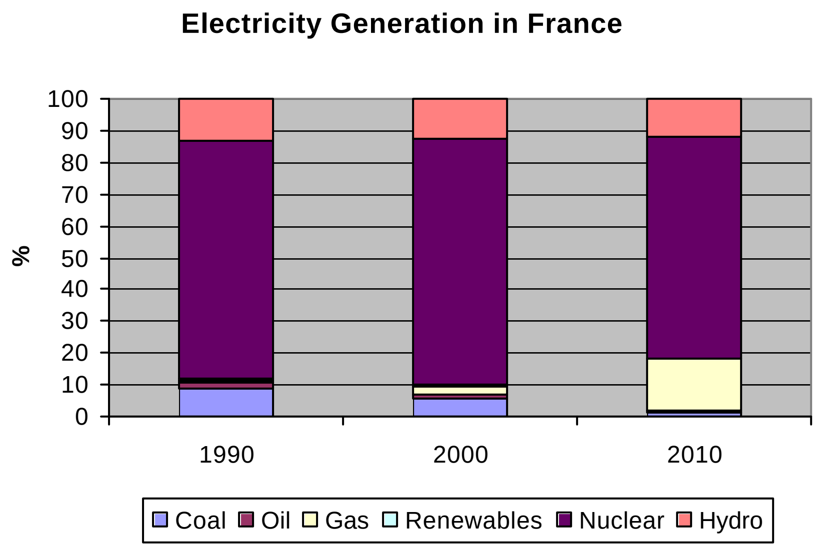
France

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
59	0	11	1959	415 500	80.0

Source: IAEA PRIS Database, September 2003

France has by far Europe's most extensive nuclear program with around 50% of the EU's nuclear generating capacity. The nuclear utility, Electricité de France, is also a major exporter of electricity and is an active player in many markets in Europe and the World. Currently, France is undertaking a review of its energy policy which is due to be finalised in 2003 and is expected to conclude that further reactors must be ordered, in particular the EPR



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
Comurhex Malvesi (UF4)	Conversion to UF4	1959	14000	t HM/a
Comurhex Pierrelatte (Rep. U)	Conversion to UF6	1976	350	t HM/a
Comurhex Pierrelatte (UF6)	Conversion to UF6	1961	14000	t HM/a
TU2 Cogema	Conversion to UO2	1988	350	t HM/a
TU2 Cogema Reprocessing Line	Conversion to U3O8	1988	1200	t HM/a
TU5 Cogema Reprocessing Line	Conversion to U3O8	1995	2000	t HM/a
W Defluorinat (Depl. UF6)	Conversion to U3O8	1984	20000	t HM/a
Eurodif (Georges Besse)	Uranium enrichment	1979	10800	MTSWU/a
Cogema - CFCa	Fuel fabrication (MOX)	1961	40	t HM/a
Melox	Fuel fabrication (MOX)	1995	100	t HM/a
FBFC - Romans	Fuel fabrication (LWR)	1979	800	t HM/a
SICN	Fuel fabrication (FBR)	1960	150	t HM/a
Le Bernardan (Jouac)	Uranium ore processing	1979	600	t HM/a
La Hague - UP2	Spent fuel reprocessing	1967	800	t HM/a
La Hague - UP3	Spent fuel reprocessing	1990	800	t HM/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	**High Level/Spent Fuel**
Strategy	Routine disposal at the Centre de l'Aube facility, with further adjacent facility being built of very low level radioactive waste	Most, but not all fuel is reprocessed, remaining fuel stored at La Hague. Research on three routes for disposal; deep geological; indefinite surface storage and transmutation. Work to be completed by 2006
Interim	La Hague; Cadarache	La Hague; Marcoule
Final	Centre de l'Aube	Meuse Department: Callovo-Oxfordian clay, 500m depth, construction started - Research Sediment research, 250 m.

Source: European Commission, 2003

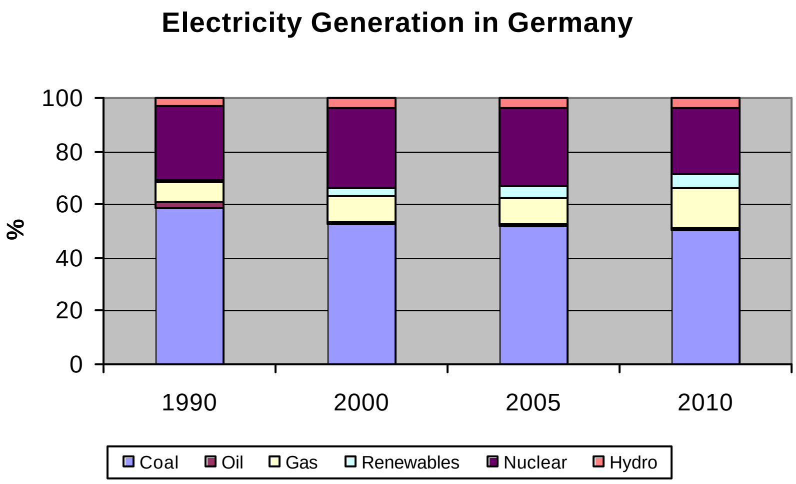
Germany

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
19	0	17	1961	162 250	29.9

Source: IAEA PRIS Database, September 2003

In June 2000 a deal was reached between the Red-Green Government and the nuclear utilities that would restrict the operation of the countries reactors to an average of 32 years. The closure dates for individual reactors would finally be determined by the utilities based on electricity output and on the potential exchange of operating years between reactors.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
Urenco Deutschland	Uranium enrichment	1985	1100	MTSWU/a
Lingen	Fuel fabrication (LWR)	1979	650	T HM/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	Under review	Under review
Interim	In past at Morsleben	Vitrified waste stored at Gorleben, storage of spent fuel on site, but central store likely
Final	Konrad ?	Extensive exploration of salt dome

Source: European Commission, 2003

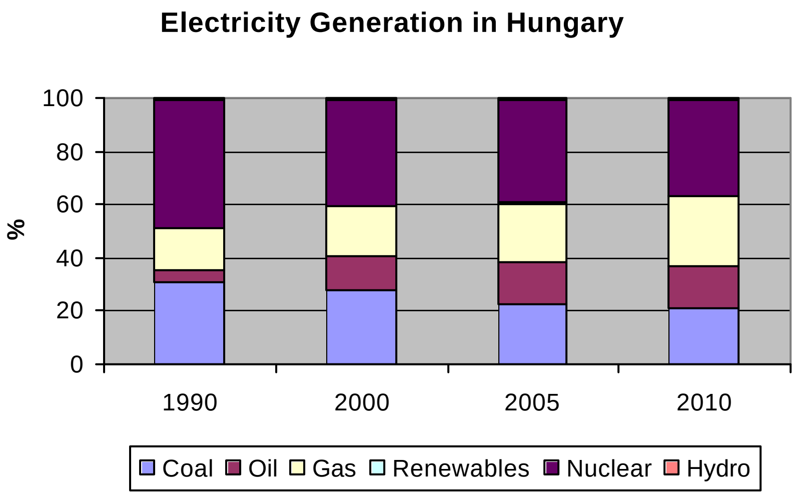
Hungary

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
4	0	0	1982	12 787	36.1

Source: IAEA PRIS Database, September 2003

The Paks station has until recently had a relatively good safety record, however, in April 2003 an incident occurred in unit 2 while fuel assemblies were being cleaned which resulted in the release of radiation. The reactor has not operated since.



Source: IEA 2003

Fuel Cycle Facilities

Hungary has no fuel cycle facilities

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	In the long term the Uveghuta site has been identified.	Previously spent fuel was returned to Russia
Interim	Puspokszilagy, site is used	At Paks
Final	Uveghuta	

Source: European Commission, 2003

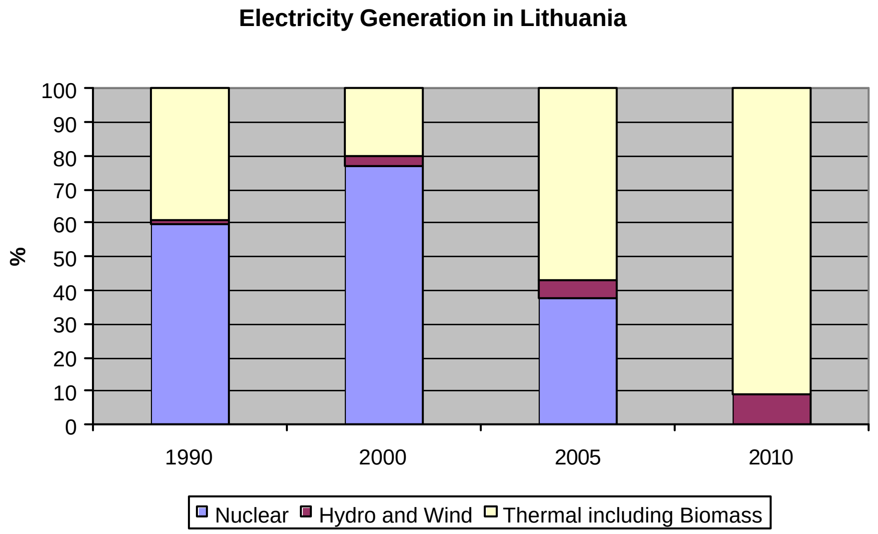
Lithuania

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
2	0	0	1983	12 900	80.1

Source: IAEA PRIS Database, September 2003

As part of the Accession partnership agreement both of the RBMKs at Ignalina are required to be closed. Unit 1 by end of 2004 and unit 2 by end of 2009. However, some concern continues to be raised regarding the closure of unit 2, which some the Lithuanian authorities say is dependent on increased assistance from the EU.



Source: European Commission 2003 b

Fuel Cycle Facilities

Lithuania has no fuel cycle facilities.

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	Focus is on waste conditioning facilities, possible final repository	Until the 1990s all spent fuel was returned to Russia
Interim	?	Dry cask at Ignalina
Final	?	Possible regional final repository

Source: European Commission, 2003

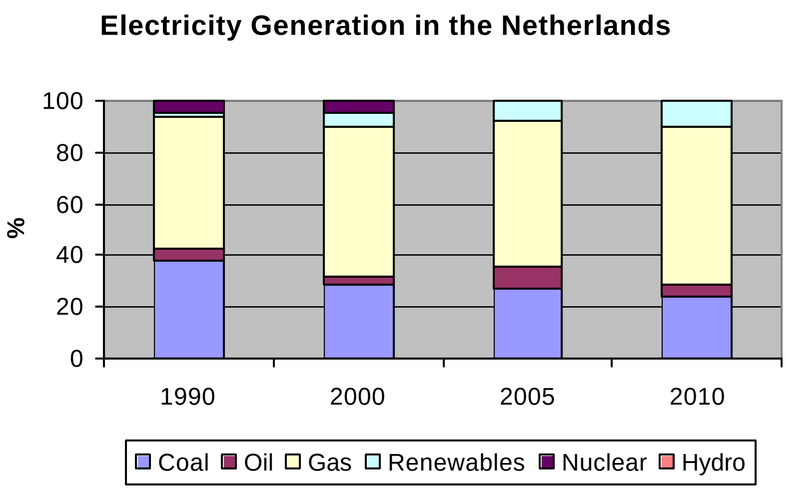
Netherlands

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
1	0	1	1968	3 687	4.0

Source: IAEA PRIS Database, September 2003

The Dodewaard reactor was closed in 1995. The country's other reactor, Borssele, was due to be closed in 2003, but in 2002 the decision was overturned due to a legal challenge by the operator and the start of a new Government.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
Urenco Nederland	Uranium enrichment	1973	1500	MTSWU/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy		Reprocessing of spent fuel at La Hague and Sellafield
Interim	Planned at the Borssele facility	HABOG facility at Borssele
Final		Long –term indefinite storage

Source: European Commission, 2003

Slovakia

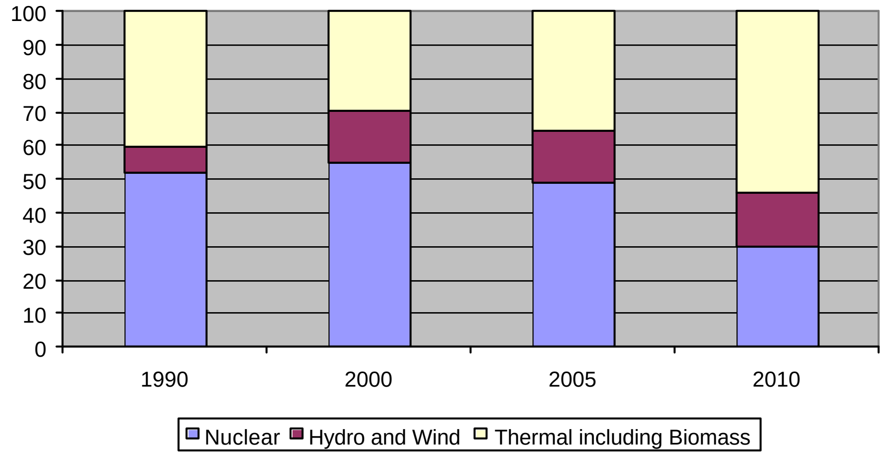
Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
6	2	1	1972	17 953	54.6

Source: IAEA PRIS Database, September 2003

Slovakia will be the only EU country in May 2004 with reactors said to be under construction; however, the uninterrupted completion of even these appears unlikely. The current restructuring and partial privatisation of the State utility SE will impact upon the completion of reactors 3 and 4.

Electricity Generation in Slovakia



Source: European Commission 2003b

Fuel Cycle Facilities

Slovakia has no fuel cycle facilities

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy		National research programme for deep geological disposal
Interim	Mochovce	Stored on site of NPPs either in or away from reactor storage
Final		

Source: European Commission, 2003

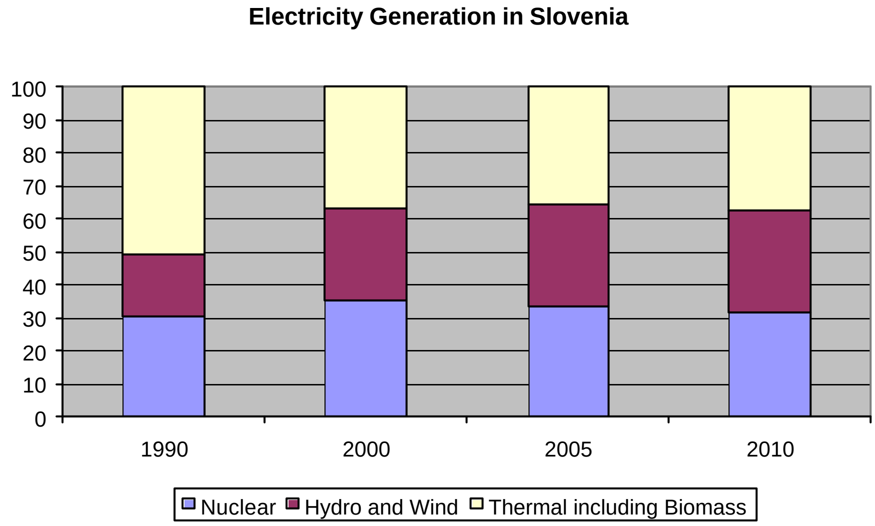
Slovenia

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
1	0	0	1981	5 308	40.7

Source: IAEA PRIS Database, September 2003

The Krsko reactor remains under the joint ownership of the Croatian and Slovenia Governments. Since the political changes in the region the operation and ownership of the reactors has been disputed. However, in July 2001 an agreement appeared to have been reached by which a 50:50 split in ownership was confirmed with a similar division of costs and output, with the establishment of a new company Elesgen. The decommissioning strategy, which the Croatian side dispute, was not included in this agreement



Source: European Commission 2003b

Fuel Cycle Facilities

Slovenia has no fuel cycle facilities

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy	Permanent storage under consideration	National plan for deep geological disposal
Interim	Krsko on site storage	On site storage at Krsko
Final		

Source: European Commission, 2003

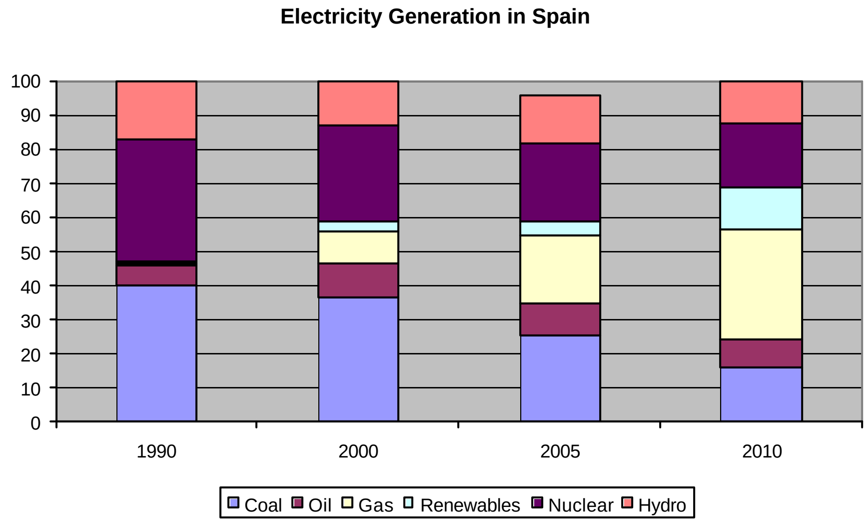
Spain

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
9	0	1	1968	60 284	25.8

Source: IAEA PRIS Database, September 2003

The countries first planned closure of a reactor has been scheduled for April 2006, the first unit at Vandellos was closed in 1990 following a fire. On the short term there are no plans for new construction although consideration is being given to extending the lives of the existing reactors.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
Fabrica de Combustibles	Fuel fabrication (LWR)	1985	300	t HM/a
Planta Quercus (PEMS)	Uranium ore processing	1993	950	t HM/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy		Some spent fuel has been reprocessed, no decision on final d isposal before 2010
Interim		Trillo NPP
Final	Disposal at the El Cabril facilty (short lived wastes)	

Source: European Commission, 2003

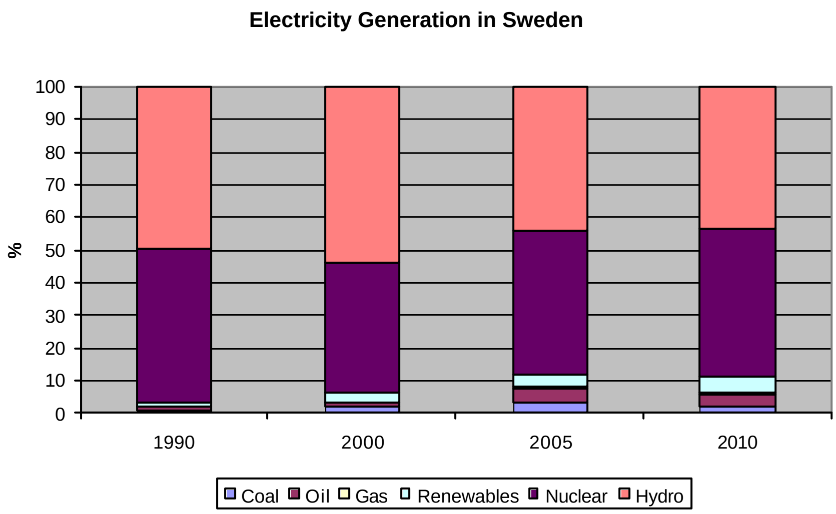
Sweden

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
11	0	2	1964	65 574	45.7

Source: IAEA PRIS Database, September 2003

Under the terms of the 1980 referendum all the country's reactors were due to be closed by 2010. However, the initial phase-out dates have been delayed and to date only one reactor, Barseback 1, has been closed. The second unit at the station was scheduled for closure in 2003, but this too has been delayed. Currently, negotiations are taking place to propose a 'German' style phase out, whereby the industry would be given a cap on the total electricity to be generated, which could then be allocated to different reactors.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
ABB Atom Fuel Fabrication Plant	Fuel Fabrication (LWR)	1971	600	t HM/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	High Level/Spent Fuel
Strategy		Site investigations at two deep disposal sites
Interim		All spent fuel stored centrally at CLAB at Oskarshamn
Final	Disposal on near to or surface storage at Forsmark, Oskarshamn, Ringhals	Research at the Stripa mine a granite site and at Aspol HRL a 200-500m granite site.

Source: European Commission, 2003

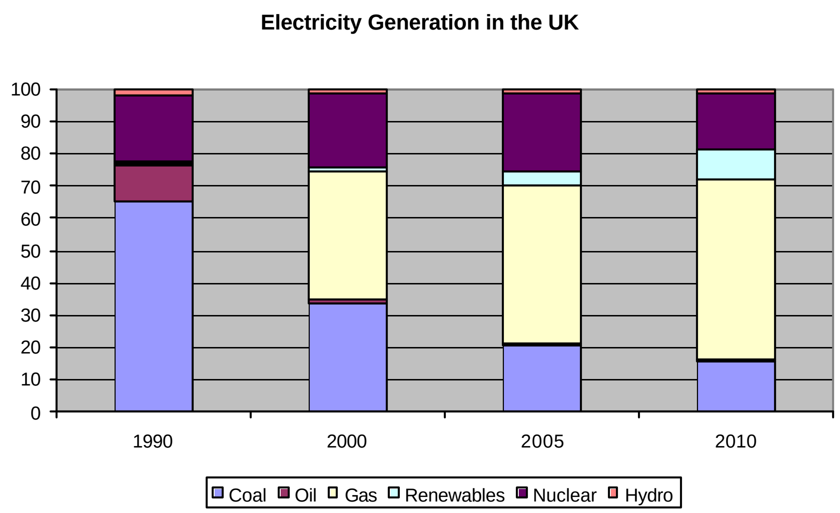
UK

Reactors

Operating Reactors	Under Construction	Closed Reactors	First Grid Connection	GWh 2002	% Electricity
27	0	18	1957	81 976	22.4

Source: IAEA PRIS Database, September 2003

The privately owned British Energy has had to rely on a €1 billion loan from the Government to avoid bankruptcy as its share price fell by 80% in the year, to a low of around €0.05, from a high of €10 some years earlier. In addition, under a restructuring plan, the Government is now offering around €5 billion in ongoing state aid to the company, mainly to help it deal with it radioactive waste liabilities. The restructuring plan is subject to a review by the European Commission. In February 2003, the Government announced a White Paper on Energy policy, which emphasised an enlarged role for renewables and energy efficiency. Decisions on the future expansion of nuclear power will be left for future administrations.



Source: IEA 2003

Fuel Cycle Facilities

Facility	Detailed Type	Start	Design Capacity	Unit
BNFL Springfields Enr. U Residue Recovery Plant	Conversion to UO2	1985	65	t HM/a
BNFL Springfields Line 3 Hex Plant	Conversion to UF6	2002	1200	t HM/a
BNFL Springfields Line 4 Hex Plant	Conversion to UF6	1994	6000	t HM/a
BNFL Springfields Main Line Chemical Plant	Conversion to UF4	1960	10000	t HM/a
BNFL Springfields OFC IDR UO2 Line	Conversion to UO2	1995	550	t HM/a
BNFL Springfields U Metal Plant	Conversion to U Metal	1960	2000	t HM/a
UKAEA Conversion Plant	Conversion to U Metal	1989	4	t HM/a
Urenco Capenhurst	Uranium enrichment	1976	1300	MTSWU/a
BNFL Springfields Magnox Canning Plant	Fuel fabrication (GCR)	1960	1300	t HM/a

BNFL Springfields OFC AGR Line	Fuel fabrication (AGR)	1996	290	t HM/a
BNFL Springfields OFC LWR Line	Fuel fabrication (LWR)	1996	330	t HM/a
UKAEA Fuel Fabrication Plant	Fuel fabrication (MTR)	1958	500	t HM/a
BNFL B205 Magnox Reprocessing	Spent fuel reprocessing	1964	1500	t HM/a
BNFL Thorp	Spent fuel reprocessing	1994	1200	t HM/a
Sellafield MOX Plant (SMP)	Fuel fabrication (MOX)	2002	120	t HM/a

Source: IAEA, September 2003

Waste Management

	Low and Intermediate	**High Level/Spent Fuel**
Strategy		Reprocessing at Sellafield or storage at Sizewell. Government strategy under review.
Interim	Sellafield	Sellafield, Dounreay or Sizewell.
Final	Drigg and Dounreay	

Source: European Commission, 2003

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