Nuclear

Sector Report - 8th in a series

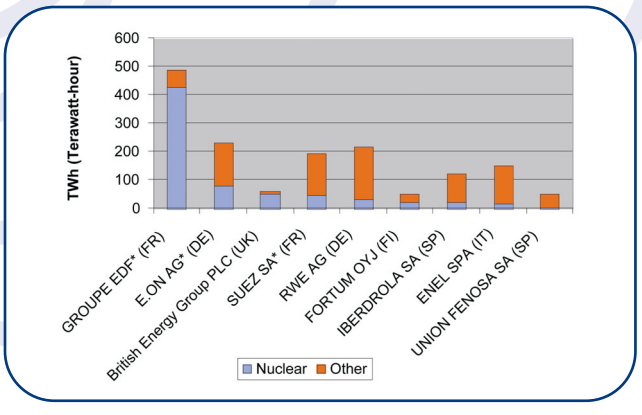
Eurosif

This Eurosif sector report has been compiled with research by ECPI. It describes the major Environmental, Social and Governance (ESG) challenges facing the European Nuclear energy industry and the associated risks and opportunities these pose for long-term returns.

NUCLEAR OVERVIEW

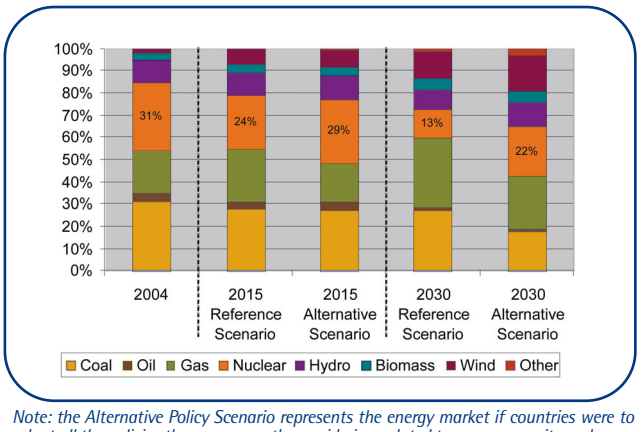
- From 1980 to 2005 world electricity generation has grown at an average rate of 3% per annum. In the same time horizon, the share of nuclear power in world electricity generation increased from 8% to about 16%. Nine utility companies dominate the EU nuclear power landscape. (*see chart I*)
- Nuclear capacity grew by 17% each year between 1970 and 1990 and slowed to 2% from 1990 to 2004, following the Chernobyl accident.
- Nuclear power plants (NPPs) are capital intensive with a 'front-loaded' cost structure[1]. NPPs have stable and predictable costs,[2] a long lifetime (50-60 years for new plants), extensive lead times (planning and construction) and long payback periods.
- Most of the existing nuclear plants are generation II light-water reactors from the 1970s. Generation III plants, developed in the 1990s, include evolutionary reactors with passive safety systems,[3] longer lifetimes as well as more optimised fuel use, construction time and reduced waste. Generation IV nuclear reactors are under development to improve safety and economic performance, enhance proliferation resistance and minimise nuclear waste.

I: Share of nuclear in total electricity generation of European utility companies (2007)



Source: ECPI research, based on annual reports from companies and MSCI Pan European Index (Utilities).
*Note: * indicates 2006 data*

II: Scenarios of Fuel Shares in EU Electricity Generation



Source: "World Energy Outlook 2006", International Energy Agency

Note: the Alternative Policy Scenario represents the energy market if countries were to adopt all the policies they are currently considering, related to energy security and energy-related CO2 emissions. "Other" includes geothermal, solar, tidal and wave energy.

NUCLEAR TRENDS

- Within the EU, nuclear power currently represents 31% of electricity generation, and there are competing views about its future share going forward. (*see chart II analysing different scenarios*)
- Additionally, the nuclear share in electricity generation varies greatly between the EU Member States: in 2006 it represented 78% in France, 32% in Germany, 18% in the UK and only 9% in Romania.[4]
- Economic competitiveness of nuclear power depends on many factors: available alternatives, overall electricity demand in a country, market structure and investment environment, environmental constraints and investment risks due to possible political and regulatory delays or changes. Factors like the introduction of a carbon emissions cost and increases in coal and gas prices improve the business case for new NPPs.
- Uranium resources are considered to be abundant and widely distributed around the world.[5] Fuel (i.e. uranium) represents a relatively small part of the overall cost, making nuclear power less vulnerable to fuel price changes than gas- and coal-fired power plants.
- With a carbon price of $25/tCO$_2$ there is a potential for nuclear to represent 19%-22% of global electricity generation by 2050, resulting in a 6%-10% reduction in CO$_2$ emissions worldwide by mid-century. However, if the key issues of waste management, proliferation and social acceptance are not properly handled, this share could drop to 7%.[6]
- With the expansion of nuclear power, risk of proliferation should be carefully considered by governments and international organisations. Concerns are linked to nuclear facilities without adequate controls, the existing stock of separated plutonium (which can be used for weapons), and global nuclear technology transfer bringing countries closer to being able to produce nuclear weapons.

[1] *They have very high building costs but are relatively cheap to operate (low fuel costs).*
[2] *Broken down as: 60%, for investment, 20% for fuel cycle (including: uranium (5%), conversion (1%), enrichment (6%), fuel fabrication (3%), spent fuel management (5%)), 20% for operations and maintenance and 1-5%.for decommissioning.*
[3] *Reactors shutdown in accident conditions without active intervention.*
[4] *IEA 2008a*
[5] *According to the IEA the identified primary uranium sources (i.e. newly mined uranium) are sufficient for several decades at current operation rates, while "undiscovered" resources can provide uranium supplies for several hundred years, (WEO 2006).*
[6] *IEA 2006a*

ENVIRONMENTAL, SOCIAL AND GOVERNANCE ISSUES	KEY CHALLENGES	BUSINESS RISKS & OPPORTUNITIES
• In response to climate change, the Kyoto Protocol has committed its signatories to reducing their greenhouse-gas (GHG) emissions by 5.2% from their 1990 level by the target period of 2008-2012. • Energy consumption accounts for 80% of Europe's GHG emissions today. Nuclear energy is considered to be **one of the largest single sources of carbon-free and base load electricity.** A study[7] showed that the total amount of CO_2 emitted per kWh of electricity produced from nuclear power is 3.48 grams, while CO_2 output from Natural Gas is 400 grams/kWh and from coal 700 grams/kWh.	• Although running a Nuclear Power Plant (NPP) generates practically no CO_2, carbon emissions arise from: mining of uranium, its enrichment and conversion into Nuclear Fuel, its final disposal as well as the construction of the nuclear plant and its decommissioning. The amount of CO_2 generated by these secondary processes depends mainly on the method and sources of electricity used to enrich the uranium. • Many NPPs are near large rivers, lakes and the sea since they need a constant supply of large volumes of water for cooling, putting them under **risk of drought and/or flooding.**	**Climate Change**	• With nuclear's 31% share of electricity production in Europe, the non-emission rate of the nuclear power sector represents close to 900 million tonnes of CO_2 yearly in the EU. This represents almost the quantity of CO_2 emissions produced annually by the transport sector.[8] • Reports[9] recognise that nuclear energy is **one of the measures that could mitigate climate change**, however the timescale needed from the initial policy decision to consider nuclear power up to the start of operation is long (10-15 years). • Under the EU Emission Trading Scheme (ETS), full auctioning of emission allowances will be possible from 2013 onwards for the power sector. As this will create tensions on the carbon market, **profitability of nuclear companies should improve compared to other energy sources (particularly coal)**. • The threat of drought and/or rising sea levels may affect existing and future NPPs and jeopardise their proper and continuous functioning. For instance, some French NPPs experienced incidents due to cooling water temperatures during the heat wave in 2003, while another (Blayais) was flooded in December 1999 following a severe storm, forcing a shut down. (*see RWE case study*)
• While the number of severe accidents throughout the overall supply chain of nuclear power generation is relatively low[10], there is **a risk of extreme events for the community** at large and the environment resulting in long term effects. • NPPs and reprocessing facilities have experienced adverse safety, environmental and health effects. The two largest accidents in nuclear power history, **Three Mile Island (1979) and Chernobyl (1986)**, have had the greatest impact on global perception of the industry. Accidents at fuel cycle facilities in Japan, Russia and the US have also exerted a strong influence. The Chernobyl accident led to reviews and new safety measures worldwide and the creation of a so-called "safety culture".	• NPP safety is also dependent on the level and scope of government regulations, the design and construction requirements and the level of regulatory oversight and inspection.[11] • There is increased **concern about the safety and security of the transportation** of nuclear materials. Twenty million packages are transported annually by road, rail and sea.	**Safety**	• In terms of plant technology, passive safety systems are standard for new plants: it has been designed to meet single-failure criteria and to be able to work without AC power (power from alternating current circuits), heating, ventilation and air conditioners, and cooling water systems.[12] • A key process to be strictly monitored is the **upgrading of older generation reactors** especially when it implies extending their life time. • When assessing safety issues, investors should look at the age of the power plants, and the frequency and severity of incidents. • The supply chain management tender process should be based on a wide set of criteria such as safety, quality, time and cost. It also requires the creation of a database of approved and certified suppliers. Companies should also report on incidents within their subcontracting companies. • There is continual research into the transport of radioactive materials: the US Department of Energy currently proposes that a dedicated train be used for this purpose while Sweden uses sea transport.
• While energy generated from Nuclear Power has small land requirements and minimal fuel and waste volumes, the management and disposal of high-level radioactive spent fuel is one of the most controversial issues facing the nuclear industry. The main issues at the moment are (1), **the lack of a final waste repository in operation** and (2), some by-products have a **high toxicity and need to be isolated for long periods**, representing a potential burden for future generations. • The recycle route includes the reprocessing of the spent fuel resulting partly in recovered uranium and plutonium used for repeated fuel manufacturing and partly in high and medium level waste sent to final disposal.[13]	• The main constituents of spent fuel are low, intermediate, and high level waste.[14] Low and intermediate level waste account for about 97% of the volume of waste produced. • Plutonium is a unique waste component: it is fissionable and capable of releasing significant amounts of energy and is a hazardous material. Because of its potential use in nuclear weapons, there is **great sensitivity about isolating plutonium** from other components of the nuclear waste stream. • According to the International Atomic Energy Agency (IAEA), a typical 1,000 MW(e) (i.e. megawatt electrical) nuclear power station, which would supply the needs of a city the size of Amsterdam, produces about 30 tonnes of high level solid packed waste per year.[15]	**Spent Fuel Waste Management**	• Currently, no country has a complete system for storing high level waste permanently but many have plans to do so in the next 10 years. The future generation IV nuclear reactors with closed fuel cycles are expected to have the potential to substantially minimise the waste management issue, but it will take time and it remains a longer term option. • Concerning the practical implementation of geological high-level waste disposal, significant progress has been achieved in Finland, Sweden, France and the US. The World Nuclear Industry appears to have reached a consensus that **deep geologic disposal can provide a safe means of disposing high level waste**. The proposed disposal techniques include multiple barriers to isolate the waste from the biosphere for at least 100,000 years. (*see SNE-TP case study*) • Nevertheless, all proposed disposal methods face strong opposition from environmental groups since **nothing similar has been attempted on such a long timescale before**. • Due to the long decay period of waste, the problem of its disposal is an **intergenerational issue**. Until the issue of waste disposal and management is solved, the benefits from nuclear energy enjoyed by the current generation must be balanced against the cost for future ones. • Investors have difficulties comparing provisions reported by companies as they depend greatly on the discount rate and the cost of future waste disposal, which are all country and regulatory specific. There are **great discrepancies of cash provisioning** between companies, impacting their valuation.
• The steps of reactor decommissioning include: shutdown of reactor, management of spent fuel left in the plant, dismantling and demolishing of plant, treatment and disposal of plant waste, site clean-up and landscaping accompanied by continuous security and surveillance.	• The timeline for this process could take up to 100 years, in extreme cases, causing **a burden for future generations**.	**Plant Decommissioning**	• Since many NPPs will reach the end of their lifetime within the next few decades, the issue of decommissioning will become a subject of increased interest. As about 107 NPPs are permanently shut down or undergoing decommissioning, **the expenditure on decommissioning over the next 30 years is expected to increase tenfold.** However the real cost of plant decommissioning remains difficult to assess.
• Social acceptance can vary considerably from one country to the next. For instance, the British government's announcement to encourage new nuclear power plants has attracted much scrutiny; Belgium and Sweden have currently decided to phase out nuclear power but may reconsider. • For capital intensive developments, such as nuclear power projects, **supportive government policy is essential** since it requires a stable and predictable investment climate.	• Even though safety is an integral part of plant design and operation and the safety record for nuclear power appears sound in terms of number of accidents occurred, **nuclear power is publicly perceived as inherently dangerous**, as if it can never be made safe enough. • A majority of people strongly oppose an NPP within a certain distance of their home due to concerns about safety and contamination.	**Social Acceptance**	• The potential impact on the public from safety or waste management failure combined with the costliness of nuclear power development could make the case for nuclear power expansion difficult. • Long-term sustainability, safety of operation and waste management all influence the public perception of nuclear power as a viable energy source: companies which **engage in open and two-way dialogues** on key issues and the protection of the population against radiological hazards may increase their licence to operate by winning public support. • Since energy technology infrastructures are inherently long lived, nuclear power requires **stewardship over generations**: going nuclear means a long-term commitment of substantial social, human, institutional and economic resources. • A majority (53%) of European citizens consider the risks of nuclear energy to outweigh its advantages, but 50% of them acknowledge they are not well enough informed about the safety of NPPs.[16]
	• There is a lack of comprehensive, high-quality nuclear technology education at universities and a limited ability of academic institutions to attract top-quality students.	**Educating New Talent**	• The lack of attractiveness of the nuclear sector for highly educated students and the aging of companies' staff represent a **risk in terms of knowledge transmission and technology development** for the next 10 to 15 years.[17] To counter this, some companies are developing their own training schools.[18]

[7] Vattenfall 2005. Study conducted on Vattenfall's own plants.
[8] "A Vision Report" EC Sustainable Nuclear Energy Technology Platform.
[9] Including reports from the Intergovernmental Panel on Climate Change, and the Massachusetts Institute of Technology.
[10] Considering only fatal accidents and comparing the deaths occurred per Terawatt-year (/TWe.yr), hydro has 883, coal 342, gas 85 and nuclear power 8.
[11] National regulations, the IAEA's nuclear safety and wastes management conventions and the Euratom Treaty in the EU are examples of efforts to achieve standardised practices for the development of nuclear energy.
[12] Using only natural forces, such as gravity, natural circulation and compressed gas without any pumps, fans, diesels, chillers, or other rotating machinery.
[13] Annual discharges of spent fuel from the world's reactors total about 10, 500 tonnes of heavy metal per year.
[14] Low level waste includes radioactive materials used in various processes as well as supplies and equipment contaminated with radio-active materials. It is generally disposed rapidly after being produced. Intermediate level waste is more radioactive than low level waste but not hot enough to affect the design of storage or disposal facilities. High level waste is highly radioactive and often thermally hot.
[15] A 1,000 MW(e) coal plant produces some 300,000 tonnes of ash alone per year.
[16] Based on a 2007 review of the last Eurobarometer surveys on radioactive waste and nuclear safety.
[17] In 2008 Areva is planning to recruit 1,000 engineers while EDF plans to hire 5,000 engineers by 2017 for its nuclear segment.
[18] For instance the Forsmark School in Sweden, adjacent to the Forsmark power plant (Vattenfall).

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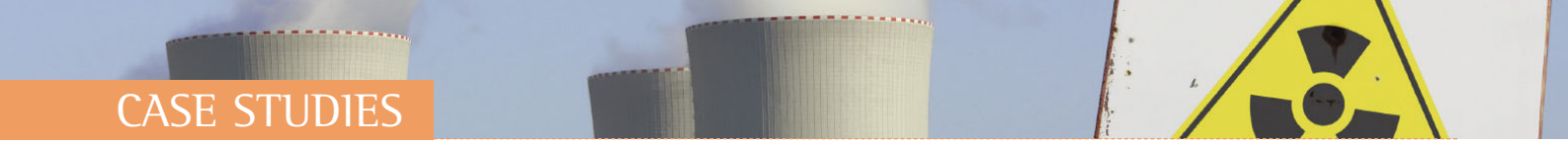

The launch of the European Union Sustainable Nuclear Energy Technology Platform (SNE- TP)

In November 2007 the European Commission declared that nuclear fission has a strategic role to play in the energy mix when addressing challenges such as security of supply and climate change, whilst increasing the competitiveness of Europe's energy industries. The SNE-TP includes the main companies and organisations working on nuclear energy in Europe (industry, utilities, research organisations, universities, public bodies). Its initiatives are focused on coordinating R&D among EU Member States. Programs include the management of radioactive waste, reactor system design and technologies for radiation protection, as well as side activities such as implementing research infrastructures, human resources and training.

Its activities cover the study of residual high-level long-lived waste behaviour in geological disposal, also part of the Euratom CARD project. The ONKALO underground research facility in Finland is being built to prepare the final disposal facility for high-level nuclear waste from the Olkiluoto power plant. In 2001 the Finnish Parliament approved plans to build this repository while the construction licence application is expected to be submitted in the 2010s.

Posiva Oy is the company responsible for practical preparations, R&D and the final disposal of spent fuel.

Source: ECDGE 2007; www.posiva.fi

Areva's stakeholder dialogue, as a source of performance improvement

Areva is the only company covering the entire nuclear cycle in its operations. A cornerstone of Areva's commitment to a sustainable development is the pursued open and constructive dialogue between the company and its stakeholders.

In 2004, Areva held its first stakeholder consensus building session in France with NGO members of Comité 21 (French committee for environment and sustainable development). Two other sessions were held in December 2006 and January 2007. The meetings involved a progress report to stakeholders and asking them for their opinions and proposals. Following the first session the company has supported Niger's adherence to the Extractive Industries Transparency Initiative (EITI) which was then implemented during the second half of 2006. This initiative brings together businesses, governments and civil society organisations seeking to strengthen governance in countries rich in natural resources. Areva aims to further expand this type of initiative to other countries where the group has mining activities.

While supporting Areva's initiatives, NGOs continue to engage in dialogue with Areva and expect the company's talks to translate into concrete action.

Source: www.areva.com

RWE-Lingen – Managing drought risks and its positive side effects

RWE Power, Germany's largest power generator and leading producer of energy resources, has an 87.5 % stake in the 1,400 MW Emsland nuclear power plant (KKE). KKE's electricity production equals about 11 billion kWh per year, covering the power demand of approximately 3.5 million homes and reducing carbon emissions by an annual 8 million tons.

The company uses a state of the art technology in order to maintain power generation at times of drought. The water for KKE's cooling processes is drawn from an artificial reservoir, known as Geeste reservoir (SBG), which was built for the nuclear power plant 12 km from the plant. The reservoir is filled from the river Ems via the Dortmund-Ems channel. When the river's water level is low, the channel receives the volume of water needed for the power plants cooling process from the reservoir.

Environmental aspects were taken into consideration from the very beginning. These included the creation of a 50 hectare wetland biotope and reforesting 113 hectares of woodland. Although initially the SBG was merely a technical project to manage the changes of water volume, by now the reservoir has a very important leisure value in the region.

Source: www.rwe.com - www.geeste.de

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