Nuclear power
energy insecurity

Briefing 2008

ANALYSIS & ALTERNATIVES

BRIEFING FEBRUARY 2008

GREENPEACE

greenpeace.org

Nuclear power
energy insecurity

Introduction

The world today is confronted with dangerous climate change, threatening the lives of millions of people and the ecological integrity of the entire planet. Experts warn that fundamental changes must be made to energy production and use within the next ten years to avert its worst impacts. We must reduce the carbon dioxide (CO_2) emissions from fossil fuels that cause climate change. The decisions and investments made now about energy supply and infrastructure will affect the next 50 years of electricity generation.

Against this global backdrop the nuclear industry has made concerted efforts to promote itself as "clean" energy and politicians and the media have latched on to nuclear power as a potential energy security solution. In 2005, US President George W. Bush said, *"A secure energy future for America must include more nuclear power."*[1] José-Manuel Barroso, President of the European Commission, said that nuclear power can meet *"growing concerns about security of supply."*[2]

These statements have little grounding in reality. The facts disprove nuclear industry spin and political support.

DATE February 2008

GPI REFERENCE GN089

PRINTERS
primaveraquint.nl

DESIGN & LAYOUT
onehemisphere.se

COVER IMAGE
Chernobyl atomic station
© Dmytro/Dreamstime

Printed on 100% recycled post-consumer waste with vegetable based inks.

Published by Greenpeace International
Ottho Heldringstraat 5, 1066 AZ Amsterdam, The Netherlands
greenpeace.org

image Platform/oil rig Dunlin in the North Sea showing oil pollution.

Nuclear power energy insecurity

Energy Security and the nuclear industry's agenda

It was the oil shocks of the 1970s that first thrust energy security onto the global agenda. As a result, many consumer countries increased national exploration for fossil fuels. However, diminishing stocks and the need to reduce CO_2 emissions rule this option out in any sustainable energy policy today.

Nowadays, the international context of energy security is very different. Causes and threats of disruption of supply in recent years have varied; from the impact of extreme weather events like hurricanes Katrina and Rita on highly centralised energy networks[3] to oil workers' strikes in Venezuela; from rapidly increasing energy demand in fast-growing economies such as India and China to decreasing domestic fossil fuel supplies in the USA and Europe.

As in the 70s, however, practical supply concerns continue to be undeniably bound to geopolitics. Supplier countries may depend on income from their exported resources, and consumer countries are concerned by supplier countries' control over their fuel supply, the driver of their economies. In the US, for example, concerns over energy security have increased alongside growing tensions in the Middle East; the Persian Gulf supplies 16% of US oil[4].

Consumer country fear of dependency on foreign imports has therefore given rise to the notion of national energy independence as a route to energy security, and nuclear power has been seized upon as a means of achieving this. India, for example has made national energy independence its "first and highest priority", maximising its use of nuclear power[5]. Similar claims of national independence from Russian gas are made by proponents of the Belene nuclear power plant in Bulgaria. Little independence is acquired, however, if primary fuel, processed fuel and technology all has to be purchased abroad. In the case of the Belene nuclear power plant, it is being built by the Russian company Atomstroyexport, using Russian engineers, while the Russian company TVEL has a monopoly on fuel supply and a € 3,2 billion loan is currently under discussion with Russian banks.

Nuclear industry supporters have been keen to exploit international unease to promote nuclear power as an energy security solution[6]. Their argument, however, ignores several basic facts:

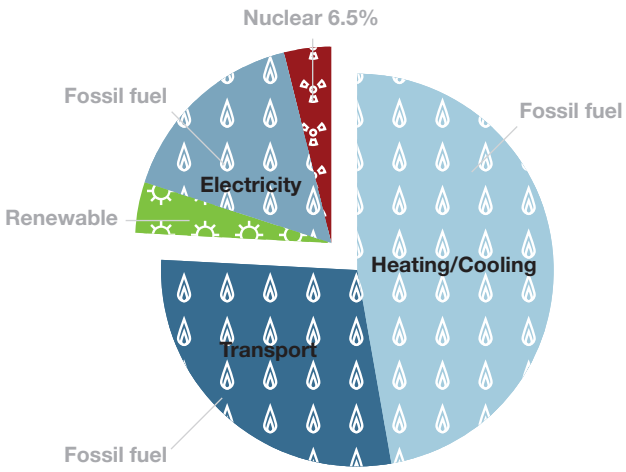
- Nuclear power cannot reduce fossil fuel dependency
- Nuclear power cannot replace imported gas
- Nuclear power cannot increase national energy independence
- Nuclear power cannot provide uninterrupted supply
- Nuclear power cannot guarantee future investment

By comparison, decentralised renewable energy and energy efficiency address these basic facts, and offer the only solution.

Nuclear power cannot reduce fossil fuel dependency

Nuclear power stations only produce electricity; the 439 operating commercial nuclear reactors[7] currently generate around 15% of global electricity. However, nuclear power can only ever marginally address our need for hot water and central heating and does not meet our transport needs at all. As such, it only represents 6.5% of the world's overall energy supply (see Figure 1.1)[8].

Figure 1.1 Energy use by sector - global



As nuclear power can only provide electricity, it cannot meet our transport or heating energy needs.

The nuclear industry has been in steady decline since the Chernobyl accident in 1986. As more nuclear power stations come to the end of their lives, nuclear power's small portion of the world's energy will continue to decrease.

Even if existing world nuclear power capacity was doubled by 2030, based on International Energy Agency (IEA) business-as-usual scenarios, its share of world energy consumption would rise to barely more than 10%. Therefore, increasing nuclear power capacity by 100% would only result in reductions of less than 5% in fossil fuel dependency and CO_2 emissions[9].

Renewable energy can be the cheaper option. To double nuclear power capacity by 2030, taking into account retiring nuclear power plants, would require 500 GW of new capacity - this would cost between two and three trillion US dollars. The same 500GW of additional renewable capacity, given the continual downward trend in costs, would cost a comparative 1.5 trillion US dollars, saving as much as half the cost[10].

Nuclear power
energy insecurity - continued

Nuclear power cannot replace imported gas

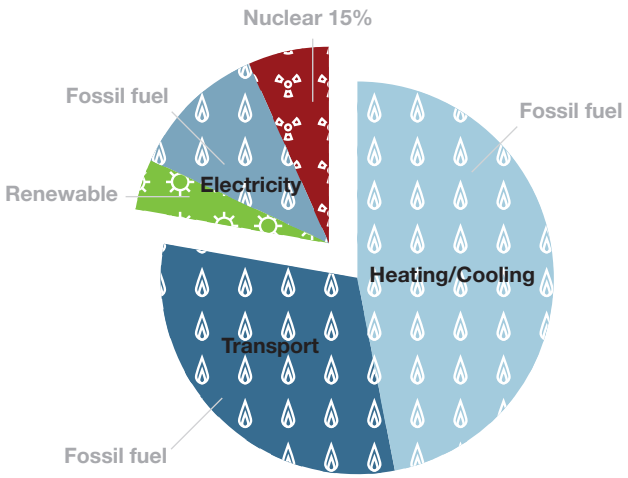
In Europe, for example reducing indigenous gas supplies has made it more dependent on external fuel imports. Then in 2006 the Russian state-owned gas supplier Gazprom cut off gas supplies to the Ukraine and some European countries experienced reduced supplies.[11]

In Europe the projected demand for imported gas is set to increase imminently (see Figure 1.3). However, on average, nuclear reactor construction takes a decade from planning through to operation. Even if nuclear power was able to meet a small part of the world's current energy needs, it would come long after it was required.

In addition, only 21% of final natural gas consumption in the 27 countries of the European Union (EU27) is used for electricity generation[12], with most of this covering peaks and troughs in electricity demand. Nuclear reactors are not designed to be switched on and off according to demand. With the majority of natural gas being for heating or other industrial purposes, new nuclear power stations, restricted to electricity generation, would fail to meet the needs caused by any shortfall in natural gas supply.

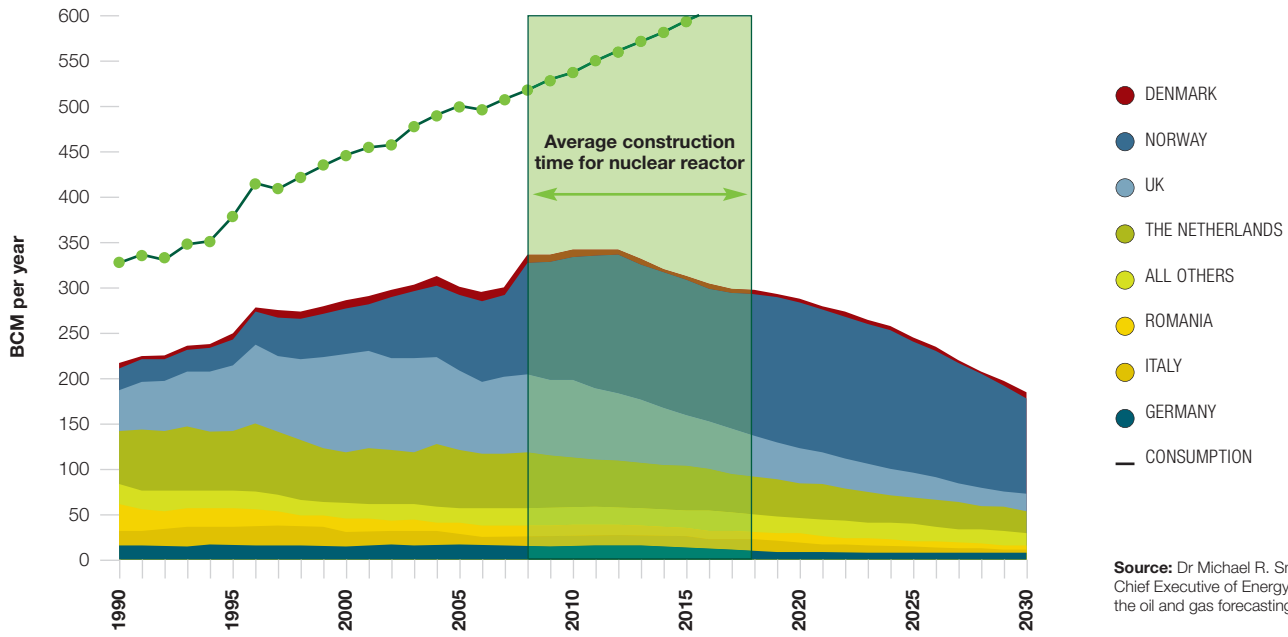
Renewable energy technologies and energy efficiency measures are available now. Construction time for installing a large wind turbine has fallen to only two weeks, with an associated planning period of between one and two years. A diverse mix of renewable energy technologies - wind, solar, geothermal, biomass and hydroelectric - would be able to meet both base load and fluctuating demand. What's more, if we used the existing gas fired power plants more efficiently to generate electricity and heat together - cogeneration - we could increase the energy content of gas we use for electricity by 90%, without having to increase total gas consumption.

Figure 1.2 Energy use by sector - Europe



As nuclear power can only provide electricity, it cannot meet our transport or heating energy needs.

Figure 1.3 European gas production and consumption - actual and forecast 1990 - 2030



Source: Dr Michael R. Smith, Chief Executive of Energyfiles, the oil and gas forecasting company.

image "Nuclear" means trouble in any language, Tuwaitha nuclear facility, Iraq.

Nuclear power cannot increase national independence

In the nuclear age, the world is delineated according to the "haves" and "have nots" of nuclear technology; the nuclear industry's forefather, the nuclear bomb, casts a dangerous, geopolitically complex shadow over international relations. Consequently, there is a political price tag associated with gaining any nuclear technology.

Those with nuclear technology try to control its spread by setting up international government and industry partnerships and deals. A civil nuclear club was recently formalised in the US-led Global Nuclear Energy Partnership (GNEP), proposing a number of states to provide nuclear fuel and waste management for developing countries. Meanwhile, the nuclear technology "have nots" want to become members of this exclusive club for the power and status it brings. Lula da Silva, the president of Brazil, expressed this clearly saying that having uranium enrichment technology would make Brazil "more highly valued as a nation"[13].

In 2006, US President George W. Bush and Indian Prime Minister Manmohan Singh announced a bilateral eight year agreement for the USA to provide India with nuclear power assistance. US Undersecretary of State for Political Affairs, R. Nicholas Burns, said, "India, unlike Iran and North Korea, earned special treatment from the United States"[14].

Used as a political bargaining chip, nuclear power increases geopolitical tensions and neither guarantees national energy independence nor energy security.

Without the safety or proliferation concerns that belong to nuclear power, renewable energy technologies and skills can easily be exported globally and domestic industries built up. Harnessing domestic natural resources, decentralised renewable energy and energy efficiency could really provide increased energy security without the political price tag.

Box 1 A stretched international supply chain

There are practical problems with the interdependent structure of the nuclear supply chain (see Table 1). One small break in the chain can have wide repercussions; flooding in just two Canadian mines, for instance, has affected the spot price of uranium globally, leading to increases in electricity price.[15]

The global nuclear supply chain is already stretched to its limits. The few manufacturers of large reactor components have limited capacity over the coming years[16]. There is currently a three year backlog for specialised steel containers for reactor cores, fabricated only by Japan Steel Works[17]. Components produced in limited numbers, for specific reactor designs and by few manufacturers, means reactors can be out for longer than necessary for maintenance.

The aging nuclear industry also faces a serious experienced personnel shortage. The Czech company Skoda Engineering has the technology to manufacture parts, but no qualified staff. A lack of trained personnel is a problem for both industry and regulatory institutions in many countries. This creates a bottleneck that leads to mistakes during construction; one of the factors which has led to delay and cost overruns at Olkiluoto reactor, under construction in Finland. The nuclear industry would already be over-extended to replace existing capacity, let alone expanding its current fleet into the future.

Small markets and a globally stressed supply chain make national independence through nuclear power impossible and construction delays, supply interruptions and price increases inevitable.

Table 1 Status, issues and energy security implications in the nuclear energy supply chain

Uranium mining	Fuel fabrication	Contstruction & maintenance
• At current global nuclear capacity, known uranium resources will last 34 years. Including estimated amounts and former military sources, uranium resources will last 70 years.[18] Any significant nuclear expansion would reduce the time that uranium was available. • 58% of supply from 3 countries: Australia, Canada and Kazakhstan. Mined in 18 countries.[19] • 52% mined by 3 companies: Cameco, Rio Tinto and Areva.	• Fuel is fabricated from uranium ore: • Conversion plants in 5 countries: USA, Canada, France, UK and Russia. • Large enrichment plants in 6: France, Germany, the Netherlands, UK, USA, and Russia. Smaller plants elsewhere.	• Limited manufacturing capacity for specialised and large components.
• As the quality of uranium goes down, costs and CO_2 emissions from production go up. Lower quality uranium requires more energy to convert to fuel. Similarly, uranium from unconventional sources (e.g. the sea or rocks) requires more energy to recover that it will produce. • Recent price hikes on spot market. US$ 40-60 million sold on the spot market per annum. June 2007 prices rose to US$ 136 per pound, compared with US$7 in 2000 on the spot market, due to shortfall in supply.	• Fuel supply monopolies exacerbate bad situation. • Often reactor types need certain fuel types. Russian built Temelin rector in the Czech Republic initially encountered significant problems with changing fuel supplier in 2006[20].	• Parts often one or few of a kind. • Shortage of trained personnel for construction and operation
• Any expansion of nuclear capacity would significantly reduce uranium supplies to a level that threatens security of supply. • Small number of countries and companies involved in mining. • Recently unpredictable spot market prices.	• Consumer nations dependent on limited number of countries for fuel fabrication. • Reactor design and fuel supply contracts add supply complications.	• Delays in construction. • Plants offline for maintenance - due to unavailable components.

Nuclear power
energy insecurity - continued

Nuclear power cannot provide uninterrupted supply

Large-scale nuclear power plants delivering base load to a centralised system means that one small fault can lead to loss of electricity in whole cities or regions. For example, in July 2007 an earthquake in Japan knocked out seven large reactors at the Kashiwazaki-Kariwa power plant. This plant provides 6-7% of Japanese electricity and Tokyo depends heavily on it. The plant remains offline today and is expected to be out of operation for at least a year. Sweden suffered similarly in 2006 when safety problems shut down four reactors, cutting off 20% of Sweden's electricity supply.

A decentralised system, where buildings (from homes to industrial units) have their own wind turbine, solar panels or co-generation units and smaller scale power plants generate electricity closer to communities is far more energy efficient[21] and less prone to disruption.

Nuclear power cannot guarantee future investment

The Three Mile Island and Chernobyl accidents, with their shocking impacts, led to such a loss in public trust in the industry that orders for new reactors quickly stopped across the world, bringing the industry to a standstill. What's more in spite of current talk of a nuclear renaissance, the high expectations are not matched with orders for new reactors. An accident now, in a much larger and more complex reactor like the European Pressurised water Reactor (EPR), could have even more devastating consequences than Chernobyl[22] and would bring the industry to its knees. With such a high human and financial risk, it is no wonder the nuclear industry struggles to find investment.

There has not been an order for a new reactor in the US for 29 years. The government is even trying to tempt private investors with tax credits, federal loan guarantees and contributions to risk insurance. But even with these expensive government incentives, the rating agency Moody's does not consider nuclear power generation a sound investment. It is concerned about the prospect of construction delays, cost overruns and the implications for rate-shock and future disallowances. From a credit perspective, business and operating risk profiles will increase for companies that pursue new nuclear generation.[23]

If the nuclear industry cannot guarantee future investment to cover its current tiny contribution to world energy supply, it cannot offer an expanded secure continuous supply of electricity long into the future.

With a fairer legal and political framework, green electricity could keep the lights on with cleaner, safer, cheaper electricity. Success stories like Germany's use of a feed-in tariff or Texas' renewable portfolio standards (RPS) have encouraged investment in Renewable Technology and led to market competitiveness without additional subsidies.[24] Global investment in renewable energy has already doubled in the past three years and there is potential for a lot more growth.[25]

Decentralised renewable energy and energy efficiency - the only solution

A choice for nuclear power cannot guarantee energy security, nor does it reduce dependency on fossil fuels or CO_2 emissions significantly.

It is also an expensive and dangerous distraction, preventing sounder investment in clean, secure renewable energy. In Finland, where they are building the EPR, the power market is blocked by the new reactor, which represents 85% of the country's planned investments in new power generation between 2006 and 2010[26]. According to Oras Tynkkynen, a Finnish Member of Parliament, "We have made the choice, we have chosen the nuclear path and that has meant we have neglected sustainable alternatives like energy efficiency and renewable energy sources"[27].

As Amory Lovins of the US Rocky Mountain Institute calculates, "Each dollar invested in electric efficiency displaces nearly seven times as much carbon dioxide as a dollar invested in nuclear power, without any nasty side effects"[28].

It is possible to access 5.9 times more renewable energy than current global demand using existing technologies. Greenpeace and the European Renewable Energy Council (EREC) commissioned the DLR Institute (German Aerospace Centre) to develop a global sustainable energy pathway up to 2050. This "Energy Revolution" scenario[29] is a realistic blueprint that phases out nuclear power and fossil fuels for a sustainable and equitable energy future through renewable energy and energy efficiency. It shows that with intelligent policy and infrastructure choices now, renewable energy and energy efficiency could provide half of our energy by 2050 without nuclear power.

1 http://www.ens-newswire.com/ens/apr2005/2005-04-28-10.asp

2 Statement read by Andris Piebalgs on behalf of Jose Manuel Barosso "Nuclear Energy within the climate change and energy security debate", Speech at the First European Nuclear Energy Forum, Bratislava, 26 November 2007. http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/07/749&format=HTML&aged=0&language=EN&guiLanguage=en

3 In a centralised system electricity is generated in large power stations and transmitted through wires in the electricity grid to homes and businesses. Hurricanes Rita and Katrina damaged the wires, causing part of the supply chain in a centralised system to collapse. This meant that, while there was no disruption in the supply of gas flowing in from the Gulf of Mexico, it was trapped at processing plants. Consumers suffered a disruption in basic electricity services.

4 Based on USA Department of Energy Crude Oil and Products Import statistics between November 2006 and October 2007. http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_m.htm

5 Address to the nation on the eve of 59th Independence Day – 2005, Abdul Kalam, http://www.education.nic.in/Elementary/Policyel/presidentspeech-14082005.asp

6 http://news.bbc.co.uk/1/hi/world/europe/4573944.stm Examples pro nuclear bodies, people and politicians: Speech from Tony Blair- nuclear power back on agenda with a "vengeance" – a reason given dependency on Middle East and Russian fossil fuel imports: http://www.number-10.gov.uk/output/Page9470.asp Nuclear Engineering International blogs:http://neinuclearnotes.blogspot.com/2006/07/forbes-looks-at-gazprom.html. Article by Dieter Helm-http://www.opendemocracy.net/globalization-institutions_government/europe_energy_4251.jsp. Outside EU27: Belarus- move to nuclear for" political reasons" to be less dependent on gas from Russia: http://news.bbc.co.uk/2/hi/europe/7039403.stm

7 IAEA Power Reactor Information System, http://www.iaea.org/programmes/a2/

8 International Energy Agency, World Energy Outlook 2006. However, other analysis by the International (IIASA) shows that nuclear power represents only 2.2% of world energy consumption. This is because the IIASA considers the electric output of a nuclear plant a primary energy source. The IEA on the other hand considers heat the primary energy source and then assumes 33% efficiency. Consequently, the value in primary energy of a kWh of nuclear power produced today according to IIASA's methodology is roughly one third of that of the same kWh according to the IEA methodology.

9 Figures based on International Energy Agency, Business As Usual scenario, 2004.

10 Nuclear figures based on: most recent experience from Olikuoto-3 with construction cost of 4,300 USD/kW. Moody's analysis gives low estimate at 5,000 and high at 6,000 USD/kW. (New Nuclear Generation in the United States: Keeping Options Open vs Addressing An Inevitable Necessity, Moody's Investor Services, October 10th 2007). Renewable figures based on parameters given in the Greenpeace Energy Revolution Scenario and Future Investment Report:http://www.greenpeace.org/international/press/reports/energy-revolution-a-sustainab and http://www.greenpeace.org/international/press/reports/future-investment

image A local Tibetan woman talks to Greenpeace, she has five children and runs a busy guest house in the village of Zhang Zong. She is pictured here with solar panels in the background, which supply energy for her business.

Greenpeace recommendations

The world must stay as far below a 2° Celsius temperature rise as possible. Getting on course to meet this target is only possible by employing sustainable renewable energy and energy efficiency. Nuclear power is not part of the climate solution but an expensive and dangerous distraction.

- Global greenhouse gas emissions must peak and decline by 2015 and be halved by 2050.
- Binding commitments are needed for industrialised countries to cut emissions by 30% in 2020 and 80% in 2050, with domestic measures and to direct massive funds for decarbonisation in developing countries.

An end to the nuclear age:

- Phase out existing reactors.
- No new construction of commercial nuclear reactors.
- Stop international trade in nuclear technologies and materials.
- Phase out all direct and indirect subsidies for nuclear energy.

A renewable energy future:

- Divert state funding for energy research from nuclear and fossil fuel energy technologies towards clean, renewable energy and energy efficiency.
- Set legally-binding targets for renewable energy.
- Adopt legislation to provide investors in renewable energy with stable, predictable returns.
- Guarantee priority access to the grid for renewable generators.
- Adopt strict efficiency standards for all electricity-consuming appliances.

11 According to the BBC on 2 January 2006, "Ukraine - loses 100% of Russian imports, Hungary - Russian imports down 40%, Poland - supply down 14% on Sunday...,Austria, Slovakia, Romania - supplies down by a third, France...reported 25-30% drop in supply" http://news.bbc.co.uk/1/hi/world/europe/4574630.stm

12 2006 figures for EU27 Gross Electricity Generation. European Directorate-General Energy and Transport, Statistical Pocketbook 2007: http://ec.europa.eu/dgs/energy_transport/figures/pocketbook/doc/2007/2007_energy_en.pdf

13 http://www.energy-daily.com/reports/Lula_Resumes_Nuclear_Program_To_Make_Brazil_World_Power_999.html

14 US, India Reach Deal On Nuclear Cooperation, With Fuel Imports Allowed, Arms Program Could Grow, By Jim VandeHei and Dafna Linzer, Friday, March 3, 2006; Washington Post: http://www.washingtonpost.com/wp-dyn/content/article/2006/03/02/AR2006030200183_2.html

15 For example, the Russian company Atomstroyexport , with the contract to build Bulgarian nuclear power plant Belene, has already increased the expected electricity price by 23%: http://www.standartnews.com/en/article.php?d=2007-12-28&article=10984

16 Siemens has said that it cannot produce more than 3 EPRs in the next three years; Mitsubishi heavy industries can also can produce some 2 or 3 pieces a year; the US has no domestic capacity for ultra-heavy components at the moment; Russian manufacturers do not have the capacity to make more than three reactors by 2010

17 New Energy in nuclear power supply battle, Firms jostle to be in line for scarce reactor components, Chicago Tribune, January 2008: http://www.chicagotribune.com/business/chi-sun_nukejan06,0,6203019.story

18 In 2001 the European Commission's Energy Green paper [EC2001] stated known 2.8 million tonnes of uranium resources would last 40 years. The known and estimated resources, plus secondary resources 72 years came from the paper "Uranium Supply and the nuclear option" Paul Mobbs, Mobbs' Environmental Investigations and Research, March 2005.

19 World Nuclear Association, March 2007. http://www.world-nuclear.org/info/inf75.html

20 The Russian built Temelin rector in the Czech Republic initially required significant refitting by US company Westinghouse when they won the fuel contract in 2000. In 2006 following disagreement over how to deal with a fuel leakage, Westinghouse refused to replace all of the faulty fuel rods and supply was disrupted, while CEZ the Czech energy company that owns the Temelin reactor sought to make the costly changes to use Russian fuel.

21 In a centralised system, energy is lost through transmission and distribution - in the UK, for example, 61.5% of electricity is lost through centralised inefficient generation and heat wastage.

22 Assessments of the radiological consequences of releases from proposed epr/pwr nuclear power plants in France, John Large, for Greenpeace France, 3 February 2007.

23 Special Comment Credit Risks and Benefits of Public Power Utility Participation in Nuclear Power Generation Summary Opinion, Moody's June 2007.

24 Germany's time-limited feed-in tariff: Grid access is guaranteed. Power companies pay a fixed tariff for renewable electricity and spread the cost among all electricity consumers. The extra monthly costs per household was less than €1.The feed-in tariff is reduce for newly installed systems by 5 % each year. Texas, United States: Generates more electricity from wind than any other US State. Partly due to the RPS. Signed into law in 1999, the standards place an obligation on utilities to meet renewable energy targets or face a penalty.

25 Renewables 2007 Global Status Report, Renewable Energy Network for the 21st century, December 2007. Pre published summary: http://www.ren21.net/pdf/REN21_GSR2007_Prepub_web.pdf

26 Statistics Finland: Energy statistics 2006.

27 In interview with Greenpeace UK-The Convenient Solution - Show casing clean energy solutions to climate change - www.greenpeace.org/solution.

28 Guardian 12 August 2004, "Nuclear Plants Bloom" by John Vidal, http://www.guardian.co.uk/life/feature/story/0,,1280884,00.html

29 Energy Revolution-A Sustainable World Energy Outloook, Greenpeace and European Renewable Energy Council, January 2007- http://www.greenpeace.org/international/press/reports/energy-revolution-a-sustainab.

Greenpeace

Greenpeace campaigns against nuclear power because it is an unacceptable risk to the environment and to humanity. The only solution is to halt the expansion of all nuclear power and shutdown existing plants.

Nuclear power - a frightening risk to our safety and security:

All operating reactors in the world have inherent safety flaws. 1,500 quality and safety defects have already been found in the construction of the new reactor in Finland, described as state of the art.
Today, the precise death toll of the Chernobyl accident remains unknown but may be more than one hundred thousand. Radioactive pollution from nuclear power happens not only when there is an accident, but throughout the nuclear cycle, continuously harming our environment and health.

Furthermore, nuclear power puts us at risk of increased proliferation, terrorists getting nuclear materials or a nuclear reactor or nuclear transport being potential terrorist target.

There is no solution to nuclear waste:

Nuclear power produces nuclear waste, including the 200 000 tons of spent fuel amassed worldwide.
This will remain deadly for hundreds of thousands of years. There is no safe solution to the long term management and disposal of hazardous radioactive waste despite billions of dollars in investment and decades of research.

Nuclear power is an expensive distraction from real climate change and energy security solutions:

New nuclear reactors would cost more and take a decade to build, delivering minor CO_2 reductions too late and barely reducing our dependency on fossil fuels. Even if today's nuclear capacity were doubled, it would reduce CO_2 emissions by less than 5%.

The real solution to climate change is sustainable, cheap and safe decentralised renewable energy and energy efficiency.

Greenpeace

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

Published by Greenpeace International,
Ottho Heldringstraat 5, 1066 AZ Amsterdam, The Netherlands
For more information contact: enquiries@int.greenpeace.org