

# Nuclear power

Only problems  
No solutions

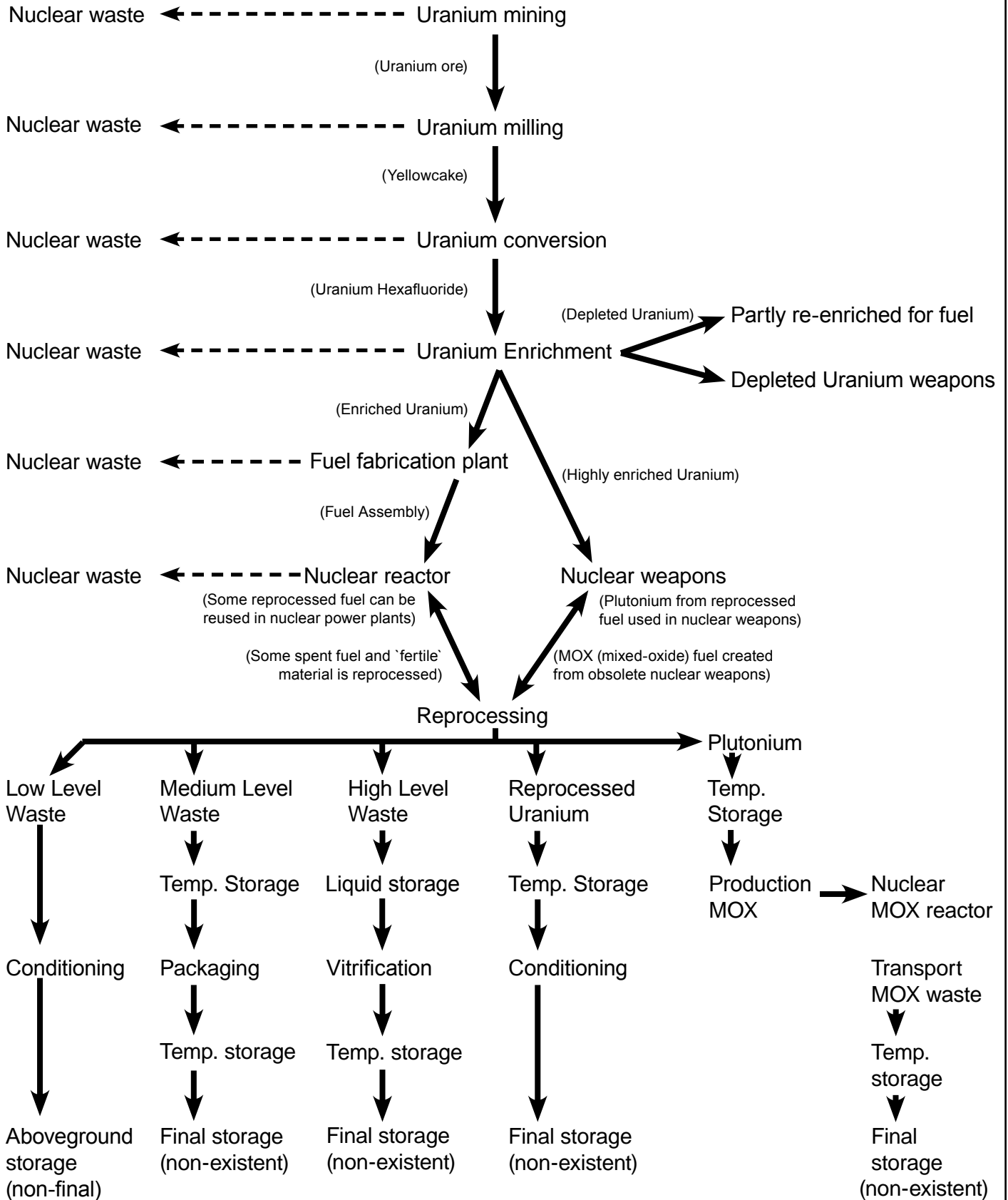


**Facts and figures**  
about nuclear power

# The nuclear chain

## (summarised)

The nuclear chain (from uranium mining to waste storage) is the most complex and extensive of all energy systems. Note: every  $\longrightarrow$  arrow means 'transport'



# Nuclear power: Only problems - No solutions

**Sometimes, it is important to restate the obvious.**

Why is smoking bad for you? **Because it causes cancer.**

Why is it not a good idea to drive drunk?  
**Because it can lead to serious accidents.**

Why should we get rid of nuclear power?  
**Because it is dangerous, expensive, dirty and not helpful.**

Although for decades the **arguments against nuclear power** have been –and still are- strong and valid, there is an increasing group of nuclear companies supported by scientists and politicians, who say we need nuclear power to fight climate change and to be independent. They also claim that all the problems associated with nuclear power are almost solved or solved.

Why do they say this? Because for them, nuclear power means profits, power and politics.

In March 2007 on the 50th birthday of the Euratom Treaty, **more than 600,000 Europeans and 800 European organisations** demanded that European leaders phase out nuclear power, end the Euratom Treaty and massively invest in energy saving, efficiency and renewable energy.

Why do they say this? Because for them safety, sustainability and social behaviour are important.

In this booklet, **we restate the obvious** by listing many hard, recent and Europe-related facts on the failures and dangers of nuclear power. All information comes from renowned and/or independent sources. We look at the impossibilities of permanent storage of nuclear waste, the financial and technical problems of building new nuclear power plants, the impacts of dirty uranium mining, the numerous and serious nuclear accidents that have taken place recently, the dangers of proliferation, and the data that show that nuclear power does not help to save the climate.

To us, these facts lead to one obvious conclusion: **nuclear power has no future.**

## **European Petition Campaign against Nuclear Power**

*atomstopp (Austria)*

*Friends of the Earth Europe (EU/Brussels)*

*GLOBAL2000 (Austria)*

*Réseau Sortir du Nucléaire (France)*

*WISE - World Information Service on Energy (Netherlands)*

*Women against Nuclear Power (Finland)*



# ① Nuclear power still creates



German policemen guard a Castor transport of nuclear waste, November 1997

Nuclear power produces nuclear waste that is highly radioactive. **What exactly is radioactivity and what is radiation?** What radiation can do to living organisms was clearly illustrated when the Russian former KGB spy Alexander Litvinenko was poisoned with a tiny dose of polonium-210. It killed him in a few days. Nuclear radiation occurs when unstable atoms decay. It disrupts the functioning of the cells that make up our bodies. High levels of radiation kill cells, resulting in radiation burns, sickness and death.

Lower levels of radiation cause mutations, which can result in cancer and inheritable genetic damage. These effects are unpredictable. Like with smoking, we know there is a direct relation but it occurs at random. If a large number of people are exposed to radiation, for example as happened after the Chernobyl accident, we know that some people will get cancer and some women will give birth to children with genetic defects, but we cannot predict who will be affected. Also the effects can be delayed, with cancers or birth defects occurring many years after exposure to radiation.

High levels of radiation are very dangerous. The nuclear industry believes that high-level waste can be stored relatively harmlessly. Most other sources

claim that the waste is still radioactive (far above free release limits) after 240,000 years. The nuclear industry proposes long-term waste storage sites e.g. in bunkers or in deep rock formations, but has failed to realise such a long-term disposal site. It is impossible to guarantee the isolation of waste for hundreds of thousands of years. Once the waste is buried, there is no longer a possibility to check for and repair leakages. Leakages are simply a matter of time, i.e. the containers definitely will leak sometime in the future, releasing the radioactivity they contain.

Aboveground storage cannot be considered safe either. Although there is a possibility to control and repair the waste containers, mankind will be responsible for its management 'forever'. Containers

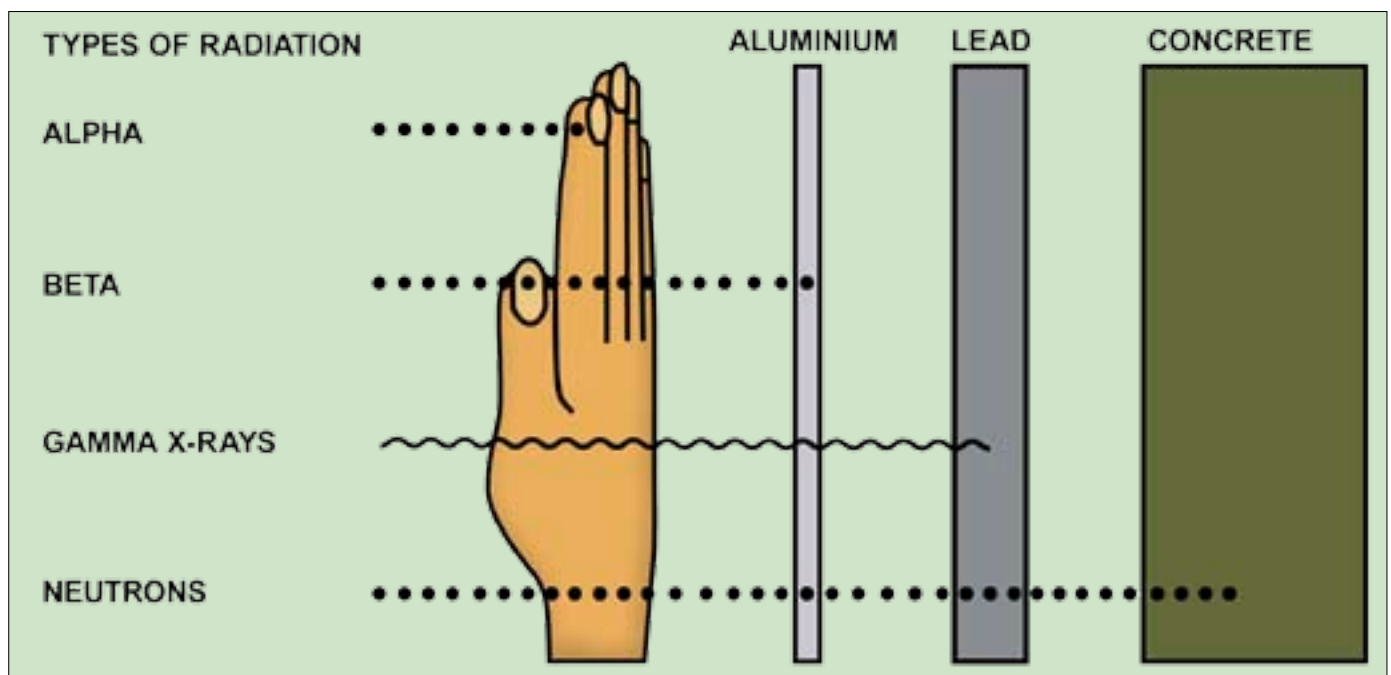
# dangerous waste

have to be replaced and the storage facility must be protected against war, terrorism and other potential dangers.

A study published in January 2007 in **Nature** casts new doubt on nuclear waste storage safety. Synthetic material that scientists had hoped would contain nuclear waste for thousands of years may not be as safe and durable as previously thought. It showed that this material (zircon) is susceptible to degradation faster than expected and may not be able to contain the waste until it becomes safe. The findings are particularly important for long-lived isotopes such as plutonium, uranium and neptunium.

The following case shows some of the problems related to underground storage. **The true but unbelievable storage of the Asse salt mine** started when until 1978, 124,000 barrels of low and intermediate radioactive waste (including 24 kg of plu-

tonium) were stored in a former salt mine in Asse, Lower Saxony, Germany. The waste was supposed to be stored 'forever' in dry salt. Recent research showed that since 1988, salt lye water has been flowing freely into the mineshaft daily (11.5 m<sup>3</sup> per day in November 2006), causing the waste drums to rust. In total, 52 million litres have entered over 18 years. The former salt mine consists of open spaces (for transport and storage), and is now subsiding, with risk of collapse. An October 2006 survey showed that the combination of rust and radioactive waste could produce inflammable or explosive gases, which build up pressure, pushing up radioactive material, possibly into the groundwater system. In reaction to the first signs of leakages, the German government started to stabilise the mine in 1995 by filling it with 2.5 million m<sup>3</sup> of salt (in 15 years). According to the Ministry of Science & Technology these costs amount to several hundreds of millions of Euros to be paid by the government.



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# 2

# Nuclear power is very expensive



Construction work at Temelin nuclear power plant 1997.

**It costs a lot of money to build a nuclear power plant. In a competitive electricity market companies will have difficulties finding investors for such a risky, long-term, politically sensitive project. Private banks withdraw their support and doubtful and disputed public money is used to fill the gaps.**

Construction of the **Bulgarian Belene nuclear power plant** started in the 1980s, but due to environmental protests and economic doubts the project was stopped in the 1990s. The Bulgarian government brought up the Belene project again in 2003 after having agreed to close down four blocks of another nuclear power plant as condition for EU accession. A consortium of Russian AtomStroyExport and French-German ArevaNP offered to build two reactors for the price of approximately 4 billion Euros. Bulgaria's National Electric Company (NEC) aims to keep at least a 51% share in the new plant and seeks a strategic investor for the remaining part. NEC expected to get funding from the export agencies of the chosen builders Russia, France and Germany, EURATOM, the European Investment Bank and leading global investment banks.

In 2006, the UniCredit Group, HVB and Deutsche Bank withdrew their support after public protests from customers. The banks appear to be aware of the economic risks and of the fact that their customers do not want any involvement in nuclear investments. Around the same time investment consultancy Standard and Poor's down-rated NEC from 'developing' to 'negative' on their corporate rating because of its participation in the project. Bayerische Landesbank and Commerzbank denied involvement in the Belene project, although the Bulgarian Energy Minister had mentioned them as "interested".

The Belgian KBC Group denied wanting to finance Belene through its Czech daughter CSOB and the French Soci t  G n rale Group withdrew its Czech daughter Komerčni Banka after receiving information about the risks attached to Belene. Other banks that withdrew support include NP Paribas, Credit Suisse, Merrill Lynch & Co., JP Morgan Chase and the Lehman Brothers Bank.

There is a lot of dispute about how much it actually costs to build a new nuclear reactor. Figures are speculative because after Chernobyl the market for nuclear power plants collapsed and hardly any new ones were built in Europe. Only recently a new building project was initiated in Finland with the **Olkiluoto EPR** (European Pressured water Reactor). The construction of this EPR by the French Framatome (now renamed ArevaNP) and the German Siemens (having a 34% share in ArevaNP) started in February 2005. During the Finnish Parliament's discussions on the construction of a new nuclear power plant, it was said that the EPR would cost 2.5 billion Euro. The final contract amounted to about 3 billion Euros.

Financial support for this reactor comes from the French export credits agency Coface which gave a

loan guarantee of 610 million Euro (and thus supporting Areva with French public money) and a 1.95 billion loan against the incredible low interest of 2.6% from the German Bayerische Landesbank (in other words supporting Bavaria-based Siemens). Normal interest rates are in a range from 8% up to 20% for investments with high risk, but because Coface guaranteed to take the losses and the buyer of the plant, TVO, made a fixed price contract, there is no financial risk for the bank should the total costs exceed 3 billion Euros. In 2004 the European Renewable Energy Federation (EREF) filed a complaint with the European Commission stating that Olkiluoto would receive illegal state aid through Coface, putting other energy companies to a disadvantage. The Commission has accepted the complaint but as of 2007 no decision has been taken yet.

On average, building a nuclear power plant takes ten years. The Olkiluoto EPR was planned to be built in the extremely short time span of 57 months. However, two years after construction began there is already an **18 months delay**. The plant project has been plagued by safety problems and technical mistakes. The concrete of the base slab of the reactor was found to be too porous. Safety violations were also found in other components, including the steel container of the reactor. "In the case of a fixed-price contract it is to be expected that money becomes the most important criterion in the selection of a subcontractor. In the subcontractors selection stage, TVO has limited possibilities to ensure that quality and safety criteria are given sufficient priority", says the Finnish Radiation and Nuclear Safety Authority (STUK) in a report published July 2006. During their investigation they found 700 reported irregularities.

Operating income for Areva's nuclear operations plunged 300 million Euros compared to the first half of 2005. Areva indicated that the division respon-

sible for Olkiluoto-3 was by far the worst performing. Due to delays the costs are now more than 500 million Euros over budget and the total costs are unlikely to be less than 4 billion Euros. About 600 mostly small Finnish subcontractors are working on the site. Many of them are in trouble due to the delay and some are considering legal steps against Areva.

The European Union supports the expensive nuclear industry, notably through the **Euratom Treaty**. Article 1 of the Euratom Treaty says "it shall be the task of the Community to contribute to the raising of the standard of living in the Member States and to the development of relations with the other countries by creating the conditions necessary for the speedy establishment and growth of nuclear industries". The Treaty was signed in March 1957 and channels funds to the nuclear power industry. It includes a lending facility with billions of Euros to help build or improve nuclear power plants.

All EU Member States are automatically members of Euratom. This also counts for states that never had nuclear power, have phased out nuclear power or have agreed to do so in the future. Unlike in most other fields of policy making, the European Parliament has no decision-making power over the Euratom budget. The Euratom €2.75 billion Euro budget for both nuclear fission and fusion for the next five years has hugely increased compared to the €1.35 billion Euro for the previous seven-year programme. From the same energy budget, the EU will spend only €1.175 billion on renewable energy and energy efficiency in the period 2007-2013.

In Austria, a country that declared itself nuclear-free after a referendum in 1978, a campaign was launched in January 2007 to leave the Euratom treaty unilaterally. Austrians are fed up with paying 40 million Euro annually to nuclear developments that they do not agree with.

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# 3

# Nuclear power will run out



Uranium sludge pond in Dolní Rožínka, Czech Rep. © Greenpeace/WISE/Vaskú

**Uranium** is the sole source of nuclear power. The concentration of uranium in the earth's crust is about the same as that of tin or zinc. Uranium occurs in many kinds of chemical compounds, minerals, and in different types of rocks in the earth's crust. In 2005 the world nuclear fleet consumed about 70,000 tonnes of uranium. About 40,000 tonnes of this amount was actually mined. The remaining 30,000 tonnes was produced from depleted uranium and highly enriched uranium from dismantled nuclear weapons. Within a few years these reserves of highly enriched uranium will run out and from then on all uranium will have to be mined. The easily discoverable and extractable uranium sources are already known and in production. To date there are no publications which indicate new large rich uranium resources have been found.

When nuclear power first became an option it was thought that **fast breeders**, 'breeding' more uranium, would lead to a closed fuel cycle and solve the problem of limited fuel resources. Fifty years of intensive research in seven countries (USA, UK, France, Germany, USSR/Russia, Japan and India), with investments of many of tens of billions of dollars have failed to demonstrate that the breeder cycle is technically feasible. The 2003 study *The Future of Nuclear Power* does not expect breeders to come into operation during the next three decades.

**Mining and milling uranium** removes hazardous substances in the ore from their relatively safe underground location and converts them to fine sand and then sludge, making it possible for the hazardous materials to disperse in the environment. The uranium content of the ore is often only between 0.1% and 0.2%. Therefore, large amounts of ore have to be mined to get at the uranium. Piles of so-called waste rock threaten people and the environment after the shutdown of a mine because they emit radon gas and the seepage

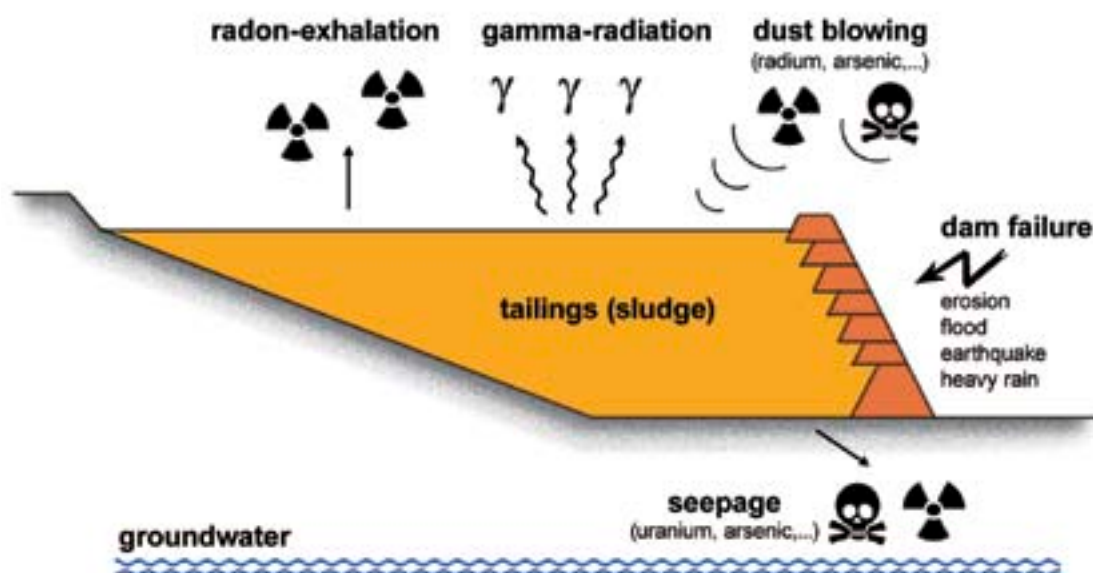


water contains radioactive and toxic materials. To keep groundwater out of the mine during operation, large amounts of contaminated water are pumped up and discharged into rivers and lakes. When the pumps are shut down after closure of the mine, there is a risk of groundwater contamination from the rising water level. Uranium mill tailings are normally dumped as sludge in special ponds or piles, where they are abandoned and prone to failure. In Saxony, Germany the Helmsdorf pile near Zwickau contains 50 million tonnes of solids and the Culmitzsch pile in Thuringia near Seelingstädt contains 86 million tonnes.

On December 24, 2006, a pipe carrying radioactive waste from a uranium mill in **Jadugoda, India** to a storage dam burst, discharging highly toxic waste into a nearby creek. The accident occurred in a small village inhabited largely by displaced families whose lands were acquired to construct two of the three storage dams. Similar accidents in other countries show that the negative effects on human and environmental health will impact not just Jadugoda, but also several downstream communities, perhaps even hundreds of kilometres away. The toxic sludge spewed into a creek for nine hours before the flow of the radioactive waste was shut off. As a result, a thick layer of toxic sludge along the surface of the creek killed scores of fish, frogs and other riparian life.

**Nuclear mining waste was dumped in the French environment.** Cogema is the French government-owned nuclear group, one of the largest suppliers of uranium in the world and the only company to offer the industry every stage of the nuclear fuel cycle: from mining to waste management. Now that France's most lucrative uranium deposits are mined out, Cogema's mining holdings are concentrated in Niger, Canada, and Kazakhstan. The south of France suffers from radioactive pollution as result of waste dumping until 2001 at old uranium mining sites of Cogema. It has left 27 million tonnes of mining waste that will be radioactive for millions of years. In an attempt to hold Cogema responsible for cleaning up its waste, Sources et Rivières du Limousin, a independent organisation of fishers in the Limoges region, filed a case with the Court of Justice. Although the Court ruled in March 2004 that Cogema had not violated the law, the case raised a lot of public attention and may help to raise the environmental and health standards of the way mining waste is handled.

## Uranium Mill Tailings Hazards



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# ④ Nuclear power causes seri



An exploded pipe inside the Brunsbüttel nuclear reactor in Germany  
- 14 Dec. 2001. © Greenpeace Germany

**Accidents with nuclear installations are not something from the past. Nor do they only occur in old reactors like the Chernobyl reactor that burned down in 1986, spreading a cloud of radioactivity over half of Europe. Accidents happen with all types of nuclear power plants, all over the world.**

After the Chernobyl disaster the **International Nuclear Event Scale** (INES) was introduced by the International Atomic Energy Agency (IAEA) in order to enable prompt information in case of nuclear accidents. There are 7 levels on the INES scale indicating the seriousness of an event. Since the introduction of INES there have been many incidents that were rated as level 3 or 4, which indicate a serious accident. In many cases, design flaws, a sloppy safety culture, poor judgment under stressful conditions and a naive faith in a highly sensitive technology lead to a chain of events that only by sheer luck did not end in a major disaster involving public exposure to radiation and health and environmental effects. Commercialisation of electricity production has increased dangers because now production often goes before safety. Three European incidents, all classified on the INES scale as Level 3 accidents, are described here.

In the spring of 2003 one of the four Russian designed VVER 440-213 at **Paks, Hungary**, was taken offline for its annual refueling and maintenance period. Parts of the fuel elements were to be cleaned with a new system, hired from Framatome

ANP (a joint venture of French ArevaNP and German Siemens which is now trying to building the new European nuclear reactor in Finland). At one moment during this operation, radioactive gas discharges were detected as coming from the cleaning system. The discharges were probably due to insufficient cooling of the 30 highly radioactive fuel elements inside the system. This brought the cooling water in the cleansing tank to boil, then boiled away all the water, heated up to 1200 degrees Celsius, and finally the tank crumbled like porcelain as the operators, in an attempt to avoid disaster, unleashed a torrent of cold water over the fuel elements. According to reactor physicists, a nuclear explosion, i.e. a limited but uncontrolled chain reaction, could have occurred. Radioactive gas flowed into the reactor room, from which the operators had fled in panic. The gas was later blown unfiltered into the outside air at full ventilator strength for 14 hours to make the room accessible for personnel in radiation protection gear.

The incident was initially classified at level 2 ("incident") of the International Nuclear Event Scale (INES), but later reclassified to level 3 ("serious incident"). The Hungarian Atomic Energy Agency initially hesitated to upgrade the incident's classification to level 3 because it feared that such a rating could cause unwarranted public "excitement". After the incident a number of violations of the safety culture were identified, including improper management of cleaning works and lack of proper training of personnel operating the cleaning.

In April 2005 a leak was detected in the **THORP reprocessing plant at Sellafield, UK**. The leak was caused by a broken pipe at a point where the pipe work feeds into one of two accountancy tanks. Then in-cell cameras pinpointed the source and extent of the leak. According to the owner of the plant 83 m<sup>3</sup> of dissolved reactor fuel and nitric acid including some 160 kg of plutonium leaked on the floor undetected from July 2004 to April 2005.

The THORP reprocessing plant was commissioned in 1994 and was expected to operate for at least 25 years. THORP has contracts to reprocess spent fuel from the UK, Japan, Germany, Switzerland, Sweden, Spain, Italy and



the Netherlands which is brought in by ships and trains. THORP is failing to meet these contracts. In April 2005, THORP had reprocessed 5729 tonnes of fuel out of the 7000 tonnes, which should have been completed by 2004.

The 'repair' of THORP involves bypassing the damaged pipe work and its associated accountancy tank and using the second tank and pipe system instead. The inability to physically check the second system because of the dangerously high radiation levels within the cell will make it impossible to guarantee that this alternative 'route' is safe and fit for use. It is doubtful that the repair will fully satisfy safeguards required by Euratom inspectors.

Plant owner BNG (British Nuclear Group) estimates radioactivity levels in the liquid to be around 100,000 TBq (Chernobyl released 89,000 TBq) though some believe this to be a highly conservative figure. BNG was fined £500,000 (€ 750,000) for the accident. THORP faces yet another crisis in the form of who will be paying the conservatively estimated £50 million (€ 75 million) costs of the leak accident. Reprocessing customers from Germany are seeking to prevent being charged for the costs of the THORP accident. THORP owner NDA (Nuclear Decommissioning Authority) is also claiming costs from its insurers for the breach of contracts due to the accident costs.

In July 2006 a short circuit occurred during repair works on an interlocking station adjacent to **Sweden's Forsmark-1** nuclear reactor. In former times it was standard precaution to take the nuclear plant off line during such repair works but that was before commercialisation. Taking a reactor off line means loss of production and so loss of income.

The short circuit led to a blackout in the nuclear reactor's control room. The automatic shutdown system of the reactor that should bring activity back to the minimum necessary for its own mainte-

nance, failed to operate. The automatic emergency power system failed to start operating because it was interconnected with the blackout line.

For 23 minutes no one in the control room could be sure what was happening in the reactor. The decision was taken to evacuate all personnel who did not absolutely have to remain on duty. However, no evacuation took place -- for the simple reason that the name system was blacked out too. Eventually, an engineer from Forsmark-2 managed manually to get diesel-supported generators to kick in.

According to a former safety chief at Forsmark, the reactor came close to a meltdown and it was sheer luck that saved the day. According to him, the safety culture in the Swedish nuclear industry is poor, and many nuclear plants no longer have design-competent personnel. All too much is left to trial and error. An internal report on safety at Forsmark that was leaked to investigative journalists supports this opinion. The analysis included examples of known installation errors, diesel failures, workplace hazards, and alcohol and drug abuse incidents at the plant. Many faults and malfunctions are recorded in the minutes of production meetings, but few are communicated upward along the chain of command. Nor are such events reported to the regulatory authority. After the accident, twin reactor Forsmark-2 and two other nuclear reactors were taken off line just in case they have the same faulty installation.

**INES scales do not tell everything.** The Forsmark accident was rated at 2 on the INES scale. That rating is accurate as no radioactive emissions occurred and no functions were permanently damaged. But the INES scale says nothing about the risks involved, about the severity of what might have happened. No one can say just how close Forsmark came to a meltdown and explosion comparable to the magnitude of Chernobyl. The only thing everyone can agree on that it was entirely too close.

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# 5

# Nuclear power means nucl



The U.S. DOE Pantex plant Amarillo Texas, The United States Nuclear Weapons Facility.

**Nuclear energy is the civilian spin-off from the early days of nuclear weapons. A major reason for opposing a nuclear renaissance is that it considerably increases the risk of nuclear proliferation. The two most vulnerable steps in the civilian nuclear chain with regard to nuclear proliferation are uranium enrichment and the reprocessing of spent nuclear fuel.**

In line with the **Nuclear Non-Proliferation Treaty (NPT)** that encourages countries to develop nuclear capacity for civilian purposes, Iran is developing a programme for a complete nuclear fuel cycle. It has essentially completed a civilian nuclear power reactor at Bushehr. Russia will provide the fuel for the reactor and will take back the spent fuel for storage and possibly reprocessing. Iran also operates four small research reactors, three supplied by China and one supplied by the USA. Two other facilities are suspected of being part of a nuclear-weapon programme: a factory located near the town of Arak and two enrichment plants under construction at Natanz.

**Enrichment of uranium** is a so-called dual-purpose process: it can be used to produce low-enriched uranium for use in nuclear reactors

and/or highly enriched uranium used in atomic weapons. The plant in Iran can be used for the production of nuclear weapons. As can enrichment facilities in Brazil, China, France, Germany, Japan, the Netherlands, Russia, the United Kingdom and the United States. In 1983 military experts already called for a moratorium on building new enrichment facilities. At that time only three commercial-scale enrichments plants existed, all owned by the German/British/Dutch consortium Urenco. In 2006, general director of the IAEA (International Atomic Energy Agency) Mohamed ElBaradei again called for a –temporary- moratorium (for example, for 5 or 10 years) for new uranium enrichment and plutonium reprocessing facilities – but only for countries that do not currently have such technologies. This would include a new Iranian facility, but exclude the plans of Louisiana Energy Services,



which is seeking a licence to build an uranium enrichment plant in New Mexico, USA. The call for this selective moratorium comes from the same ElBaradei who in a February 2007 speech at the London School of Economics said: "How do they expect this system of haves and have-nots to be sustainable? How do I go to country X and say 'you should keep your obligation not to develop nuclear weapons', when the big powers are making no progress towards their obligations (in the NPT) for disarmament?"

**Reprocessing plants** cannot be safeguarded effectively. Safeguarding the plutonium in spent nuclear reactor fuel elements before reprocessing is relatively simple. For many years, the elements are so hot and radioactive that they are self-protecting because they must be handled with remote equipment. However, once the plutonium is removed from spent reactor fuel elements in a reprocessing plant, safeguarding it is quite a different matter. Safeguarding agencies claim that a commercial plutonium reprocessing plant can be safeguarded with an effectiveness of about 99%. This means that, even with the most optimistic assessments, at least 1% of the plutonium will be unaccounted for. In Britain's Sellafield reprocessing plant THORP for example large quantities of plutonium were unaccounted for over the last years. In 1999 24.9 kg plutonium went missing, in 2001 it was 5.6 kg plutonium and in 2005 as much as 30 kilo plutonium could not be accounted for. According to the owners of the plant the figures were estimates and "gave no rise to concern over either safety or security". But according to independent experts, the loss of enough plutonium for 7 to 8 nuclear bombs is a very serious shortfall. If there is an accounting collapse with the most poisonous product mankind can produce, there is reason for serious concern.

A nuclear power plant also produces plutonium in its normal electricity generating process. It is

generally recognised that nuclear weapons can be made from reactor-grade plutonium, although those made using weapon-grade plutonium are somewhat more effective. Only 6 kg of plutonium is enough to build a simple nuclear weapon.

In 1995 the IAEA established an **Illicit Trafficking Database** to facilitate exchange of authoritative information related to trafficking in radioactive materials. The preliminary 2006 IAEA Illicit Trafficking Database reports 85 incidents involving theft or loss of nuclear or other radioactive materials, mainly radioactive sources. In about 75% of the cases, the materials lost or stolen had not been recovered at the time of reporting. Fifteen more incidents involved the seizure of nuclear and radioactive materials from individuals who possessed them illegally, some of them attempting to sell them or smuggle them across borders.

Activists bicycle tour against nuclear weapons, Belgium, August 2006, FoE Flanders.



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## ⑥ Nuclear power emits CO<sub>2</sub>



Steam from cooling towers of Three Mile Island NPP in Harrisburg, USA

The advantage of nuclear power plants from a climate perspective is that they **do not emit CO<sub>2</sub> directly**. However, the nuclear system is the most complex and extensive of all energy systems (see p.2). It includes ore mining and processing, enrichment of uranium, fuel fabrication etc., the so-called upstream fuel-cycle, and downstream (post-plant) activities that are needed to process and store nuclear waste. Because these are complex processes dealing with highly dangerous radioactive material, lots of facilities and equipment (e.g. robots to demolish decommissioned power plants) are needed. Furthermore, steel, concrete and other materials are necessary for the construction for both the nuclear power plant and the facilities in the up- and downstream of the nuclear fuel system. The energy used for these activities partly comes from fossil fuels, which causes greenhouse gas emissions.

In a **life-cycle analysis** the greenhouse gas emissions and other environmental impacts of different types of energy production can be calculated and compared. International studies carrying out life-cycle analyses for nuclear energy find emissions of greenhouse gases in a range between 30 and 40 up to 120 grams of CO<sub>2</sub> per kWh of generated nuclear electricity. The higher figure is based on the expectation that the ore grade of uranium will fall rapidly. This means that more energy will be needed

to mine usable amounts of uranium. As high-grade uranium stocks decrease, the CO<sub>2</sub> related to mining uranium will increase. Assuming that global generation capacity remains at 2006 levels, after 2016 the ore grade of uranium will fall significantly from today's levels and after 2070 nuclear energy will fall from the 'energy cliff' meaning that the nuclear system will consume more energy than it will be able to produce. This effect will occur earlier if the global generation capacity of nuclear power is extended.

Nuclear power **only uses the electricity** it generates, the produced heat is wasted. Co-generation systems producing both electricity and heat are much more favourable in reducing emissions than nuclear energy.

If we want to maximise the reduction of greenhouse gas emissions, we must reduce cost-effectively. A fair comparison of the costs of greenhouse gas abatement ('avoiding') using nuclear energy with the abatement costs of alternative power generation options must be based on life-cycle emission analyses. Figures from the German Öko-Institute show that the greenhouse gas abatement costs of electricity efficiency options and of biogas cogeneration are below those of nuclear energy, while wind (offshore) is in the same order of abatement costs.

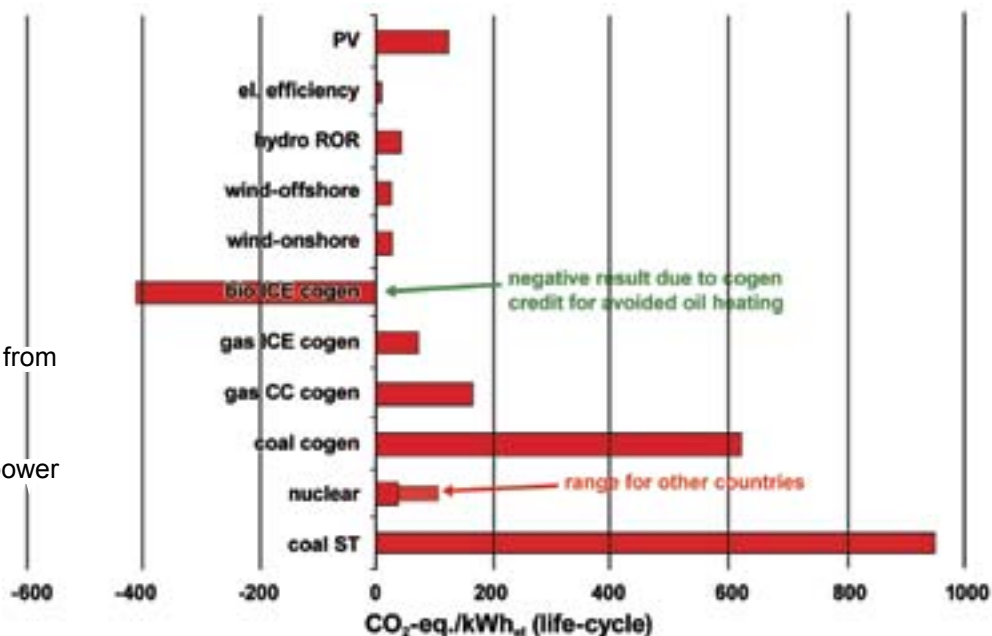
**Imagine** we start building new nuclear power plants because a nuclear power plant emits less CO<sub>2</sub> that a coal-fired plant. To reduce emissions we will need many more plants than the present worldwide number of 435 plants that account for 16% of electricity production. At the same time, in the next 20 years many of the present 435 nuclear power plants will be closed because they are past their lifetime or

have technical problems. Until now, the average lifetime of closed reactors is 22 years. In an optimistic scenario which assumes a 40 year lifetime for existing plants, we would need to build 80 new plants in 10 years to keep global nuclear production at present levels. If we want to keep production at present levels, in 20 years we would need another 200 plants to be built and connected to the grid in 2025. On average building a nuclear power plant takes 10 years and costs about 3 billion euros. Its lifetime is expected to be 40 to 60 years. So, even if we start building tomorrow and we manage to build 280 new plants in the next 20 years, we will still have only replaced the present nuclear capacity and not replaced a single coal-fired plant. In addition, we will have spent an absurd amount of money for only a small part of a temporary solution to the climate change problem. We will have caused many new environmental and security problems. In other words, we can secure the supply of energy and fight climate change much more cheaply by investing in energy savings and renewable energy instead of new nuclear power.

**Figure:**

Life-cycle greenhouse gas emissions from electricity generation in Germany..

- PV** = Photo-Voltaic solar energy
- Hydro ROR** = Run-Of-River Hydro-power
- ICE** = Internal Combustion Engine
- CC** = Combined-Cycle
- cogen** = co-generation (combined electricity and heat)
- ST** = Steam Turbine



**Sources:**

- Jan Willem Storm van Leeuwen *Energy security and uranium reserves* Oxford Research Group 2006
- Jan Willem Storm van Leeuwen *Nuclear power: energy security and global warming*
- A physical view Ceedata Consultancy 2005
- Uwe R. Fritsche, *Sui-San Lim Comparison of greenhouse-gas emissions and abatement cost of nuclear and alternative energy options from a life-cycle perspective (updated version)* Öko-Institute 2006
- Atomkraft: Ein teurer Irrweg. *Die Mythen der Atomwirtschaft* Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU) March 2006

## Sometimes, it is important to restate the obvious.

Why is smoking bad for you?

**Because it causes cancer.**

Why is it not a good idea to drive drunk?

**Because it can lead to serious accidents.**

Why should we get rid of nuclear power?

**Because it is dangerous, expensive, dirty and not helpful.**

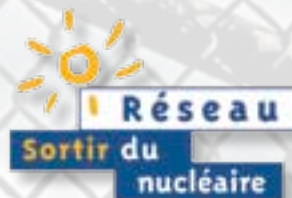


In this booklet, we restate the obvious by listing many hard, recent and Europe-related facts and figures on the failures and dangers of nuclear power. All information comes from renowned and/or independent sources. We look at:

- the impossibilities of permanent storage of nuclear waste
- the financial and technical problems of building new nuclear plants
- the impacts of uranium mining
- the serious nuclear accidents that have taken place recently
- the dangers of proliferation
- the data that show that nuclear power does not help to save the climate.

To us, these facts lead to one obvious conclusion:

**Nuclear power has no future.**



### European Petition Campaign against Nuclear Power

**atomstopp** – [atomstopp.at](http://atomstopp.at)

**Friends of the Earth Europe** – [foeeurope.org](http://foeeurope.org)

**GLOBAL2000** – [global2000.at](http://global2000.at)

**Réseau Sortir du Nucléaire** – [sortirdunucleaire.org](http://sortirdunucleaire.org)

**WISE - World Information Service on Energy** – [www.antenna.nl/wise](http://www.antenna.nl/wise)

**Women against Nuclear Power**

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This booklet was made by Wendela de Vries, Peer de Rijk & Frank van Schaik

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