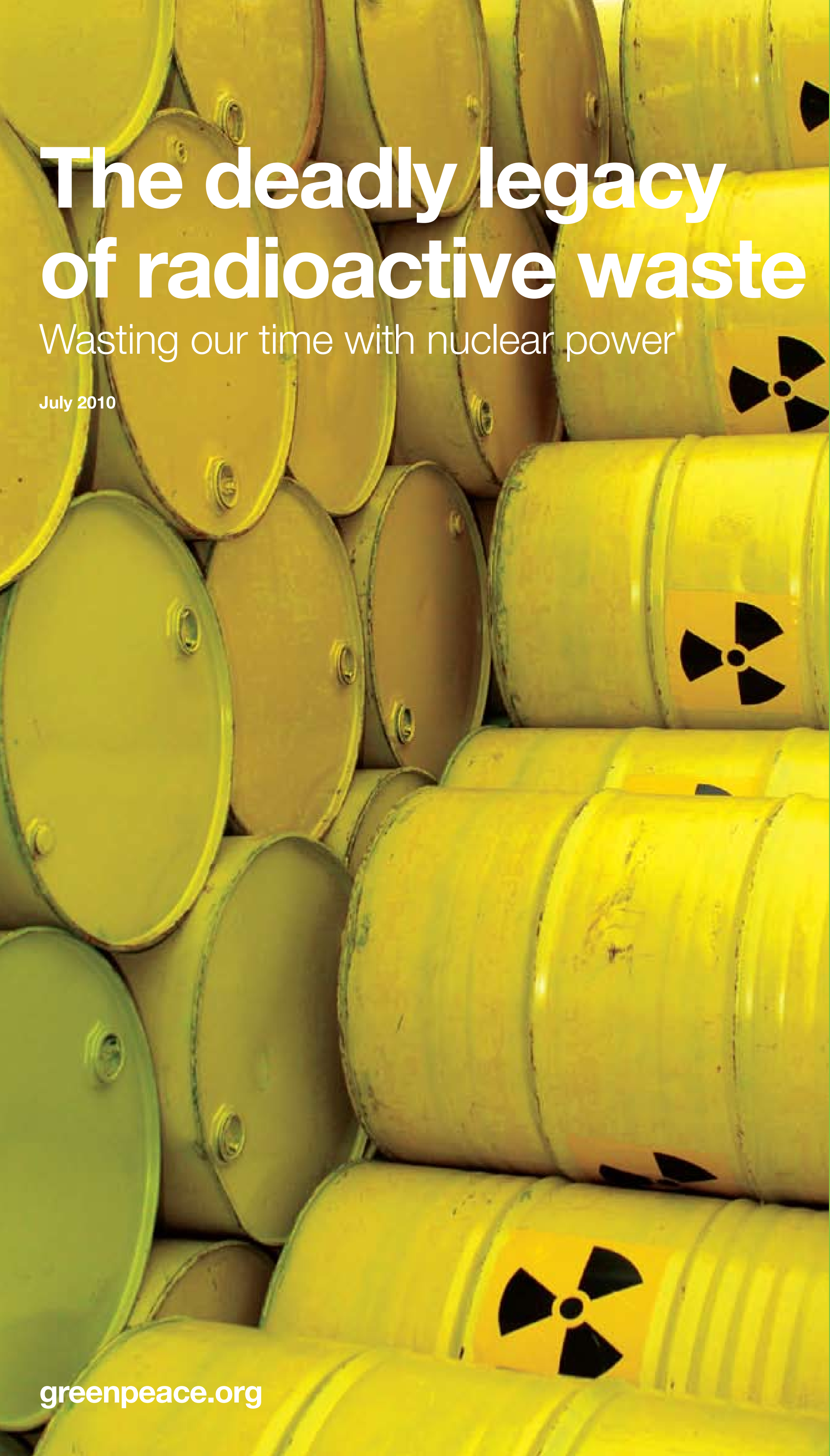
The deadly legacy of radioactive waste

Wasting our time with nuclear power

July 2010



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Catalysing an energy revolution

Image June 1982: Greenpeace action protesting at the dumping of nuclear waste in the Atlantic by the dumpship Rijnborg. Two barrels are dropped on top of a Greenpeace inflatable, causing it to capsize.

Introduction

Would you drive a car if it had no brakes? Probably not. Yet, for the last 50 years, the nuclear industry has driven nuclear power with no concern for the safety of its deadly by-product: nuclear waste.

This briefing illustrates why - for now, and for the coming hundreds of thousands of years - the nuclear waste problem is here to stay and why we should stop wasting our time with nuclear power. It summarises some of the failed ‘solutions’ for radioactive waste over the last 50 years, and illustrates the problems of the current proposals for nuclear waste storage.

For over 50 years the nuclear industry has produced large volumes of hazardous radioactive waste along the whole nuclear chain - from uranium mining and enrichment to reactor operation, waste reprocessing and decommissioning. Today, nuclear energy is being sold to politicians and consumers as one of the options for fighting climate change that will also deliver energy security. However, nuclear energy is a dangerous obstacle on the road to a clean energy future.[1] On top of other substantial problems related to safety and costs, nuclear waste remains a major flaw of nuclear energy.

The International Atomic Energy Agency (IAEA) estimates that the industry annually produces 1 million barrels (200,000 m^3) of what it considers ‘low and intermediate-level waste’ and about 50,000 barrels (10,000 m^3) of the even more dangerous ‘high-level waste’.[2] These numbers do not include spent nuclear fuel, which is also high-level waste.

It takes 240,000 years for radioactive plutonium to decay to a level that is safe for human exposure, which is an even longer period than modern humans have been on the Earth (200,000 years). There is no way to guarantee that these substances can be kept safe for this amount of time. It is senseless to allow the nuclear industry to continue producing more nuclear waste.

‘If a problem is too difficult to solve, one cannot claim that it is solved by pointing to all the efforts made to solve it’

HANES ALFVEN, Energy and Environment, Bulletin of Atomic Scientists, *May 1972* (quoted in the Royal Commission on Environmental Pollution - Nuclear Power and the Environment - Sept 1976)

Failed solutions

Billions of euros have been spent over the past half-century on finding a solution to the nuclear waste problem. The attempts have all been unsuccessful.

Russia, USA, France, UK, Netherlands, Japan and others Waste dumping at sea banned

For years, low level radioactive waste was dumped at sea, ‘out of sight and out of mind’. Disintegrating barrels brought the waste back into the environment and dangerous substances accumulated in the bodies of animals. After 15 years of campaigning by Greenpeace, an international treaty was signed in 1993 banning all dumping of radioactive waste at sea.

Germany Water floods waste dump in salt layers

In Asse, Germany, an experimental radioactive waste dump was set up in the 1960s in salt formations deep underground. A few years ago it was discovered that it had started leaking water in 1988 and is currently flooding with 12,000 litres of water each day. As a result, all 126,000 barrels of waste already placed in the dump now need to be cleared out. Asse was envisaged as a pilot project for a final storage solution in the salt layers under Gorleben, but there is now serious doubt in Germany about the viability of salt layers as storage for nuclear waste.

France Waste inventory unknown

One of the largest nuclear dumps in the world, the Centre de Stockage de La Manche (CSM) in northern France was opened in 1969 to store low-level waste. It was closed in 1994. It currently stores 520,000 m^3 of radioactive materials from waste reprocessing and French nuclear reactors. A 1996 commission set up by the French government concluded that the site also contained long-living waste and high-level waste, and that the true inventory was effectively unknown. In 2006 it was found that contaminated water from the site had already been leaking into an underground aquifer, threatening the surrounding agricultural land.

USA Seismic fault line compromises bedrock storage

In 1987, Yucca Mountain - about 80 miles north of Las Vegas - was designated as the site for long-term disposal of radioactive wastes in the United States. However, the US Geological Survey has found a seismic fault line under the site and there are serious doubts about the long-term movements of underground water that can transport deadly contamination into the environment. As a result of these problems and billions of dollars in cost overruns, the US government stopped funding the project in early 2010.

Image March 2010: Greenpeace activists in Moscow place barrels marked with the nuclear symbol and chain themselves in front of the French embassy. Greenpeace is protesting against nuclear waste being imported to Russia from France.

New research brings new challenges

Forsmark, Sweden – Olkiluoto, Finland: copper corrosion

Sweden plans to pack waste in cast iron inserts in copper canisters and place them in holes bored in tunnel floors, deep underground (400-500 metres), surrounded by bentonite clay. Water is expected to make the bentonite clay expand so that it fills the cavities in the surrounding granite rock which would reduce groundwater movement.

Finland adopted the same system and Switzerland and the UK are considering this option. But there are already major concerns. The copper canisters were expected to survive corrosion for at least 100,000 years but recent research shows that they can fail in just 1,000 years or less[3]. There are also concerns about the build-up of hydrogen produced as a result of corrosion. High temperatures from the canisters could also affect the clay buffer, while groundwater flows could bring contaminants from any compromised containers into the biosphere. Furthermore, Nordic countries will face at least one Ice Age in the coming 100,000 years[4], entailing extremely violent earthquakes, penetration of permafrost to the disposal depth and below, potential intrusion of water and unpredictable changes in groundwater flows.

Bure, France – Dessel, Belgium: uncertainties of clay as a natural barrier

Unlike Sweden and Finland, which rely on man-made barriers to prevent leakage, France and Belgium are exploring clay as a natural barrier. The waste is to be contained in simple stainless steel canisters, which can corrode much faster than the Swedish copper ones. Hence the French/Belgium concept relies on the natural clay formation to contain radioactivity. The crucial question is whether it can be guaranteed – for hundreds of thousands of years – that no cracks or channels will form in the clay layers, which would cause water to leak in and out again, poisoning nearby aquifers.

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New reactors create superwaste

The EPR: spent fuel 7 times more hazardous

Nuclear waste research has so far focused on waste produced by existing reactors. However, the nuclear industry is pushing new, so-called 'Generation III' designs, which are designed to use nuclear fuel more efficiently. The amount of dangerous materials in spent nuclear fuel significantly increases with the time the fuel stays in the reactor. Consequently, the spent fuel becomes more hazardous as more energy is extracted from the fuel. This so-called high burn-up of fuel should increase electricity output for a certain amount of fuel, and hence the economic profit for the operators.

Recent studies show that spent nuclear fuel from the European Pressurised Reactor (EPR), a French design currently under construction in Finland, France and China, will be up to seven times more hazardous per unit of electric output, because of drastic increases in the amount of easily released, dangerous and long-living radioactive isotopes such as iodine-129[5] than that produced by existing nuclear reactors[6]. The spent fuel also becomes hotter, more brittle and more likely to lose integrity in accident situations or in storage. This means that not only will waste produced by the EPR be more dangerous to health, but also the technical demands, risks, costs of storage and disposal will be far more challenging, likely increasing the overall cost of nuclear waste disposal.

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Image Mayak, in Russia's Ural Mountains, is the largest nuclear complex in the world. Accidental or deliberate releases of radioactive material have exposed around 272,000 people in the surrounding areas to high levels of radiation. Thousands have died, and many more live with its debilitating legacy.

The human risk of storage

Human interference

Once placed into final storage, nuclear waste also needs to be monitored and secured from human interference as well as natural events. Stored civilian and military nuclear waste, such as plutonium or uranium, are sources of radioactive material that can be used for the production of nuclear bombs. A few kilograms of these substances would be sufficient to make bombs similar to the ones used on Japan during World War II. Even a very modest amount of radioactive material from waste storage sites would be sufficient to make a 'dirty bomb', which could contaminate an entire city. To deal with the problem, the nuclear industry proposes, at the very best, to guard storage sites for 300 years. But there is no proposal to ensure security for the other 239,700 years.

Dump site selection

Several countries have attempted to find a suitable location for waste disposal. However, science is often not the decisive criteria – usually, sites with low local resistance are preferred over those with best geological conditions. With few exceptions, sites right next to an existing nuclear plant are chosen.

In Finland, more than 100 locations were found to be potentially suitable. However, public opposition in those locations made the authorities change the criteria for site selection from 'best available' to 'good enough', allowing for inclusion of Loviisa and Olkiluoto. These towns already host nuclear power stations and resistance against a nuclear waste storage was relatively low. The final site choice was for Olkiluoto – conveniently on the same peninsula that also hosts a low-level waste storage, two nuclear power stations and a third one under construction.

Interim storage: leakage and terrorist risk

Some countries, like the Netherlands, have set up interim storage for 100 years to safeguard the dangerous waste for a definite period of time. In the meantime, leakages and accidents need to be prevented. The large amounts of highly radioactive waste in storage could lead to massive contamination in the event of failure of the containers or the buildings themselves, either through deterioration or due to external events such as natural disasters (earthquakes, flooding) or malevolent acts. While the nuclear waste debate focuses on final storage, most spent nuclear fuel remains in poorly safeguarded interim storage for decades to come; addressing the flaws in intermediate storage should be the first priority.

Reprocessing – the myth of a nuclear 'cycle'

The nuclear industry talks about the 'nuclear fuel cycle' and claims that, after use, nuclear fuel is recycled. In reprocessing facilities, the plutonium and unused uranium are separated out from other waste with the intention to reuse it in nuclear plants. In reality, the term 'reprocessing' or 'recycling' is misleading, since a lot of the recovered materials are not reused. For example, the UK now has a 100 tonne stockpile of separated plutonium. Thousands of tonnes of reprocessed uranium from France are exported to Russia, where 90% is stored without any further foreseen use. Reprocessing does not get rid of any of the radioactivity in the spent fuel - but the process does spread it about through discharges to the environment and through creating a larger volume of low, intermediate and high-level wastes.

Transport of nuclear waste

Nuclear waste, such as spent nuclear fuel, plutonium and other highly radioactive material, is transported all over the planet, often passing through large inhabited areas. These deadly convoys pose a serious risk to populations and ecosystems along the routes. If an accident were to occur, radioactivity could contaminate several square kilometres or more. The convoys are also at risk of terrorist attack. Nuclear transports are regularly met with huge protests because of the risks and the lack of a solution to deal with the dangerous waste. The annual transport of nuclear waste from France to Gorleben in Germany draws tens of thousands of demonstrators. Tonnes of plutonium resulting from reprocessing are also regularly shipped from France and the UK to Japan, crossing the territorial waters of many countries on the way, as well as important marine ecosystems. Depleted uranium from Europe has been transported to Russia, where thousands of barrels are dumped in large open-air storage sites in the Urals.

The cost of nuclear waste

Because it is as yet unclear how nuclear waste can be safely stored for the amount of time necessary, it is very difficult to make a full projection of costs. In many countries, nuclear energy companies are required to reserve money for waste processing and storage in the future. In several countries, however, these waste funds appear to be far too small and have in the past been used for new risky investments. When the UK privatised nuclear utility British Energy, the State had to spend £5.3 billion (€6.6 billion) of taxpayers' money to fill a hole in the company's reserves for decommissioning and waste. British Energy's fund would only cover a fraction of the total cost for decommissioning and waste for all 45 existing British nuclear reactors, so far estimated to be around £70 billion (€88 billion). It is likely that the cost for dealing with all of this will continue to rise.

Greenpeace demands

- **A nuclear phase-out:** In order to manage the existing nuclear waste crisis, we should first stop producing more waste and develop clean energy production and energy efficiency. There should be a ban on all new nuclear power reactors and an immediate end to all reprocessing.

- **Storage for existing radioactive waste** must use the best available technology to prevent radioactivity from leaking into the environment and to protect human health. Storage should be managed, monitored and retrievable for an indefinite time period into the future.

- **No export of nuclear waste:** Countries should be responsible for the safe management of the nuclear waste that they have created and transport of nuclear materials (including spent nuclear fuel) should be avoided.

- **Full transparency and public participation:** Some countries have chosen nuclear waste sites without consulting the local population and without exploring alternatives. All information relevant to decisions on the management of nuclear waste should be fully transparent and a full public consultation organised.

- **Radioactive material from decommissioned nuclear weapons** should be treated in order to minimise the possibility of it being used to make a ‘dirty’ or a nuclear bomb.

Footnotes

[1] In its ‘Energy [R]evolution’ scenario, Greenpeace shows that renewables (like wind, solar, biomass, geothermal, tidal and wave energy) and energy efficiency deliver faster, cheaper and cleaner solutions. Sven Teske, e.a., Energy [R]evolution – A Sustainable Global Energy Outlook, Amsterdam (2008), Greenpeace/EREC, *http://energyblueprint.info/*

[2] IAEA Factsheet: Managing Radioactive Waste, 1998, *www.iaea.org/Publications/Factsheets/English/manradwa.html*

[3] Hultquist, G. et al. (2009). Water Corrodes Copper. Catalysis Letters, Volume 132, Numbers 3-4. *http://dx.doi.org/10.1007/s10562-009-0113-x*

[4] Matti Saarnisto, Evaluation report on the Posiva report 2006-5 (2008), STUK (Finland’s nuclear regulating agency). Available on demand.

[5] The amount of iodine-129 instantly released, if and when the nuclear waste dump leaks, is 7 times as large in the case of the high burn-up waste produced by the EPR reactor, compared to typical currently operating reactors.

[6] Posiva 2008, Environmental Impact Assessment Report, page 137. *www.posiva.fi/files/519/Posiva_YVA_selostusraportti_en_lukittu.pdf*; Nagra (2004): Estimates of the Instant Release Fraction for UO2 and MOX Fuel at t=0. *www.nagra.ch/g3.cms/s_page/83220/s_name/shopproductdetail1/s_element/142590/s_level/10190/s_product/20408/searchkey/Instant%20Release%20Fraction*

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