Continued Nuclear Power Faces Problems

Globally, electricity production with nuclear power has remained at the same level for 20 years, while its share of global electricity output is the lowest in four decades. Some reactors have been shut down, but most continue to operate. Their average age is high – and rising. The oldest reactors in the world began operating in 1969. Continuing to operate the existing reactors is less costly, and less politically sensitive than building new ones. But the global trend of life-time extension (LTE) is creating a number of problems:

1) *Globally, the **risk of accidents** tends to increase.* The US is the leader in LTE, a policy that is also followed in Argentina, Armenia, Canada, India, Switzerland, the UK, Russia and several eastern European countries. The reactors were originally designed for 25 to 40 years of operation, in many cases 50 to 60 years ago. They would never be permitted today. Some design flaws can be corrected by retrofits, but not all.

   Reactors age. They are subject to erosion, corrosion and embrittlement, which can lead to cracks and failures in the cooling system. Inside the reactor vessel, the uranium fuel is incredibly radioactive. It must not escape, and the fuel must be kept cool at all times.

   In the Fukushima accident in 2011, three reactors exploded a few days after a tsunami knocked out backup power and hence cooling. Those reactors were about 40 years old.

   The Japanese safety authority could have prevented the accident but was not truly independent and was governed by the same ministry that was responsible for developing nuclear power. Overly tame authorities may also present a problem in other countries, such as the US and Sweden.

2) If an accident happens anywhere in the world, it affects nuclear power everywhere. Following the Fukushima accident, permits to restart reactors were not granted, and in 2013 not a single kWh was produced by Japanese nuclear power. While Japan has restarted some reactors, many reactors in Japan and other countries were closed for good. Germany and Taiwan decided to shut down all their reactors. Belgium has shut down at least 3 of its 7 reactors. Such events cannot be planned for.

3) Nuclear power causes *instability in the electricity supply grid.* The biggest threat to the stability of the grid comes from fast shutdowns (scrams) of nuclear reactors, especially the largest, which in Sweden are Oskarshamn 3, and in the Nordic countries Olkiluoto 3. In a scram the supply can be cut by 1400–1600 megawatts within a second. The supply frequency then drops noticeably hundreds of kilometres away. In the worst case it can lead to grid collapse, which is rare but did happen in 1983 and 2003 in Sweden, when nuclear power was largely responsible for both triggering the collapse and delaying the restoration of supplies.

   Wind power fluctuates, but it never switches suddenly from full power to zero.

   Unplanned shutdowns of reactors over long periods of time – months or years – are quite common. In the event of simultaneous failure of several reactors of the same design (generic faults), it can affect the electricity supply of an entire country, as in France in 2022.

4) Nuclear power is *highly vulnerable in time of war,* in the event of a drone attack or if the enemy uses terrorists. Terrorists can strike even if a country is not at war. Wind power is also vulnerable to attack, but it will not have the same consequences.

5) *Lifetime extensions require more uranium,* which is often mined in ways that are harmful to the environment, to workers and to indigenous peoples. Geopolitically, Russia has influence over countries that contribute more than half of global uranium mining.[1]

6) LTE produces *more waste.* This must be stored safely for hundreds of thousands of years. Plutonium 239 has a half-life of 24,400 years, and there are some elements in the waste that are longer-lived and more that are intensely radioactive.

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1 Russia, Kazakhstan, Uzbekistan, Niger.

7) A high proportion of nuclear power and looming uranium shortages will favour new reactor technologies that use more enriched fuels or plutonium fuel obtained by reprocessing. Both increase the risk of nuclear weapon proliferation, including the theft of plutonium by terrorists. This applies to fast neutron reactors cooled by liquid metal, such as the Blykalla reactor. Such reactors use plutonium as fuel and require reprocessing facilities where plutonium is extracted from spent nuclear fuel by cutting it up and then dissolving it in boiling nitric acid. Once separated, the plutonium can be used for nuclear bombs.

8) LTE involves an active decision, which requires planning. Plans often cover a period of 10 or 20 years and need hundreds of millions of Euros in investment. The Grand Carénage extension of 32 French reactors is estimated at €66 billion[2], or more than €2B per reactor. A 20-year extension of Sizewell B in the UK is estimated at £500–700 million[3]. Extending the lifetime may in practice be more expensive as additional problems are often found, especially for boiling water reactors which are an obsolete design and pose radiation challenges.

Once started, such investments lead to a lock-in effect and strong vested interests to carry on.

9) If society continues to invest in nuclear power, it will be at the *cost of investments in energy efficiency, renewable energy and other climate technologies* such as alternative cement and electric transport.

10) Investments in lifetime extensions may be loss-making. The total cost of **new solar and wind** electricity is **already lower** than the cost of **continued nuclear** generation in many cases.[4] Uranium will become more expensive for geopolitical reasons. Fuel production will become more expensive due to future requirements for more accident-tolerant fuel. Waste management will be more expensive. Maintenance may become more expensive as reactors age. At the same time, competitors such as solar, wind and energy-saving measures are becoming cheaper.

One spectacular failure was the investment of about €1 billion in LTE at Oskarshamn-2 in Sweden. When completed in 2016, the reactor was not seen as fit or profitable to restart, so it was permanently shut down and the investment written off[5].

11) Politically and strategically, it is a relatively easy option *to **say no to new nuclear power*** while **saying *little about existing reactors***. But it is not a responsible path. *Old nuclear plants are **more dangerous** than new,* and more dangerous every year, and it has all the other drawbacks of nuclear power. Existing nuclear power also leaves the door open for a future commitment to new nuclear power. The Netherlands has just one reactor, Borssele, which is more than 50 years old. Since 2009, there has been a campaign to build a new reactor, Borssele 2. The above-mentioned trial of fourth-generation nuclear power is under way at the Oskarshamn nuclear power plant. It is very far from a real nuclear reactor, but there are similar "ghost reactor projects", which are either not real nuclear reactors or do not have real final investment decisions in place or even final design plans in many countries. They are there to pave the way for political and technological continuity of nuclear power. Such new reactor projects, however few of them will be realised, are a complement to lifetime extensions of existing reactors. Without extensions, nuclear power will die. Without new projects, extensions are pointless.

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[2] https://www.francetvinfo.fr/replay-radio/le-mot-de-l-eco/66-milliards-d-euros-le-vaste-chantier-d-edf-pour-moderniser le-parc-nucleaire-francais_5730758.html

[3] https://www.bbc.com/news/uk-england-suffolk-61023039

[4] In Sweden, the cost of operating reactors in recent years has been 22.5–40 öre/kWh, the same range as onshore wind power. For the US see Lazard 2024 https://www.lazard.com/research-insights/levelized-cost-of-energyplus/ page 14.

[5] https://www.nyteknik.se/nyheter/omstart-av-oskarshamn-1-och-2-stoppas/844552 https://www.okg.se/oskarshamn-2