Review of the Estonian Green Movement on the Risks of Nuclear Power

A group of local enthusiasts is promoting the idea of building a nuclear power plant somewhere on the Estonian seashore. Seeking for support, the enthusiasts of nuclear energy (1) speak about atomic power plants as a clean and safe way to produce energy, and as a possible solution for fighting climate change. The environmental association Estonian Green Movement presented a broader picture in its initial survey, where it pointed out various facts and examples from all over the world that demonstrate the risks and questions that arise around nuclear energy. We decided to concentrate on five serious problems of nuclear energy: nuclear waste, safety, technology readiness, the burden on public finances and the time-critical nature of the climate crisis.

1) Ultra-dangerous nuclear waste

The production of nuclear energy inevitably causes radioactive waste, a significant part of which, remains extremely dangerous for thousands of years due to its high radioactivity. Being life-threatening, nuclear waste requires very reliable storage for hundreds or thousands of years, which is inevitably costly. Unfortunately, nowadays there is not a single working solution for long-term storage in the whole world, even though nuclear waste has been produced for already 50 years.

To date, waste is mostly stored in temporary storage sites in nuclear power plant areas which are subject to a risk of leakage and terrorist attacks (2). Leaks of temporary stored nuclear waste have taken place, for instance, in the Marshall Islands (3), moreover, problems occur even in Germany, a country that has a rich and long-standing experience in nuclear energy. In the USA, the country that produces the most nuclear energy, the lack of final storage facilities is also a big problem (4). The Yucca Mountains are the only geologically suitable site for final storage, but for over 30 years it has not been possible to build a storage facility there due to the lack of interest and money (5).

Finland is one of the few countries that has been working for a long time to find a geological disposal facility for hazardous nuclear waste. However, the task is difficult. The search for the planned storage site began already in 1983, the construction started in 2004 and the site Is still not ready (2; 6). For Estonia, constructing such a site would be extremely expensive. One of the options for storing waste produced by a hypothetical Estonian nuclear power plant is to use the, not ready yet, Finnish final storage "Onkalo", where the waste would be buried into granite (7). However, this solution is impossible because according to the Finnish law, foreign nuclear waste cannot be either stored or processed on Finland's territory (34). Even if a Finnish storage site existed, its operators agreed to accept Estonian nuclear waste and the laws allowed it, the super-hazardous waste would have to be transported through the Gulf of Finland. Even in the case of a hypothetical final storage facility in Finland or in any other foreign country (8), the spent nuclear waste would first still need to be cooled down for many years on the site of a nuclear power plant before it could be transported.

Moreover, the small modular nuclear reactors that are advertised by Estonian nuclear enthusiasts but are not actually in the development stage (i.e. not in commercial use), would use the exact same fuel that is used for existing large nuclear power plants (9). Many modular nuclear power plants that are under development would simply be smaller and therefor use less fuel per reactor (2). However, the composition and the radioactivity of the nuclear waste would still be the same, no matter the size of the plant. One modular nuclear power plant would produce approximately 20 tons of nuclear waste per year (10). If instead of one big "ordinary" reactor, were installed a couple of small ones, the difference in the absolute amount of waste generated would not be very large.

Moreover, building modular nuclear power plants near "ordinary" ones or instead of "ordinary" ones, would not reduce the size of the final storage facility and the level of radiation associated with the fuel. Most likely, modular nuclear power plants have the tendency to use relatively high concentrations of nuclear fuel made from fissile material (for e.g. uranium and plutonium), which can lead to a reactivation of a nuclear reaction at the final storage site.

On paper there are also newer ones, the so-called nuclear power plants of the 4th generation, which in theory would utilize already used fuel as fuel (7), which means that they would not make the situation with nuclear waste even worse. Such nuclear reactors are in the initial phase of development now. It will be possible (if at all) to see them in reality in decades. Based on power plants that have not yet been used and have not been tested in commercial use, it makes no sense at all to discuss the economy and safety of nuclear energy-neither in Estonia nor elsewhere. It is also wrong to say that the production of high-risk nuclear waste is a clean way of producing energy.

2) Safety issues

In addition to the unavoidable generation of hazardous radioactive waste, one of the major risks associated with nuclear energy is that accidents cannot be avoided in the long term (this applies to all forms of energy production).

Risk studies unambiguously show that large and complex technological systems (a nuclear power plant is one specific example) are not infallible and cannot be infallible (12). The risk of serious accidents increases together with the more frequent extreme weather conditions, that are due to climate change, that is why all risks tied to nuclear power plants increase, as well as the possibility that we will not be able to rely on nuclear power anymore one day. This also reduces the reliability of nuclear energy as a guarantee of a secure energy supply.

In the case of nuclear energy, even low-risk accidents involve high costs. For instance, a turbine might break down without causing major disruption to its immediate surroundings, but a nuclear disaster may make large areas uninhabitable for a long time. What is important here is not the probability of a worst-case scenario but the ability of the society to cope with the consequences of such a scenario. The problems become especially serious when for e.g. water sources are being contaminated. A nuclear power plant constructor must be responsible not only for the health and the belongings of the local population, but also for the local flora, fauna, ground, and water of a whole region, that can potentially become victim of radiation. For instance, the Fukushima catastrophe in 2011 entailed the evacuation of 150 000 people, among them, 40 000 have not been able to move back home even after 10 years (13).

In Estonia, nuclear enthusiasts have compared the amount of yearly radiation that one gets living near an operating nuclear power plant with the amount of radiation one is exposed to eating a simple banana (14). However, this comparison is not appropriate because the radiation dose that one gets eating food does not remain in the body, whereas the radiation received from a nuclear power plant might stay in the body, for example in the thyroid, provoking risks for the health (15).

3) Technological threats

A nuclear power plant requires large investments to be launched and to be kept operational, and in the interest of giving back the investments, the life of the plant should be at least of 40-50 years. The energy market is currently evolving and changing rapidly, with the advantage of flexible and distributed solutions over a central "big station", regardless of the "big" technology. Large investment in a technology that requires a very long payback period create a dependence on this technology, the so-called “track dependence”. This phenomenon occurs when a specific technology (that is applied for example for the extraction and use of oil shale) may no longer be economically or environmentally viable. At the same time, existing technologies and social structures still require investment and maintenance of life, and as a result, technology is seen as “impossible to set aside”. Which means that the government may be put under great pressure to keep the industry alive at all costs. This situation is profitable for companies operating in the sector. In the same way, at its time, the oil shale industry resulted from the enthusiasm of individual Soviet scientists, although it was clear already back then, that it was a low value source of energy (16; 17).

All of this illustrates that if the government agrees to use nuclear energy, then it must take into account the technology and its effects “for a very, very, very long time” (18). In comparison, when the market changes, it is possible, for example, to dismantle a park of wind turbines or of solar panels, it is also possible to reuse certain components and store some of their parts without creating additional costs and problems for centuries ahead.

As already mentioned, new modular nuclear reactors can seem to be reliable, because they are not available yet for a commercial use. They just exist on paper (19). Therefore, all conceivable problems and objections are easier to fend off. Various expressions and words such as « not related to the proliferation of nuclear weapons”, ‘protected from overheating” and “cheap” seem to solve problems, however, they also create a deceptive illusion (20). But these words and expressions do not say anything about reality. There is a lack of transparent civilian control over the small nuclear reactors on military submarines in military use today as well as over their effects and safety.

A scenario like in Chernobyl or Fukushima is most probably unlikely to happen in Estonia, but this is not a reason not to worry, because what happened in both of these catastrophes was considered to be impossible. Without decades of testing, a modular nuclear power plant as a new technology would also be risky, as there is no experience to anticipate all the risks. At the same time, it is not possible to predict the unlikely but catastrophic, so-called "black swan", scenarios.

In the case of nuclear energy, the so-called negative “learning curve” can be seen - the more nuclear power plants are built, the more problems are identified (21). The more nuclear power plant designs are developed, the more different safety issues are identified, which will also lead to higher unit costs of nuclear energy (22).

For instance, in Canada, three small nuclear reactors of the same type as modular reactors have been unsuccessful. Namely, two 10-megawatt MAPLE reactors were built, but they never became operational because safety problems could not be solved, which led to the fact that the project was abandoned a dozen years ago (23). The 10-megawatt Mega-Slowpoke district heating reactor was never licensed due to similar safety concerns. This completed reactor is currently being dismantled without having produced a single megawatt of energy, while a huge amount of energy has been spent on its construction (19).

Even if a new type of small nuclear reactor receives a permit for operation, it makes sense to test the reliability of this new technology for at least decades. Releasing a totally new technology into the world is a big risk not only for Estonia but also for the whole region. Especially in the case of a country that has no experience in operating and supervising a nuclear power plant and where an overall knowledge in energy matters appears to be low at the government level (24).

4) A long-lasting burden on public finances

Supporters of Estonian domestic nuclear energy argue that the costs associated with building and maintaining a nuclear power plant do not require large subsidies from the state, because it is a private business, and the risks are borne by the investors. However, similar projects around the world have shown that it is expensive to maintain a nuclear power plant and that it therefor requires large public investments (2). It can also again lead to the so-called path dependence described above. For example, in the event of a major financial problem, a nuclear power plant may create the expectation of a massive state rescue operation (this can be compared to the capitalization of large banks during the financial crisis, since they were considered too large to shut down).

Even if a nuclear power plant was built and operated with purely private capital, it would automatically incur high costs from the state budget as well. In Estonia, there is no significant public sector competence to ensure safety related to a nuclear power plant. Creating a legal framework for the deployment of nuclear energy alone will absorb money, time and attention from government agencies and politicians, whereas that money, time and attention could be used more sensibly. Similarly, taxpayers' money would be used to train a number of professionals (part of the training would have to be abroad), to create special new state control and supervision authorities and to set up safety infrastructure, a crisis capacity and management plan.

The experience of other European nuclear countries shows that even in a country with single reactors, a national regulator that is independent from the energy producer, employs at least a hundred top experts with an annual budget of more than 15 million euros. The tasks of the independent monitoring regulator are regulated on an international level, and the requirements do not change accordingly to the size of the reactor. All these huge expenses are unavoidable for the state if it intends to let the entrepreneurs try new technologies in Estonia. If a company planning a nuclear power plant fails, the investments made by the state will also be lost.

World experience has shown that nuclear power plants are economically risky and low profit. The UK's Hinkley Point nuclear power plant can compete with other electricity producers only because it has been granted a 35-year fixed purchase price (twice the current market price for electricity) (32). During the construction of nuclear power plants, large overhead costs are not uncommon, due to significant delays in production and delivery (25). Primary cost estimations should not be taken into account as 97% of nuclear projects exceeded the primary planned budget. One average nuclear project costs in reality an average of $ 1.3 billion more than originally planned (26). For example, the Finnish Olkiluoto reactor, often cited as an example in Estonia, was supposed to start being operative in 2009, but even now it is still assumed that the reactor will be connected to the grid at best at the end of 2021. As a result, the originally planned costs have tripled.

It is emphasized that modular nuclear power plants are cheaper than "conventional" ones, because their central components can be assembled on the line of a huge factory, like house parts in a modular house factory. Theoretical cheapness thus implies mass production, which in turn requires a proven, well-performing standard nuclear power plant project. Currently, there are about 150 different theoretical models of nuclear power plants developed by various startups. Right now, the needed demand for mass production is not achieved, so without this demand it is not possible for start-ups to find the investors they need for constructing expensive factories that would produce the components for modular nuclear power plants. Therefore, entrepreneurs persuade governments to invest taxpayers' money in the hope that, unlike in the past, this time something will come out of the "renaissance of atomic energy" (19; 27).

Most probably, some of the start-ups that project nuclear power plants are willing to pay for the installation of their first reactor in whatever country (for example, in Estonia that does not have an independent and critical oversight) as far as it helps them to impress future investors and customers. But in this case, we are dealing with a pilot project, and Estonia is essentially becoming a testing laboratory for nuclear energy.

5) Nuclear energy will not solve the climate crisis

One of the most serious global challenges is the anthropogenic climate crisis. The Intergovernmental Panel on Climate Change (IPCC) has stated that to contain the rise of the average atmospheric temperature we need to act right away. (28) The achievement of the European Union's 2050 climate neutrality target requires immediate and sustained action in this direction rather than, for example, waiting for a technical breakthrough in the 2040s. Even if fuel-free and waste-free technologies are found (not a single generation of atomic energy is), then during the decades that are required for its implementation, the climate crisis might worsen irreversibly.

It is not forbidden for private investors and scientists to test new technologies (unless it mindlessly drains the public sector budget) but among the most important principles for solving the climate crisis is that the solution should be the fastest and the cheapest. For example, the already existing and constantly widespread wind and solar energy combined with storage already do correspond to this principle (19). Countries that use more renewable energy than nuclear energy also have a smaller carbon footprint (29).

As a positive example, Germany has decided to close all its nuclear power plants by 2022. This gave the market a clear sign to invest in alternatives. The country bought 30 000 megawatts of solar and wind power in just eight years. It would have been impossible to produce an equivalent volume of atomic energy capacity in just eight years. With the installation of wind turbines, Germany reduced its CO2 footprint already in the first year of construction, and the number keeps decreasing every year.

In fact, the nuclear power plants do not directly emit greenhouse gases into the air during the fission process of atoms, but their carbon footprint must be estimated by the life cycle of nuclear fuel as a whole. For instance, significant amounts of fossil fuels are used to extract resources, to crush ore, to enrich uranium, to build power plants and storage facilities for nuclear waste, to stop the activity of a nuclear power plant, and finally to transport waste, and in addition to all these points, there are the environmental costs associated to thousands of years of storage. (30)

Considering the previous points, nuclear energy does not contribute to an emission-free climate, but it is comparable in its CO2 emissions to solar and wind energy. However, there is a danger that a hypothetical "nuclear renaissance" will cut subsidies for renewable energy, since the direct and hidden costs associated with the nuclear power plant are high in both financial and political terms. There are examples in the world when producers of nuclear energy paid to let wind turbines being shut down, because otherwise nuclear energy would not be able to compete with the price of renewable energy (31). Moreover, the production volumes driven by the renewable energy boom have created a market situation in which renewable energy sources can now or will soon be manageable without any additional subsidies. Annual analysis by the financial advisory firm Lazard, show that building new electricity generation capacity is more costly in nuclear power plants than in renewable energy. Unlike nuclear power plants, the cost of building renewable energy capacity is on a clear downward trend (33).

Summary

1) There is no escape from ultra-hazardous nuclear waste

- Nuclear waste originates from all known types of reactors

- Waste is stored for decades on the territory of nuclear power plants, waiting for a final disposal

- A working solution for final disposal in the world does not exist yet

- The problem of radiation has been going on for millennia

2) There are still security issues

- Large and complex technologies are not infallible

- Shutdowns or damages at a nuclear power plant endanger the power supply

- An evacuation zone in the event of even a minor accident is of tens of kilometers

3) The technologies are not ready

- In a rapidly developing energy market, flexible and local solutions are preferred

- Nuclear energy implies dependence on the path of specific technologies

- Commercial modular reactors exist only on paper

- Many of the experimental reactors that were built were shut down before they could be operative

4) A long-lasting burden on public finances

- The state would have to begin developping costly competence of licensing and independent supervision

- The state would also have to create plans and funding in the event of a possible major disaster

- Due to the path dependence, government support may be required to maintain the viability of nuclear energy

- The above costs are disproportionate and in the interests of only one private power plant

- Mass production of modular reactors (like other nuclear power plants) on the basis of private capital alone is not realistic

5) Nuclear energy will not solve the climate crisis

- Action to tackle the climate crisis is needed now, developing and building new types of nuclear power plants takes time and is expensive

- The fastest and cheapest solution are the number one priority- Countries that use more renewable energy than nuclear energy have a smaller carbon footprint

- Nuclear energy directly inhibits the production of wind and solar energy

- Creating new electricity generation capacity is more costly in nuclear power plants than in renewable energy

Considering the above information, we urge decision-makers, local governments, experts and other citizens to seriously weigh the suitability of a nuclear power plant for Estonia. Do we want to firmly link Estonia to a form of energy that is risky in many ways, or do we want to contribute to renewable energy sources? Our little Estonia cannot afford the luxury of moving in both directions at once.

NGO Estonian Green Movement
26 November 2020

References:

[1] Can be found by the names of: OÜ Fermi Energia, MTÜ Eesti Tuumajaam or Kaasaegse Tuumaenergia Infokeskus, can be seen from AK news (https://www.err.ee/1136971/tuumaenergia-pooldajad-avaldasid-tallinnas-ja-tartus-meelt) also from other places like Eesti Naine (https://lood.delfi.ee/eestinaine/elud/em-perpetuum-mobile-em?id=91158999).

[2] Parshley, L. (2020). The countries building miniature nuclear reactors. https://www.bbc.com/future/article/20200309-are-small-nuclear-power-plants-safe-and-efficient

[3] Rust, S. (2020). U.S. says leaking nuclear waste dome is safe; Marshall Islands leaders don't believe it. https://www.latimes.com/environment/story/2020-07-01/us-says-nuclear-waste-safe-marshall-islands-runit-dome

[4] Teffer, B. (2016). Why Germany is digging up its nuclear waste. EU observer. https://euobserver.com/beyond-brussels/132085

[5] Eureka County (2019). Current Status of the Yucca Mountain Project. https://www.yuccamountain.org/faq.htm#:~:text=On%20The%20Ground%20Accomplishments%3A%20Today,have%20yet%20to%20be%20developed

[6] Gordon, H. (2020). A hole in Finland is being prepared to contain radioactive waste for 100,000 years. But will the future co-operate? https://www.wired.co.uk/article/olkiluoto-island-finland-nuclear-waste-onkalo

[7] Kaasaegse Tuumaenergia infokeskus (2020). Jäätmed. https://moodulreaktor.ee/jaatmed/

[8] Posiva. General Time Schedule for Final Disposal. http://www.posiva.fi/en/final_disposal/general_time_schedule_for_final_disposal

[9] International Atomic Energy Agency (2019). Small Modular Reactors: A Challenge for Spent Fuel Management? https://www.iaea.org/newscenter/news/small-modular-reactors-a-challenge-for-spent-fuel-management

[10] Vasser, M. (2020). Pooliku infoga tuumajaama ei ehita. Virumaa Teataja. https://virumaateataja.postimees.ee/6882972/pooliku-infoga-tuumajaama-ei-ehita

[11] Krall, L. (2020). A Critical Analysis Of The Nuclear Waste Management Consequences For Small Modular Reactors. Stanford Freeman Spogli Institute of International Studies. https://fsi.stanford.edu/events/critical-analysis-nuclear-waste-management-consequences-small-modular-reactors

[12] Perrow, C. (1984). Normal Accidents: living with high-risk technologies.

[13] Friends of the Earth Japan (2020). 10 years after the Fukushima Nuclear Disaster - Listening to the Unheard. https://www.youtube.com/watch?v=IKnJyWBNYXk&ab_channel=FoEJapan

[14] Tuumaenergia pooldajad avaldasid Tallinnas ja Tartus meelt. https://www.err.ee/1136971/tuumaenergia-pooldajad-avaldasid-tallinnas-ja-tartus-meelt

[15] Edwards, G. (2017). “About Radioactive Bananas”, Canadian Coalition for Nuclear Responsibility. http://www.ccnr.org/About_Radioactive_Bananas.pdf

[16] Holmberg, R. (2008). Survival of the Unfit: Path Dependence and the Estonian Oil Shale Industry. Linköping Studies in Arts and Science No. 427.

[17] Tammiksaar, E. (2013). Põlevkivitööstuse algus Eestis – eeldused ja põhjused. Akadeemia, 2, 287. https://www.digar.ee/viewer/et/nlib-digar:130563/171883/page/48

[18] Simon, F. (2020). The European Commission “will not stand in the way” of countries that choose to build new nuclear power stations, said EU climate chief Frans Timmermans, who warned however about the life-cycle costs of the technology, “which means that you will be stuck with it for a long, long, long time”. https://www.euractiv.com/section/energy/news/brussels-wont-stand-in-the-way-of-new-nuclear-plants-says-eu-climate-chief/

[19] Edwards, G., Duguay, M., Jasmin, P. (2019). Small modular nuclear reactors – a case of wishful thinking at best. https://nbmediacoop.org/2019/12/21/small-modular-nuclear-reactors-a-case-of-wishful-thinking-at-best

[20] World Information Service on Energy (2019). Small modular reactors: an introduction and an obituary. https://wiseinternational.org/nuclear-monitor/872-873/small-modular-reactors-introduction-and-obituary

[21] Shellenberger, M. (2020). Apocalypse Never. Harper Collins Publishers.

[22] Glaser, A., Ramana, M. V., Ahmad, A., & Socolow, R. (2015). Small Modular Reactors: A Window on Nuclear Energy. Princeton University.

[23] World Nuclear News (2008). AECL halts development of MAPLE project. https://world-nuclear-news.org/Articles/AECL-halts-development-of-MAPLE-project

[24] Gamzejev, E. (2020). Eesti Energia saadab 1300 töötajat sundpuhkusele. https://pohjarannik.postimees.ee/6698904/eesti-energia-saadab-1300-tootajat-sundpuhkusele

[25] Energy Watch Group (2018). The disaster of the European nuclear industry. http://energywatchgroup.org/wp-content/uploads/2018/03/Nuclear-disaster_EPR_EN.pdf

[26] Sovacool, B. K., Gilbert, A., & Nugent, D. (2014). Risk, innovation, electricity infrastructure and construction cost overruns: Testing six hypotheses. Energy, 74, 906-917.

[27] Ramana, M. V. (2018). Are Thousands of New Nuclear Generators in Canada's Future? https://thetyee.ca/Opinion/2018/11/07/Nuclear-Generators-Canada-Future

[28] IPCC, 2018: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. In Press.

[29] University of Sussex (2020). Two's a crowd: Nuclear and renewables don't mix. https://techxplore.com/news/2020-10-crowd-nuclear-renewables-dont.html?fbclid=IwAR0ffDPK4Uh4BuwEPpPTREbE65N8w-pJYeOH8Vpzri0f8sg_0w4wl1PeRhw

[30] World Business Academy. Nuclear Power: Totally Unqualified to Combat Climate Change. https://worldbusiness.org/nuclear-power-totally-unqualified-to-combat-climate-change/

[31] How nuclear power is switching off windfarms in Scotland – The truth about wind power compensation payments. https://100percentrenewableuk.org/how-nuclear-power-undermines-renewable-energy-the-truth-about-wind-power-compensation-payments

[32] Wholesale Electricity Price Guide. https://www.businesselectricityprices.org.uk/retail-versus-wholesale-prices/

[33] Lazard (2019). Lazard's Levelized Cost of Energy Analysis – Version 13.0. https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf

[34] OECD (2019). Nuclear Legislation in OECD and NEA Countries. Regulatory and Institutional Framework for Nuclear Activities. p. 10-11. https://www.oecd-nea.org/law/legislation/finland.pdf