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Small Modular Nuclear Reactors in Estonia; recommended or not? **2**

It is jokingly said that nuclear energy seems to be 95% of the talk on future energy discussions, and perhaps only 5% of the solution. This certainly seems to hold for the Baltic country of Estonia - a nation with no nuclear power plants, but a lot of recent activity in order to assess the possibilities of changing the situation via small modular nuclear reactors (SMRs). Madis Vasser, board member of the Estonian Green Movement wrote a report on the issue.

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Small Modular Nuclear Reactors in Estonia: Recommended or not?

It is jokingly said that nuclear energy seems to be 95% of the talk on future energy discussions, and perhaps only 5% of the solution (IEA estimate[1]). But every anecdote always has a bit of truth in it. This certainly seems to hold for the Baltic country of Estonia - a nation with no nuclear power plants, but a lot of recent activity in order to assess the possibilities of changing the situation via small modular nuclear reactors (SMRs).

The present report[2] details how the nuclear meme has entered into governmental planning documents - be them long-term visions or concrete action plans. Following this, some fresh reports specifically on Estonian SMRs are unpacked in greater detail - focusing on the modeling studies of the future Estonian energy system and the educated guesses of local energy experts. The report ends with takeaways and generalizations of the Estonian experience for the wider CEE region - while every country is certainly different, the arguments for and against SMRs are often similar.

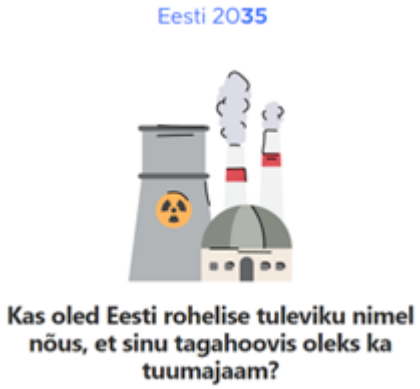
As discussions surrounding nuclear energy can become heated, the following report tries to avoid citing materials that may be biased to either side of the debate and adds disclaimers where appropriate. The aim here is to present the diligent work of others, so readers can draw their own informed conclusions.

Evolution of the SMR meme in Estonia (2018-...)

In late 2018, the process of compiling the National Energy and Climate Plan (NECP 2030) started. While the very first draft of the document did not include any mention of local nuclear capacity[3], the next iteration already described “safe nuclear energy”, “rising demand for nuclear”, “meeting baseline energy possibly with nuclear”, but also that “such reactors are not yet available anywhere in the world”[4]. This prompted 11 environmental organizations to send official feedback stating among other things that SMRs are indeed experimental and cannot be relied upon when making long term energy plans, especially when other alternatives are already available. Also, it was noted that “safe nuclear” does not exist, since even the officially cited source documents claim only “safer nuclear”, as complete safety would be impossible. As for rising demand in nuclear, this too was pointed out as a mistranslation, as the original source of the claim found a modest increase of nuclear energy in only one of the modeled future energy scenarios. Overall, environmental NGOs suggested that before a want for nuclear can manifest, there should be a public debate about the need for such a technology in Estonia.[5] However, in the final NECP many of these issues were left unresolved[6].

In 2019 another development document was proposed, that of Estonia 2035[7] (approved in 2020). While the broad and visionary final text does not include mentions of nuclear energy[8], the accompanying media campaign had the nuclear question clearly highlighted[10] (below).

Estonia 2035 interactive poll. The caption reads:



“Would you allow a nuclear power plant in your backyard in the name of a green future?” Answering “yes” results in promises of cheap electricity and intact nature. Answering “no’’ states that 100% renewables might actually be a cheaper option for Estonia, but there will be wind parks everywhere.

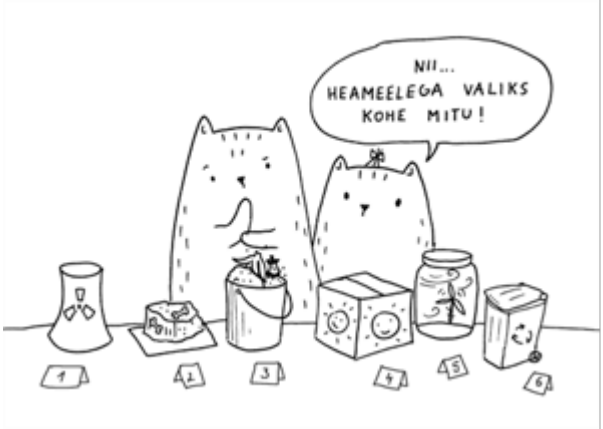
In 2020 the Ministry of Environment compiled a memorandum on the possibilities of adopting nuclear energy in Estonia[11]. The 14-page brief to the government references the aforementioned ENMAK 2030 plan and states that the nuclear process involves at least 10-15 years of preparatory works and could cost the state over 10 million euros before anything is even built, also noting that this estimate comes from the developers and might thus be a severe underestimate. Still, the document approves analysis produced by the private company Fermi Energy as a reliable source of information. The memo notes that pre-assembled reactors could lead to cheaper builds, but in case of factory defects the repairs might become very costly. It is also advised to avoid 4th generation reactors, as these are deemed too experimental. Conversely, on nuclear risk mitigation 4th generator reactors are recommended as the go-to option. Regarding nuclear waste, the memo presents a calculation that if a NPP should be operational by 2035, uses conventional fuel which is changed once every 6 years, cools around 10 years, and can then be stored by revised IAEA guidelines in temporary storage for up to another 100 years, the final repository question becomes current only in the year 2151.

However, it is clearly stated that the NPP developer must submit detailed plans in advance on how they will deal with this issue in the distant future.

In 2021 the Estonian Ministry of Environment established a nuclear energy working group[12] to assess if small nuclear could be a future option for the country, compiling material for a principal decision whether or not to continue developing nuclear capabilities made by the Estonian parliament in 2024. The main working group comprises of officials from various ministries and is frequented by the private nuclear energy company Fermi Energy. The Council of Estonian Environmental Organizations is represented in the sub working group on siting of the NPP and high-level nuclear waste repository. So far the government has allocated at least 350 000 € to procure several preliminary studies on siting[12], human resources and regulatory framework[13], and legal context[14]. The first commissioned reports should be ready by early 2023.

It is reasonable to believe that the reports will be heavily influenced by the current developments in the energy markets and European security situation. For example, Estonia has just announced a national target for 100% renewable electricity generation by 2030[15] in order to lower the electricity prices in the long run. Also, as Russia becomes more aggressive towards and more strictly sanctioned by the EU, any sort of nuclear technology collaboration or even building of critical infrastructure in shelling distance of the Russian boarder becomes increasingly unlikely in the next decades.

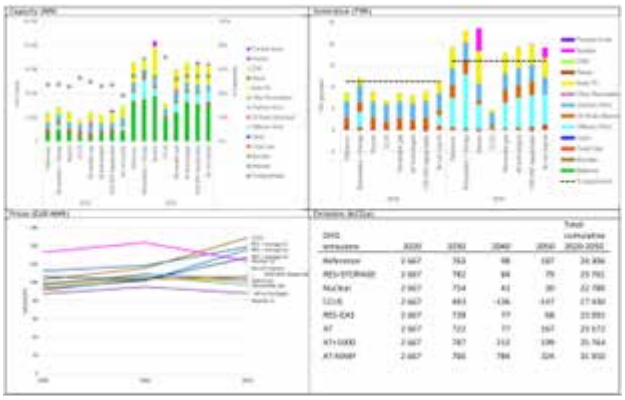
Studies About SMRs in Estonia (2021-2022)



"So… I'd like to pick several!" Illustration from the questionnaire by Sandra Silver

While there is no shortage of nuclear-financed studies[16] on the suitability of SMRs in Estonia, only a few reports currently exist that are funded by public sources and could be used to answer the question if SMRs are recommended for Estonia or not. One notable survey is "Estonian Energy Futures"[17], conducted using the Delphi method. It was done in spring 2021 by researchers at the University of Tartu, who polled 130 Estonian experts on their views about the possible future energy sector solutions. The options were later classified according to the most popular answers into three large categories: "needed swiftly"; "needed, but time consuming"; and "not recommended for Estonia". The latter section comprised of three separate options: transforming current oil shale power plants to biomass; adding carbon capture technologies to current oil shale installations; and building a small modular nuclear reactor. It is important to note, however, that these answers were purely subjective, albeit educated guesses by the respondents.

A far more thorough study titled "Transitioning to a climate-neutral electricity generation in Estonia"[18] combining detailed modeling and many rounds of stakeholder feedback was conducted in 2021-2022. Ordered by The Ministry of Economic Affairs and Communications and supported by the European Commission in collaboration with Trinomics, the Stockholm Environment Institute and E3-Modelling.



The results are set to become the data-informed backbone of Estonian energy decisions in the coming decades. The report aims to "define pathways and develop an Action Plan in order to achieve climate neutral electricity production by 2050". In order to "provide Estonian officials with a clear understanding of the costs and benefits associated with different pathways", the analysis looks at 7 different scenarios, two of which contain SMRs. The recommended choice according to the study authors is broadly renewable energy sources with storage, scoring positively on most criteria and based on proven technologies. The "not recommended" tier hosts carbon capture and the nuclear pathways, as it is "too risky to rely on the technology to achieve the decarbonization objectives". Also, as the authors note, "historically, nuclear projects are characterized by higher than expected costs, repeated cost increases during the project, and delays." See below for an overview table and the original document for detailed descriptions about each scenario.

	1.RECOMMENDED			2.VIABLE		3.NOT RECOMMENDED	
Criteria	**RES+Storage**	**Renewable Gas**	**All technologies (AT)**	**No net imports**	**1000 MW dispatchable capacity**	**Nuclear**	**CCU**
Stakeholders' preference	++	+	++	-	0	-	--
Socioeconomic impacts	++	++	0	++	0	-	--
Security of supply	++	0	0	0	++	+	--
Main implementation challenges	0	0	++	0	0	--	-
Risk analysis	0	++	++	--	++	--	--
Limit of fossil use (fossil gas gen. in 2050)	++	++	-	--	-	++	--
Sensitivity analysis	++	++	0	++	0	++	--
Avg. electricity prices in 2050	-	+	+	+	+	++	--
Total cumulative investment costs (2022-2050)	--	--	0	0	0	--	++
Renewable subsidies costs in 2030	--	0	0	--	0	0	++
CO_2 emissions by 2050	0	0	0	-	0	0	++
Electricity from Biomass in 2050	--	--	--	++	--	0	++

Criteria chosen by the consultants and evaluated through modeling and roundtable discussions.

Note that "All technologies" does not include nuclear.

When applying a set of evaluation criteria proposed by the Ministry and changing the scoring logic, results however change noticeably[19] - in this case, large nuclear becomes the leading choice. See below.

	1.RECOMMENDED			2.VIABLE		3.NOT RECOMMENDED	
Criteria	**Nuclear**	**All technologies (AT)**	**RES + Storage**	**Renewable Gas**	**1000 MW dispatchable capacity**	**No net imports**	**CCU**
Investment cost	6	2	7	5	3	4	1
Electricity price in 2050	1	2	6	3	4	5	7
GDP (output changes compared to reference, €bn)	2	6	1	3	5	4	7
Jobs created (2030 to 2050)	1	4	2	3	6	5	7
Share of domestic generation in 2050	1	4	2	6	3	5	7
Total score	11	18	18	20	21	23	29
Aggregate ranking	1	2	2	4	5	6	7

The recommended pathways according to both previous tables are “All technologies” (excluding nuclear) and “RES+Storage”. Of special note is the “also viable” scenario “1000 MW dispatchable capacity”. This approach envisions the deployment of one SMR by 2050 with the total power output of 300 MW and a load factor around 65-70% to balance renewables at certain times. This is in stark contrast with the current public business plans of Fermi Energy, aiming at a combined 1200 MW with constant generation and starting up the first yet undecided reactor design already by 2031. When environmental stakeholders highlighted the unrealistic nature of such claims, the official answer read: “We acknowledge your perspective but note that some stakeholders thought our final assumptions about nuclear power were not sufficiently optimistic.” However, the governmental report also notes: “An added risk of the Nuclear pathway is that it may create a false sense of security, and be used as a justification to postpone important decisions.”

In early February 2022 the Ministry of Environment conducted a survey “Knowledge of nuclear energy and preparedness of adapting it in Estonia” among the general population in order to assess the perceptions about nuclear[20]. The most potential future energy sources were seen as wind (72%), with solar and nuclear tied to second place (54%). The results showed that 59% of the respondents approve of nuclear energy in Estonia, while 22% are opposed and 19% have no opinion. Here it is important to note that so far there has been minimal communication from the Ministry side on the overall topic of nuclear (a communication plan is currently in the making), so the media space has been dominated by spokespersons with clear vested interests in nuclear energy. Also, the survey was done just before the Russian assault on Ukraine and its civil nuclear facilities, so the public opinion may have shifted since then.

From these few available studies it follows that the majority of local energy experts and government-contracted consultants find SMRs as not recommended for Estonia, while government officials and the general public saw potential in them at least in the beginning of 2022.

Recommendations for discussing SMRs

There are other CEE countries expressing interest in SMRs, e.g Poland, Romania, Czech Republic, Latvia and Lithuania. Some of these are new markets for nuclear energy and there the debate might follow the Estonian example most closely. Below is a list of some takeaways to remember in order to start a fair and balanced national discussion on SMRs.

Small reactors, big words. A brief mention about “small”, “modular”, “new generation” and/or “advanced” nuclear may be pushed into any official government plan by proponents, in order to be used later as a reference to show the necessity and broad national interest in nuclear energy. Stakeholders should monitor and document the situation, give official feedback and point out any potential exaggerated, unproven or mistranslated claim

Generational divide. Public debate might initially and perhaps intentionally revolve around “next” or “4th” generation reactors (generally any non-light water designs). While having certain improvements over 3rd generation technology, it must be remembered that “advanced” isn’t always better[21]. Also, since the NPP developers wish to deploy their plans usually in the next decade, the only feasible reactor choice will be 3+ generation with its benefits, and its flaws. Often this is not made clear.

Two is a crowd. SMRs are often touted as the solution for the situations where the wind does not blow and the sun does not shine. Since renewable energy technologies are constantly developing and being already deployed at scale, economically an even more important question is about what happens to SMR output when the wind and the sun are present, flooding the market with cheap electricity. It is unlikely that an SMR will be built to be operational only for a few months per year.

Analysis paralysis. While SMR developers can and do publish study after study, it is vital to validate these claims by third parties who do not have a direct financial interest in the results of the analysis. This can be especially difficult in non-nuclear countries where such expertise is lacking or already concentrated in the companies pushing for SMRs. Forming a network of international experts is advised for each stakeholder.

Public participation. A candidate country for nuclear energy must have a national working group on the matter and it is essential to have civil society and environmental organizations present already in the early stages. The working group may be composed of already overworked non-specialists, which also means that important decisions are not rigorously analyzed, making them useless in some later stage. An open process will save time, money and nerves in order to decide if small modular nuclear reactors are indeed recommended for the country or actually not.

About the author

Since 2018 Madis Vasser, PhD, has worked for the environmental NGO Estonian Green Movement on energy and climate issues and currently serves as a board member. He is the representative of the Council of Estonian Environmental NGOs in the national nuclear energy sub-working group on siting of the NPP and nuclear waste repository, led by the Ministry of Environment. Recently he graduated the Foundational Infrastructure for Responsible Use of Small Modular Reactor Technology (FIRST) program on Nuclear Safety and Siting of SMRs, organized by the US Department of State, Office of Cooperative Threat Reduction, Partnership for Nuclear Security. Madis@roheline.ee

1. https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system
2. The full report can be found at http://www.joint-project.org/upload/file/Small_Modular_Nuclear_Reactors_in_Estonia__Recommended_or_not.pdf
3. https://eelnoud.valitsus.ee/main#0xJxUGoC
4. https://eelnoud.valitsus.ee/main#AF0B4WRR
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20. https://energiatalgud.ee/sites/default/files/2022-06/D7%20
21. https://envir.ee/media/6573/download

World Nuclear Power Status

Number of Reactors
(as of November 2022)

Source: https://www.worldnuclearreport.org/

EU: Nuclear security on ENSREG agenda

After the Fukushima disaster in 2011, civil society urged the nuclear regulators to include security risks into the stress tests that were carried out at European nuclear power plants. At that time, the European Commission opted for a separate assessment of security risks. The report published in 2012 did not include acts of military aggression.

Ten years later, the issue has been put on the agenda of the European Nuclear Safety Regulators Group (ENSREG) after all. The invasion of Ukraine by Russian military troops in the beginning of 2022 prompted Nuclear Transparency Watch (NTW) and the European Environmental Bureau (EEB) to urge the European commission and nuclear regulators for specific stress tests on nuclear installations regarding security risks like the shelling of the Ukrainian Zaporizhzia nuclear power plant.

It took more than 5 months and repeated harrowing attacks on the battered Zaporizhzia NPP, but now ENSREG will discuss the option of security stress tests for all European nuclear installations. Nuclear Transparency Watch welcomes the move by ENSREG and notes that “attacks on the Zaporizhzia nuclear power plant and the Nord Stream II gas pipeline are a stark reminder of the risk posed by energy infrastructure on EU citizens and the environment in times of military conflict.”

Source: Nuclear Transparency Watch

USA: Biden administration denies restart Palisades NPP

A bid to extend the lifetime of the Palisades NPP in Michigan failed, owner Holtec confirms. The nuclear power plant shut down last may after 50 years of service. Holtec purchased the plant with the intention of decommissioning it but just days after the acquisition was finalized the company applied for federal funding to restart the plant. The Biden administration was, however, not going for it. A spokesperson for Holtec said the company “fully understands that what we were attempting to do, restarting a shuttered nuclear plant, would both be a challenge and a first for the nuclear industry.”

In California NPP Diablo Canyon did get approval to extend its lifetime for another 5 years. President Biden granted conditional funding up to 1.1 billion dollars to the facility. The grant may offer the NPP, scheduled to be permanently shut down in 2025, an opportunity to keep the ageing plant online for a few extra years. However, there are still obstacles to overcome. The nuclear regulator will have to renew the operating license. Substantial upgrades will probably be required. The plant has faced a spat of controversies for its impact on underwater ecosystems, the production of toxic waste and its proximity to earthquake fault lines. There is steep local opposition to lifetime extension of the plant.

Sources: Reuters, The Guardian, World Nuclear News, Bridge Michigan