Eleven reasons why nuclear power has no future

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Nuclear power is dirty and dangerous now and for many generations to come. The following eleven reasons make the case for why nuclear has no future.

- **Nuclear power is too slow to help mitigate the climate crisis.** Nuclear projects take an average of 10 years to complete.[1] In contrast, the Burchill Wind Farm near Saint John, NB took three and a half years from partnership to full deployment.[2] The most advanced small modular nuclear reactor (SMNR), NuScale in the USA, pushed back its completion date from 2016 to 2029,[3] but it could take years longer. Moreover, NuScale uses the same technology as most large reactors globally.[4] Having experienced this much delay, what challenges could await novel technologies like ARC's and Moltex's small modular nuclear reactors (SMNRs) proposed for Point Lepreau, neither of which has ever operated successfully at commercial scale?[5]

- **Nuclear power is too expensive compared to the alternatives.** Wind and solar both undercut nuclear power rates. The authoritative Lazard energy analysis for 2023 [6] costed storage-backed onshore wind and solar at US $42 to $114 per megawatt-hour, compared to nuclear power at US $141 to $221. Power from SMNRs will probably be more expensive than electricity from large nuclear plants which have a history of cost increases. [7] Crucially, SMNRs can't take advantage of the economies of scale [8] which large reactors do. There are no large orders for SMNRs, making it unlikely that multiple units will ever be built. [9]

- **Chronic exposure to radioactive pollutants emitted from large and small nuclear power plants can damage human health**. [10] For example, the thyroid absorbs radioactive iodine as readily as it does the non-radioactive form, putting children at particular risk of thyroid disease and cancer. [11] Chronic exposure to radioactive materials, even at low doses, increases the incidence of cancer, leukemia, [12] anemia, genetic damage which can be passed from parent to child, immune system damage, strokes, heart attacks, and low intelligence.

- **Liquid sodium and molten salt reactors pre-dating ARC's and Moltex's small modular nuclear reactor (SMNR) designs were unreliable and dangerous.** Internationally, sodium reactors have not performed reliably, and one in Russia experienced repeated fires. [13] In the 1960s, the US Molten Salt Reactor Experiment (1965-1969) operated at only 40% capacity [14] compared to 90% for the average US commercial nuclear power plant.

- **Nuclear power does not work effectively with renewable energy.** A University of Sussex study [15] of 123 countries over 25 years found that countries that invested in renewable energy reduced more carbon emissions than countries with large percentages of nuclear power. Contrary to the claim that nuclear energy and renewables work well together, the study found that they crowd each other out.

- **Carbon emissions must be lowered by a minimum 40 to 45% below 2005 levels by 2030 to avoid the worst impacts of climate breakdown.** SMNRs won't be ready in time, [16] and better technologies already exist. Renewables with storage, energy efficiency and conservation, demand-side management, and interties such as the Atlantic Loop can provide reliable baseload electricity. [17] To wait for the SMNR silver bullet, which may never come, is to court climate catastrophe.

- **Radioactive waste remains an unsolved challenge and will be an ongoing cost to taxpayers into the far future.** Deep geological repositories (DGRs) for the disposal of high-level nuclear waste fuel are not yet operational anywhere in the world (not even Finland [18] and Sweden) [19], and the two locations (Ignace [20] and Saugeen Ojibway Nation) [21] under consideration in Ontario are opposed by many, including Indigenous peoples.[22] A little-known fact is that while the waste fuel is the responsibility of the federal government, New Brunswick is responsible for the steel and concrete building materials which will ultimately become radioactive demolition rubble. [23] Would any New Brunswicker accept having a nuclear waste dump in or near their community?

- **Most Indigenous leaders and First Nations are highly skeptical of nuclear reactors, nuclear waste, and environmental risks, such as groundwater contamination, posed by the long-term storage of such wastes**. First Nations in Ontario and Quebec [24] do not want radioactive waste from New Brunswick in their territories. Nuclear does not align with their sacred principle of caring for the next seven generations. Federal and provincial governments have a history of not consulting First Nations [25] and ignoring their concerns about nuclear installations.

- **Transporting radioactive nuclear waste long distances to a proposed geological repository would come with higher costs and increased risk of accidents.** With a DGR proposed for northern Ontario, the transport distance from Point Lepreau could exceed 2,000 kilometers. Considering the frequency of accidents involving transport trucks [26] and freight trains, [27] ask yourself if you would feel comfortable with radioactive loads [28] passing your home several times weekly for the next 40-plus years? [29] Would you feel confident that no accidents or spills would ever occur on a highway or railway track, in a town, or into one of the many waterways the trucks and trains would cross? To prevent such catastrophes, decommissioned nuclear reactors and their accumulated wastes must be stored where they are presently located.

- **Nuclear weapons are dependent on energy from the plutonium produced at nuclear power plants, making them collaborators in all nuclear weapons produced.** Moltex Energy's technology for separating plutonium, the explosive in atomic bombs, from nuclear waste fuel increases the risk of nuclear weapons proliferation. Moltex's claim that the plutonium would be too impure for use in nuclear weapons has been repeatedly discredited, most recently in a 2022 report from the US National Academy of Sciences and Medicine. The experts stated that while the method might delay the plutonium's use in weapons, it would not prevent it. [30] Nine US non-proliferation experts who advised six US presidents warned the Trudeau government that plutonium separation "will undermine the global nuclear weapons non-proliferation regime [31] that Canada has done so much to strengthen".

- **The cost of decommissioning nuclear reactors must be added to all expenses incurred at every link in the nuclear chain**, from mining and fuel fabrication to perpetual waste storage, from domestic safety and security to international proliferation prevention, from policy to regulation, from design to final disposition. The public is paying for these cumulative costs; [32] the tally must be made public.

Knowing the dangers of nuclear power will, we hope, awaken people to the environmental, financial, and social liabilities it will impose on them and their descendants, and galvanize them to demand that their government representatives act in the public's best interest.

References

[1] "Building a large nuclear plant, from the first pour of concrete to being able to power homes and offices, takes about ten years [10]." M. V. Ramana, "Small Modular and Advanced Nuclear Reactors: A Reality Check," in *IEEE Access*, vol. 9, pp. 42090-42099, 2021, doi: 10.1109/ACCESS.2021.3064948. https://ieeexplore.ieee.org/document/9374057 p 4

[2] Burchill Wind Project Timeline. September 2019 to March 2023. https://www.sjenergy.com/pages/burchill-wind-energy#timeline

[3] Ramana, M.V. "Eyes Wide Shut: Problems with the Utah Associated Municipal Power Systems Proposal to Construct NuScale Small Modular Nuclear Reactors", Physicians for Social Responsibility Oregon, August 2020, Nuscale Delays, Sidebar, p 8. https://d3n8a8pro7vhmx.cloudfront.net/oregonpsrorg/pages/21/attachments/original/1600287829/EyesWideShutReport_Final-30August2020.pdf?1600287829

[4] "This total research and development cost of roughly $1.5 billion is for a scaled down, light water reactor design, the most prevalent nuclear reactor design in the world." M. V. Ramana, "Small Modular and Advanced Nuclear Reactors: A Reality Check," in *IEEE Access*, vol. 9, pp. 42090-42099, 2021, doi: 10.1109/ACCESS.2021.3064948. https://ieeexplore.ieee.org/document/9374057 p 3

[5] "Neither of these two types of reactor designs have ever operated successfully in a commercial setting." Susan O'Donnell, "Presentation to the Legislative Assembly of New Brunswick Standing Committee on Climate Change and Environmental Stewardship. Small Modular Reactors (SMRs)" February 14, 2023 https://crednb.files.wordpress.com/2023/02/2023-02-14-cred-nb-1.pdf Page 3

[6] Levelized Cost of Energy Comparision – Unsubsidized Analysis in Lazard's Levelized Cost of Energy Analysis – Version 16.0. April 2023 https://www.lazard.com/research-insights/2023-levelized-cost-of-energyplus/ p 5

[7] City Club of Eugene Oregon. Should Nuclear Be Part of the New Energy Future? Slide: Other sources of electricity are cheaper… and becoming cheaper: Selected Historical Mean Cost of Technology 2009-2020. Starts at 23:41. https://www.youtube.com/watch?v=4D9R6l8ThpI

[8] "Small reactors, modular or not, are expected be more expensive per unit of output because of something that economists have known for decades and termed economies of scale [40]–[42]." M. V. Ramana, "Small Modular and Advanced Nuclear Reactors: A Reality Check," in *IEEE Access*, vol. 9, pp. 42090-42099, 2021, doi: 10.1109/ACCESS.2021.3064948. https://ieeexplore.ieee.org/document/9374057 p 3.

[9] "The lack of adequate demand, either in niche markets, grid connected markets, or developing countries, is a major constraint because of the emphasis on modular construction by SMR and advanced nuclear reactor designers... to achieve the theoretical cost reductions that are at heart of the strategy to compensate for the lack of economies of scale." M. V. Ramana, "Small Modular and Advanced Nuclear Reactors: A Reality Check," in *IEEE Access*, vol. 9, pp. 42090-42099, 2021, doi: 10.1109/ACCESS.2021.3064948. https://ieeexplore.ieee.org/document/9374057 p 5-6

[10] Gordon Edwards, "Radioactive Wastes: and Nuclear Demolition. A Slide Show prepared for Decommissioning Symposium." Canadian Coalition for Nuclear Responsibility, June 12, 2017, Slides 14, 15 and 16. https://www.ccnr.org/GE_Hudson_2017.pdf

[11] "In a first-of-a-kind procedure, in January 2022, a group of six men and women, diagnosed with thyroid cancer as children, filed a class action suit against TEPCO, seeking US$5.4 million in compensation." The World Nuclear Industry Status Report 2022 (V3–02/2023) A Mycle Schneider Consulting Project Paris, October 2022 https://www.worldnuclearreport.org/-World-Nuclear-Industry-Status-Report-2022-.html p 24

[12] "Here, using an ecological study design, the authors found that the incidence of leukemia *slightly decreased* [emphasis added] among children aged <15 living near nuclear power plants in Germany *where at least one reactor was shut down* [emphasis added] after the Fukushima disaster in 2011.." Graphical Abstract in A. Russo et al, "Incidence of childhood leukemia before and after shut down of nuclear power plants in Germany in 2011: A population-based register study during 2004 to 2019" International Journal of Cancer. Vol. 152 Issue 5, March 1, 2023, pages 913-920 https://onlinelibrary.wiley.com/doi/full/10.1002/ijc.34303

[13] "…prior fast reactor performance demonstrations were less than successful. The DOE report points to the Fermi-1 and Fast Flux Test Facility reactors as US examples and Phénix and Superphénix (France), Monju (Japan), and BN-600 (former Soviet Union) as international examples. But Fermi-1 and Monju both suffered major accidents. Phénix experienced operational anomalies that remain unexplained. Superphénix also never achieved full power and was unreliable. And the BN-600 experienced many sodium fires. The DOE report itself acknowledges that "the track record of [sodium-cooled reactor] demonstration plants is mixed" (Petti et al. 2017)." Lyman, Edwin. 2021. *"Advanced" Isn't Always Better: Assessing the Safety, Security, and Environmental Impacts of Non-Light-Water Nuclear Reactors.* Cambridge, MA: Union of Concerned Scientists, p 67-68 (77-78) https://doi.org/10.47923/2021.14000

[14] "Even for this lower power output, operations were anything but smooth. At the most general level, the fact that the reactor operated for just 13,172 hours over those four years, or only around 40 percent of the time. In comparison, the average commercial nuclear power plant in the United States operates at upwards of 90 percent of the time." Ramana, M.V. 2022. "Molten salt reactors were trouble in the 1960s – and they remain trouble today" Bulletin of the Atomic Scientists. Section 2 (not including the introduction) paragraph 4 https://thebulletin.org/2022/06/molten-salt-reactors-were-trouble-in-the-1960s-and-they-remain-trouble-today/

[15] "We find that larger-scale national nuclear attachments do not tend to associate with significantly lower carbon emissions while renewables do. We also find a negative association between the scales of national nuclear and renewables attachments. This suggests nuclear and renewables attachments tend to crowd each other out." Abstract, Sovacool, B.K., Schmid, P., Stirling, A. *et al.* Differences in carbon emissions reduction between countries pursuing renewable electricity versus nuclear power. *Nat Energy* **5**, 928–935 (2020). https://doi.org/10.1038/s41560-020-00696-3 https://www.nature.com/articles/s41560-020-00696-3#Abs1

[16] "Most of the advanced reactors, especially the non–light water reactors, will confront significant challenges in meeting commercial deployment by 2050." National Academies of Sciences, Engineering, and Medicine. 2023. *Merits and Viability of Different Nuclear Fuel Cycles and Technology Options and the Waste Aspects of Advanced Nuclear Reactors*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26500 P 7

[17] "The amount of electricity coming from a given solar array is really rather predictable and tends to come best in periods of light winds. And wind turbines do best when the sun is not shining brightest, so they complement each other. But more to the point, while a single wind turbine can be idled in calm weather, the wind never stops blowing over wider geographical areas. We might ask whether the problem of variable output of wind and solar power is as big as the problem of inability of baseload power to follow loads." George Harvey, "Nuclear power won't save the world: it won't even help. "Clean Technica. Nov. 19,2021. https://cleantechnica.com/2021/11/19/nuclear-power-wont-save-the-world-it-wont-even-help/ Paragraphs 8 and 9

[18] "If getting the operating license goes smoothly, Posiva is on track to begin to bury nuclear waste deep in the Finnish bedrock in 2024 or 2025." Sedeer El- Showk, "Final Resting Place", Science, Vol 375 Issue 6583, Feb. 2022. https://www.science.org/content/article/finland-built-tomb-store-nuclear-waste-can-it-survive-100000-years Second last paragraph.

[19] "SKB said it hopes construction of the facilities will start in the mid-2020s and take about 10 years to complete." David Dalton, "Sweden / Government Approves SKB's Plans for Final Repository at Forsmark for Spent Fuel", Nucnet, Jan. 28, 2022 https://www.nucnet.org/news/government-approves-skb-s-plans-for-final-repository-for-spent-nuclear-fuel-1-5-2022 Paragraph 9.

[20] "All those who gathered at the chiefs' meeting this week voted to "vehemently oppose" the NWMO's concept of a deep geological repository near Ignace, Ont., a small town of about 1,200 people between Kenora and Thunder Bay." Amelia R. Khan, "Opposition against the Deep Ground Repository: The next Land Back battleground will be north of Lake Superior, as Chiefs say no to nuclear waste on their traditional lands." Protect our Waterways No Nuclear Waste, Aug. 12, 2022 https://www.protectourwaterways.org/opposition_against_the_dgr

[21] "Similarly, we must also have a plan in place that has been agreed to by SON [Saugeen Ojibway Nation] to deal with all current and future nuclear waste before any future projects could go ahead." Kierstin Williams, 'Nuclear waste issue must be resolved before new facility can be explored, says Saugeen Ojibway Nation". Aboriginal Peoples' Television Network National News, July 11, 2023 https://www.aptnnews.ca/featured/nuclear-waste-issue-must-be-resolved-before-new-facility-can-be-explored-says-saugeen-ojibway-nation/

[22] "But Haymond disputes the company's environmental assessments and warns a full-court press to oppose the dump is coming. Pikwakanagan is the only band that has consented, and "no consent will be provided by the vast majority of the Algonquin Nation," Haymond said." Brett Forester, "Algonquin members organize for identity, land and nationhood", CBC News, Aug. 21, 2021, second last paragraph. https://www.cbc.ca/news/indigenous/algonquin-ottawa-identity-1.6940673

[23] "The non-fuel radioactive wastes will remain the responsibility of the government of New Brunswick, likely requiring the siting of a permanent radioactive waste repository somewhere in the province." Gordon Edwards and Susan O'Donnell, "Radioactive waste: a big problem for New Brunswick's proposed new nuclear reactors", NB Media Co-op, June 29, 2020 https://nbmediacoop.org/2020/06/29/radioactive-waste-a-big-problem-for-new-brunswicks-proposed-new-nuclear-reactors/ Paragraph 5

[24] "We will not allow the Government of Canada or the Provinces of Ontario and Quebec to abandon radioactive waste in our territories. The potential for long-lived contamination of the environment and of all living entities is too great." Joint Declaration between the Anishinabek Nation and the Iroquois Caucus on the Transport and Abandonment of Radioactive Waste, 2020, updated from 2017 version. https://www.ccnr.org/Joint_Declaration_2020.pdf P1, paragraph 6

[25] "As you are aware, Indigenous consultation in Canada is not discretionary, it is the Duty of the Crown, and CNSC is failing in this duty. For instance, we were not consulted on the relicensing of the Chalk River site in 2018." Kebaowek First Nation and Algonquin Anishnabeg Nation Tribal Council. Letter to Prime Minister Trudeau. May 14, 2020 https://www.ccnr.org/Algonquin_Trudeau_ltr_2022.pdf Page 3, paragraph 1

[26] "Provincial [Ontario Provincial Police] figures show careless and aggressive driving was the cause or contributing factor in the majority of the 4,274 collisions involving large commercial vehicles this year." Ian Campbell, "OPP say preventable transport truck crashes on the rise", Northern Ontario News, July 8, 2022 https://northernontario.ctvnews.ca/opp-say-preventable-transport-truck-crashes-on-the-rise-1.5980613 Paragraph 2

[27] "In 2022, 995 rail accidents[3] were reported to the TSB (Figure 1 and Table 1), up from the 2021 total of 898, but a 5% decrease from the previous 10-year (2012 to 2021) average of 1043…. Freight trains accounted for 32% of all rolling stock involved in rail accidents in 2022…. In 2022, 111 accidents involved dangerous goods (Table 1), 5 up from 86 in 2021 but below the 10-year average of 121. Two accidents resulted in a dangerous goods release in 2022, the same as the previous year, but below the 10-year average of 4." Transportation Safety Board of Canada, 2023. "Statistical Summary. Rail Transportation Occurrences in 2022. Page 6-7 https://www.bst-tsb.gc.ca/eng/stats/rail/2022/sser-ssro-2022.pdf

[28] "There are a number of factors to consider when it comes to transportation mode selection. Both transportation mode options – an all-road system or a road/rail combination system – can be safely implemented to either potential repository site. Other factors that will be taken into account include transportation package designs, existing infrastructure, and operational elements like scheduling and routing. As identified above, and based on these factors, the all-road system is the NWMO's reference case, and a road/ rail system is an unlikely option for the South Bruce site." Nuclear Waste Management Organization: Preliminary Transportation Plan. December 2021, Page 12. https://www.nwmo.ca/-/media/Site/Files/PDFs/2021/12/13/19/30/Preliminary-transportation-plan--December-2021--EN.ashx

[29] "According to the NAN [Nishnawbe Aski Nation], 60 years of waste has accumulated at Canada's nuclear sites and will require 45 years for proper disposal." Amelia R. Khan, "Opposition against the Deep Ground Repository: The next Land Back battleground will be north of Lake Superior, as Chiefs say no to nuclear waste on their traditional lands." Protect our Waterways No Nuclear Waste, Aug. 12, 2022. https://www.protectourwaterways.org/opposition_against_the_dgr Paragraph 9

[30] "While these technologies may provide some benefit in delaying direct use of the materials, there was consensus among the committee members that none provided significant proliferation resistance at this time." National Academies of Sciences, Engineering, and Medicine. 2023. *Merits and Viability of Different Nuclear Fuel Cycles and Technology Options and the Waste Aspects of Advanced Nuclear Reactors*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26500 P 226

[31] "Our main concern is that, by backing spent-fuel reprocessing and plutonium extraction, the government of Canada will undermine the global nuclear weapons non-proliferation regime that Canada has done so much to strengthen." Open letter to Prime Minister Justin Trudeau from nine US non-proliferation experts," May 25, 2021, Page 1 paragraph 3. https://sgs.princeton.edu/sites/default/files/2021-06/Open-Letter-to-Prime-Minister-Letter-Trudeau-May-2021.pdf Paragraph 3

[32] "Nuclear subsidies for crown corporations and their private sector corporate allies are crowding out investments in energy conservation and renewable technologies, fueling inflation, and making electricity less affordable." Ole Hendrickson, "Pull the plug on nuclear subsidies", Rabble.ca, Nov. 7, 2022 https://rabble.ca/columnists/pull-the-plug-on-nuclear-subsidies/ second last paragraph

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