Nuclear power was unwanted even when it was cheaper than solar and wind electricity

Today, nuclear power is "*ridiculously expensive and utterly uncompetitive"*, according to long-term nuclear supporter Nabuo Tanaka, former head of the International Energy Agency[1].

Even before economics made nuclear power obsolete, one of the main reasons to avoid nuclear power in the energy system was the spread of radioactive pollution. Radioactive elements decay, releasing ionising radiation that can break up molecules and harm living organisms.

When *radioactivity and ionising radiation were discovered* in the nineteenth century the *risks to humans were little known.* The carcinogenic effects have gradually been understood and, more recently, the genetic[2] and cardiovascular[3] impacts.

As people were exposed to ionising radiation during the testing and use of nuclear weapons, and as nuclear power developed with the support of governments, the health effects have always been controversial. Government institutions have economic and political interests[4] in the scientific results. An indication is that the World Health Organization (WHO) whose aim is "the attainment by all peoples of the highest possible level of health"[5], was instructed by member states not to initiate or publish anything on radiation effects without consulting[6] the International Atomic Energy Agency, IAEA, which was set up to "accelerate and enlarge the contribution of atomic energy".[7]

The scientific issues concerning the health effects of ionising radiation are well described in a book by Rosalie Bertell entitled "No immediate danger – prognosis for a radioactive earth".[8] This book explains the risks and how scientific methods are applied to keep those risks in dispute. As the title says, she predicts that nuclear industries will be allowed to continue increasing radioactive pollution as a result of their political and economic power.

The effects of low-level radiation from radioactive pollution are among the disputed issues. If effects are seen they may be disregarded because there is no agreed theoretical explanation, and theoretical proposals of mechanisms are disregarded because of lack of epidemiological evidence.

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[1] https://archive.thinkprogress.org/how-conservatives-killed-nuclear-power-6d3857249af3/

[2] https://www.unscear.org/docs/publications/2001/UNSCEAR_2001_Report.pdf

[3] https://www.bmj.com/content/380/bmj-2022-072924
https://www.jacc.org/doi/10.1016/j.jacadv.2024.101408

[4] https://thebulletin.org/2025/03/radiation-exposure-victims-fight-for-compensation-as-nuclear-weapons-funding-soars/?utm_source=ActiveCampaign&utm_medium=email&utm_content=Plans to colonize Mars threaten Earth&utm_campaign=20250320 Thursday Newsletter&vgo_ee=2A7OwGEBEhWVBz63kW3hpecg6PQSPJtRH+Qojf+usm55:ouUggvsyv8n1htZ3BmwTcrU0n+jRVDqI

[5] https://www.who.int/docs/default-source/documents/publications/basic-documents-constitution-of-who.pdf

[6] https://iris.who.int/bitstream/handle/10665/132639/EB23_15_eng.pdf?sequence=1&isAllowed=y

[7] https://www.iaea.org/about/statute

[8] https://archive.org/details/internetarchivebooks?tab=collection&query=No+immediate+danger+prognosis+for+a+radioactive+earth

Emissions along the supply chain

Uranium mining breaks up the shielding rock and releases uranium, other solid radioactive materials and radioactive gases. Gases are emitted into the atmosphere, in particular radon. Radioactive residues from mining will continue to release radioactive pollution into the human environment instead of staying underground for thousands of years. How much, depends on how well this generation and coming generations are able to manage the waste at the mining sites during changing economic situations, wars and climate change[9].

In the life-cycle analysis of nuclear power, the chemical processes and often energy-intensive enrichment techniques needed to extract uranium atoms with the right fissile nuclei are significant factors. Emissions of halogenated hydrocarbons which are also powerful greenhouse gases may also make a significant contribution. Thus, in the fuel fabrication supply chain, radioactive pollutants are not the only concern.

Routine emissions from operating nuclear plants

The nuclear reactors then split fissile, but not so radioactive uranium nuclei, into other nuclei that are more intensely radioactive and dangerous to the living environment. Some of these are in gas form and routinely released into the atmosphere. This is one of the ways in which radioactive pollutants are suspected of causing cancer clusters at reactor sites[10] and reprocessing plants such as La Hague[11] and earlier Sellafield[12].

All these studies are criticised with the argument that there may be other causes of the many cancer cases, and researchers should look elsewhere[13].

An interesting case is Sellafield. It was initially brought to attention by a TV programme[14], and then the study by Martin Gardner et al., cited above, showing that childhood leukaemia may be related to the exposure of the fathers of the children. The idea was heavily criticised. A further study by Dickinson & Parker[15] confirmed that pre-conception exposure of fathers correlated with an increased cancer risk, indicating a genetic effect could be involved.

Accidents happen with large radioactive emissions

The effects of Chernobyl and Fukushima have been disregarded as average doses are too low, but doses to individuals may be high, since an individual may be exposed to or have ingested particles with a high content of radioactive elements, in areas known as “hot-spots”.

One interesting controversy is between the study on the effects of Chernobyl published by the IAEA[16] and a report by Soviet researchers that concluded close to one million people will have their lives shortened as a result of being exposed to radioactive materials from the reactor. The latter was

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[9] https://www-pub.iaea.org/MTCD/Publications/PDF/te_1403_web.pdf

[10] https://pubmed.ncbi.nlm.nih.gov/18067131/
https://ehp.niehs.nih.gov/doi/10.1289/ehp.9861

[11] https://pubmed.ncbi.nlm.nih.gov/11413175/

[12] https://jech.bmj.com/content/55/7/469
https://www.jstor.org/stable/29706938

[13] https://www.nature.com/articles/news.2011.275

[14] https://en.wikipedia.org/wiki/Gemma_D'Arcy

[15] https://pubmed.ncbi.nlm.nih.gov/11992415/

[16] https://www.iaea.org/sites/default/files/chernobyl.pdf

published by the New York Academy of Science, but after intense criticism[17] it was withdrawn from distribution. But those who would like to read the arguments can still access the report on some web sites.[18]

To gain some insights into the events and experiences following the radioactive release and understand the difficulties that scientists face, one may read the *Manual for survival* by Kate Brown.[19] The continuing debate is enlightening.[20]

When examining these issues, do not automatically trust academics, especially those who refer to authority. Do question arguments and look for misleading statements based on a limited scope of investigation. But trust the scientific process, even if it can be disturbed, delayed, and slow.

When nuclear reactors suffer from a meltdown of fuel in the core and failure of the containment, as happened in one reactor in Chernobyl and three in Fukushima, a mixture of different radioactive pollutants are released. In order to limit the health effects, around 100,000 people were evacuated in these cases. The time needed to carry out the expensive measures to control the further spread of pollutants is many decades and may even be centuries.

The costs of handling a severe reactor accident are in the order of hundreds of billions of USD or euros. Given the historical frequency of one core meltdown leading to large radiation releases in every 5000 reactor-years of operation, the risk cost is in the order of 100 million USD per reactor-year. If a reactor produces 10 TWh/year, this would imply a possible risk cost of 1 cent/kWh. While such a calculation is highly uncertain it is enough to show the cost is not negligible. This cost could be privatised by insisting on insurance and catastrophe bonds, which would in turn require a market evaluation[21].

Harming future generations

The accumulation of radioactive pollutants from emissions will cause harm to coming generations. As reactors produce new radioactive elements that are intended to be stored in isolation for hundreds, thousands or hundreds of thousands of year, these isolated storage facilities must also be kept safe during future wars, new climate conditions and new civilisations – if harm is to be avoided.

Problems occur faster than anticipated. Waste storage sites such as the Asse mine[22] in Germany or the Hanford site[23] in the US illustrate the issues.

Though there are also recent failures, nuclear waste is at this stage mainly an economic problem as nuclear power companies have become unable to assume the economic liability and governments

[17] https://atomicinsights.com/devastating-review-of-yablokovs-chernobyl-consequences-of-the-catastrophe-for-people-and-the-environment/

[18] https://www.sortirdunucleaire.org/IMG/pdf/yablokova_et_al-2009-book-chernobyl-consequences_of_the_catastrophe_for_people_and_the_environment.pdf

[19] https://sts-program.mit.edu/book/manual-for-survival-a-chernobyl-guide-to-the-future/

[20] https://www.jstor.org/stable/pdf/45140248.pdf?refreqid=fastly-default:ac7d1e817d4afda3bcd7fe748adccd87&ab_segments=&initiator=&acceptTC=1

[21] https://link.springer.com/chapter/10.1007/978-3-658-25987-7_9

[22] https://www.bge.de/en/asse/

[23] https://en.wikipedia.org/wiki/Hanford_Site

have had to place the economic or environmental risks on the shoulders of future tax payers, as done in the UK[24], Germany[25] and partly in Sweden[26].

Spreading nuclear weapons increases the risk of their use

A nuclear war may be the end of the human species. The consequences were made clear in an issue of the journal Ambio: *Nuclear War: The Aftermath*[27].

With nuclear power comes the knowledge, the equipment and the fissile material that may be used to build nuclear weapons. As there are no longer any economic reasons to build nuclear reactors to generate low-cost electricity it appears as if many of the countries still building reactors are either already nuclear weapon countries, or countries that may have such ambitions[28].

Even if the intention is not to immediately make nuclear weapons, governments may feel that they want to have "nuclear capability".

However, with nuclear weapons in the world the risk of a nuclear war by mistake[29] is increasing. But mistakes may not be the only reason. Desperation that spurs terrorists to obtain and use weapons is also more likely with more countries storing weapons. The risk of mentally unstable individuals getting control of such weapons following democratic election or coups must also be considered possible.

Even if nuclear power was economically competitive for energy purposes there are many reasons to avoid this alternative.

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[24] https://en.wikipedia.org/wiki/Nuclear_Liabilities_Fund
[25] https://ec.europa.eu/commission/presscorner/detail/en/ip_17_1669
[26] https://www.regeringen.se/contentassets/36b476bc93254b8688f6eb7ca8892f19/ett-fortydligat-statligt-ansvar-for-vissa-karntekniska-verksamheter-prop.-201920157
[27] https://www.jstor.org/stable/i398478
[28] New reactor construction projects during the last 10 years: China, Russia, Egypt, Pakistan, Türkiye, India, UK, Iran, Bangladesh, Korea, Argentina, UAE
[29]https://www.ucs.org/sites/default/files/attach/2015/04/Close Calls with Nuclear Weapons.pdf
https://www-ee.stanford.edu/~hellman/Breakthrough/book/chapters/hellman.html