Nuclear Power – No Solution to Climate Change

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Proposals to expand nuclear power in order to reduce greenhouse emissions are misguided and should be rejected for the reasons discussed below – and others not discussed here, including the risks and impacts of catastrophic accidents.

1. Nuclear Power Would Inhibit the Development of More Effective Solutions

"You can spend a dollar, a euro, a forint or a ruble only once: the climate emergency requires that investment decisions must favor the cheapest and fastest response strategies. The nuclear power option has consistently turned out the most expensive and the slowest." – World Nuclear Industry Status Report project coordinator Mycle Schneider.[1]

Renewable power generation is far cheaper than nuclear power. Lazard's November 2018 report on levelized costs of electricity found that wind power (US$29–56 per megawatt-hour) and utility-scale solar (US$36–46 / MWh) are several times cheaper than nuclear power (US$112–189 / MWh).[2]

Thus the pursuit of nuclear power would inhibit the necessary rapid development of solutions that are cheaper, safer, more environmentally benign, and enjoy far greater public support.

Globally, renewable electricity generation has doubled over the past decade and costs have declined sharply. Renewables account for about 26.2% of global electricity generation.[3] Conversely, nuclear costs have increased massively over the past decade[4] and nuclear power's share of global electricity generation has fallen from its 1996 peak of 17.5% to its current share of 10.15%.[5]

As with renewables, energy efficiency and conservation measures are far cheaper and less problematic than nuclear power. A University of Cambridge study concluded that 73% of global energy use could be saved by energy efficiency and conservation measures.[6]

The 2019 edition of the World Nuclear Industry Status Report includes a chapter on climate change and nuclear power, which concludes with these words:[7]

"Stabilizing the climate needs solutions that are "granular, modular, mass-producible, fungible, quickly installable by diverse actors with little institutional preparation, and – most importantly – propelled by the powerful feedback of increasing returns and learning-by-doing." That describes energy efficiency and modern renewables but not nuclear power. Stabilizing the climate is urgent, but nuclear power is slow. It meets no technical or operational need that these low-carbon competitors cannot meet better, cheaper, and faster.

"Even sustaining economically distressed reactors saves less carbon per dollar and per year than reinvesting its avoidable operating cost (let alone its avoidable new subsidies) into cheaper efficiency and renewables. Whatever the rationales for continuing and expanding nuclear power, for climate protection it has become counterproductive, and the new subsidies and decision rules its owners demand would dramatically slow this decade's encouraging progress toward cheaper, faster options, more climate-effective solutions."

2. Small Modular Reactors vs. Small Modular Renewables

Electricity from small modular reactors (SMRs) will almost certainly be more expensive than power from large reactors because of diseconomies of scale.[8] A 2018 report by the CSIRO and the Australian Energy Market Operator found that power from SMRs would be more than twice as expensive as wind or solar power with storage costs included (two hours of battery storage or six hours of pumped hydro storage).[9] The cost of the small number of SMRs under construction is exorbitant.[10] Both the private sector and governments have been unwilling to invest in SMRs because of their poor prospects.[11]

An article by researchers from Carnegie Mellon University's Department of Engineering and Public Policy, published in 2018 in the *Proceedings of the National Academy of Science*, concludes that to develop an SMR industry in the US, "several hundred billion dollars of direct and indirect subsidies would be needed to support their development and deployment over the next several decades".[12]

The prevailing skepticism is evident in a 2017 Lloyd's Register report based on the insights of almost 600 professionals and experts from utilities, distributors, operators and equipment manufacturers. They predict that SMRs have a "low likelihood of eventual take-up, and will have a minimal impact when they do arrive".[13]

No SMRs are operating and about half of the small number under construction have nothing to do with climate change abatement – on the contrary, they are designed to facilitate access to fossil fuel resources in the Arctic, the South China Sea and elsewhere.[14] Worse still,

there are disturbing connections between SMRs, nuclear weapons proliferation and militarism more generally.[15]

The 2019 edition of the World Nuclear Industry Status Report states:[5]

"As a matter of physics, reactors do not scale down well, so the more-careful analysts acknowledge SMRs – including in China – would initially cost significantly (often about twofold) more per kWh than today's gigawatt-scale reactors. But ... today's new-build reactors already have ~5–10 times the levelized cost of modern renewables (let alone efficiency) per kWh. On durable observed learning curves (which nuclear power has never displayed), renewables will become another twofold cheaper by the time SMRs could be built, tested, and scaled. Two times 5–10 times two is a factor of 20–40 – far beyond any plausible saving from mass production. No nuclear miracle is waiting to emerge.

"Small Modular Renewables, which do scale down well and whose economies of mass production have several decades' head start, have decisively won on cost."

3. A Slow Response to an Urgent Problem

Expanding nuclear power is impractical as a short-term response to climate change. Planning and approvals can take a decade (particularly for nuclear 'newcomer' countries), and construction another decade, and it can take five years or more to repay the energy debt expended in the construction of the reactor. A University of Sydney report states: "The energy payback time of nuclear energy is around 6.5 years for light water reactors, and 7 years for heavy water reactors, ranging within 5.6–14.1 years, and 6.4–12.4 years, respectively."[16]

Taking into account planning and approvals, construction, and the energy payback time, it would be a quarter of a century or more before nuclear power could even begin to reduce greenhouse emissions in a nuclear newcomer country ... and then only assuming that nuclear power displaced fossil fuels.

The 2019 edition of the World Nuclear Industry Status Report states:[5]

"According to a recent assessment, new nuclear plants take 5–17 years longer to build than utility-scale solar or onshore wind power, so existing fossil-fueled plants emit far more CO2 while awaiting substitution by the nuclear option. In 2018, non-hydro renewables outpaced the world's most aggressive nuclear program, in China, by a factor of two, in India by a factor of three.

"Stabilizing the climate is urgent, nuclear power is slow. It meets no technical or operational need that these low-carbon competitors cannot meet better, cheaper, and faster. Even sustaining economically distressed reactors saves less carbon per dollar and per year than reinvesting its avoidable operating cost (let alone its avoidable new subsidies) into cheaper efficiency and renewables."

4. Catastrophic Cost Overruns: The Nuclear Power Industry is in Crisis

Supporters of nuclear power have issued any number of warnings[17] in recent years about nuclear power's "rapidly accelerating crisis" and a "crisis that threatens the death of nuclear energy in the West". They accept that "the industry is on life support in the United States and other developed economies", and they argue with each other about what if anything might be salvaged from the "ashes of today's dying industry".[18]

Consider the following statements, many of them from nuclear industry insiders:

- "I don't think we're building any more nuclear plants in the United States. I don't think it's ever going to happen. They are too expensive to construct." – William Von Hoene, Senior Vice-President of Exelon, 2018.[19]
- Nuclear power "just isn't economic, and it's not economic within a foreseeable time frame." – John Rowe, recently-retired CEO of Exelon, 2012.[20]
- "It's just hard to justify nuclear, really hard." – Jeffrey Immelt, General Electric's CEO, 2012.[21]
- "I don't think anybody's pretending you can take forward a new nuclear power station without some form of government underwriting or support." – Sir John Armitt, chair of the UK National Infrastructure Commission, 2018.[22]
- France's nuclear industry is in its "worst situation ever"[23], a former EDF director said in November 2016 – and the situation has worsened since then.[24]
- Nuclear power is "ridiculously expensive" and "uncompetitive" with solar. – Nobuo Tanaka, former executive director of the International Energy Agency, and former executive board member of the Japan Atomic Industrial Forum, 2018.[25]
- Compounding problems facing nuclear developers "add up to something of a crisis for the UK's nuclear new-build programme." – Tim Yeo, former Conservative parliamentarian and now a nuclear industry lobbyist, 2017.[26]
- "It sometimes seems like U.S. and European nuclear companies are in competition to see which can heap greater embarrassment on their industry." – *Financial Times*, 2017, 'Red faces become the norm at nuclear power groups'.[27]
- "I don't think a CEO of a utility could in good conscience propose a nuclear-power reactor to his or her board of directors." – Alan Schriesheim, director emeritus of Argonne National Laboratory, 2014.[28]
- "New-build nuclear in the West is dead" due to "enormous costs, political and popular opposition, and regulatory uncertainty" – *Morningstar* market analysts Mark Barnett and Travis Miller, 2013.[29]
- "Nuclear construction on-time and on-budget? It's essentially never happened." – Andrew J. Wittmann, financial analyst with Robert W. Baird & Co., 2017.[30]

US nuclear industry insider Jim Little summarizes one thread of the nuclear power crisis:[31]

"One of the more disconcerting and difficult issues facing the industry is a loss of talent and experience right at a time when it is most needed to transfer knowledge to the next generation. The nuclear workforce demographic contains a large percentage of experienced talent reaching retirement age within the next five to ten years. With fewer people entering the industry, addressing the

needs of the operating fleet will become more and more difficult and expensive. Further efforts to reduce costs by trimming workforces would only exacerbate the problem."

It makes no sense to be pinning expectations on nuclear power when the industry is crisis-ridden and incapable of delivering. It does make sense to phase-out nuclear power, as a growing number of countries are doing including Germany, Switzerland, Spain, Belgium, Taiwan and South Korea.

5. Nuclear Weapons Proliferation and Nuclear Winter

"On top of the perennial challenges of global poverty and injustice, the two biggest threats facing human civilisation in the 21st century are climate change and nuclear war. It would be absurd to respond to one by increasing the risks of the other. Yet that is what nuclear power does." – Australian academic Dr. Mark Diesendorf

Nuclear power programs have provided cover for numerous covert weapons programs[32] and an expansion of nuclear power would exacerbate the problem. After decades of deceit and denial[33], a growing number of nuclear industry bodies and lobbyists now openly acknowledge and even celebrate the connections between nuclear power and weapons.[34] They argue that troubled nuclear power programs should be further subsidized such that they can continue to underpin and support weapons programs.[35]

For example, US nuclear lobbyist Michael Shellenberger previously denied power–weapons connections but now argues that "having a weapons option is often the most important factor in a state pursuing peaceful nuclear energy", that "at least 20 nations sought nuclear power at least in part to give themselves the option of creating a nuclear weapon", and that "in seeking to deny the connection between nuclear power and nuclear weapons, the nuclear community today finds itself in the increasingly untenable position of having to deny these real world connections."[36]

Former US Vice President Al Gore has neatly summarized the problem:[37]

"For eight years in the White House, every weapons-proliferation problem we dealt with was connected to a civilian reactor program. And if we ever got to the point where we wanted to use nuclear reactors to back out a lot of coal ... then we'd have to put them in so many places we'd run that proliferation risk right off the reasonability scale."

Running the proliferation risk off the reasonability scale brings the debate back to climate change. Nuclear warfare − even a limited, regional nuclear war involving a tiny fraction of the global arsenal − has the potential to cause catastrophic climate change. The problem is explained by Alan Robock in *The Bulletin of the Atomic Scientists*:[38]

"[W]e now understand that the atmospheric effects of a nuclear war would last for at least a decade − more than proving the nuclear winter theory of the 1980s correct. By our calculations, a regional nuclear war between India and Pakistan using less than 0.3% of the current global arsenal would produce climate change unprecedented in recorded human history and global ozone depletion equal in size to the current hole in the ozone, only spread out globally."

Nuclear plants are also vulnerable to security threats such as conventional military attacks (and cyber-attacks such as Israel's Stuxnet attack on Iran's enrichment plant), and the theft and smuggling of nuclear materials. Examples of military strikes on nuclear plants include the destruction of research reactors in Iraq by Israel and the US; Iran's attempts to strike nuclear facilities in Iraq during the 1980−88 war (and *vice versa*); Iraq's attempted strikes on Israel's nuclear facilities; and Israel's bombing of a suspected nuclear reactor site in Syria in 2007.[39]

6. Climate Change & Nuclear Hazards: 'You need to solve global warming for nuclear plants to survive.'

"I've heard many nuclear proponents say that nuclear power is part of the solution to global warming. It needs to be reversed: You need to solve global warming for nuclear plants to survive." – Nuclear engineer David Lochbaum.[40]

Nuclear power plants are vulnerable to threats which are being exacerbated by climate change.[41] These include dwindling and warming water sources, sea-level rise, storm damage, drought, and jelly-fish swarms. Research by Ensia finds that at least 100 nuclear power reactors built just a few metres above sea level could be threatened by serious flooding caused by accelerating sea-level rise and more frequent storm surges.[42]

At the lower end of the risk spectrum, there are countless examples of nuclear plants operating at reduced power or being temporarily shut down due to water shortages or increased water temperature during heatwaves (which can adversely affect reactor cooling and/or cause fish deaths and other problems associated with the dumping of waste heat in water sources). In the US, for example, unusually hot temperatures in 2018 forced nuclear plant operators to reduce reactor power output more than 30 times.[43]

At the upper end of the risk spectrum, climate-related threats pose serious risks such as storms cutting off grid power, leaving nuclear plants reliant on generators for reactor cooling.

'Water wars' will become increasingly common with climate change − disputes over the allocation of increasingly scarce water resources between power generation, agriculture and other uses. Nuclear power reactors consume massive amounts of cooling water − typically 36.3 to 65.4 million liters per reactor per day.[44] The World Resources Institute noted last year that 47% of the world's thermal power plant capacity – mostly coal, natural gas and nuclear – are located in highly water-stressed areas.[45]

By contrast, the *REN21 Renewables 2015: Global Status Report* states:[46]

"Although renewable energy systems are also vulnerable to climate change, they have unique qualities that make them suitable both for reinforcing the resilience of the wider energy infrastructure and for ensuring the provision of energy services under changing climatic conditions. System modularity, distributed deployment, and local availability and diversity of fuel sources − central components of energy system resilience − are key characteristics of most renewable energy systems."

7. Nuclear Waste

Globally, countries operating nuclear power plants are struggling to manage nuclear waste and no country has a repository for the disposal of high-level nuclear waste. A January 2019 report details the difficulties with high-level nuclear waste management in seven countries (Belgium, France, Japan, Sweden, Finland, the UK and the US) and serves as a useful overview of the serious problems that beset the industry.[49,50]

The United States has a deep underground repository for long-lived intermediate-level waste, called the Waste Isolation Pilot Plant (WIPP). However the repository was closed from 2014–17 following a chemical explosion in an underground waste barrel.[47] Costs associated with the accident are estimated at over US$2 billion.[48] Safety standards fell away sharply within the first decade of operation of the WIPP repository – a sobering reminder of the challenge of safely managing dangerous nuclear waste for millennia.

More Information:

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