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Climate Crisis: Nuclear Power Is Not the Way Out

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That nuclear power is a good solution to combating climate change is a claim that is being increasingly sold across the world. This does not bear scrutiny. The expansion of nuclear power is neither desirable nor feasible for addressing the climate emergency.

Growing concern about global warming and its accelerating impacts worldwide have catalysed support for nuclear power in many places. Carbon dioxide (CO2) emissions from nuclear power – while not zero as is often claimed – are much lower than those from fossil fuel combustion. Bituminous coal, for instance, which India uses a lot, emits 93 kilograms of carbon dioxide per million Btu. Nuclear reactors, on the other hand, do not produce carbon dioxide while running. However, there are a lot of embodied emissions in the mining and processing of uranium, the concrete and metals used in building reactors, and in their decommissioning.

Nuclear power has become part of energy transition plans in numerous countries, but support for it has also surfaced in less likely places. For instance, in a recent issue of the leftist US journal *Catalyst*, Matt Huber wrote that a socialist approach to the electricity sector "points towards the importance of centralised, large-scale reliable power generation like hydroelectric dams and nuclear power." James Hansen, one of the world's most respected climate scientists, has supported nuclear power for years. In a group email, Hansen wrote in May, "Young people today have been denied the option of ready, low-cost, modern nuclear power to complement intermittent renewable energies." In their support for nuclear power, Huber and Hansen have had allies in political worthies such as Manmohan Singh, Narendra Modi, and Ram Madhav.

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In *Nuclear Is Not the Solution*, M.V. Ramana, a physicist and member of the International Nuclear Risk Assessment Group, demonstrates emphatically why such faith in nuclear power as a solution to climate change is hugely misplaced, and why expanding nuclear power "is neither a desirable nor a feasible solution to climate change."

Ramana informs us that the number of nuclear reactors worldwide has remained roughly the same since the 1980s. In the first two decades of this century, 95 reactors became operational and 98 shut down because older reactors could not compete with the available energy alternatives or because they had exceeded their viable life spans. Partly because of this stagnation in their number, the generation of electricity from nuclear reactors has stayed largely flat over the last decade. It was 2,490 terawatt-hours (TWh) in 2013 and had only crept up gingerly to 2,737 TWh 10 years later.

Mind you, this was a period in which electricity generated from modern renewables such as solar and wind power expanded significantly – over 2,000 TWh more than nuclear power supplied in 2023 (Statistical Review of World Energy 2024: 53, 56). Consequently, the share of electricity generated globally from nuclear sources has fallen sharply, to just over 9% in 2022 from about 17% 25 years ago. Electricity, as Ramana reminds us correctly, is just one form of energy. In its share of global energy consumption, nuclear power is a low 4%.

There are two key reasons why the performance of nuclear power has been underwhelming. For one, it takes ages to get a reactor up and running, 20 years typically. On an average, 10 years lapse between starting their construction to supplying electricity to the grid. That itself is after a decade has been spent getting permissions and garnering the finance.

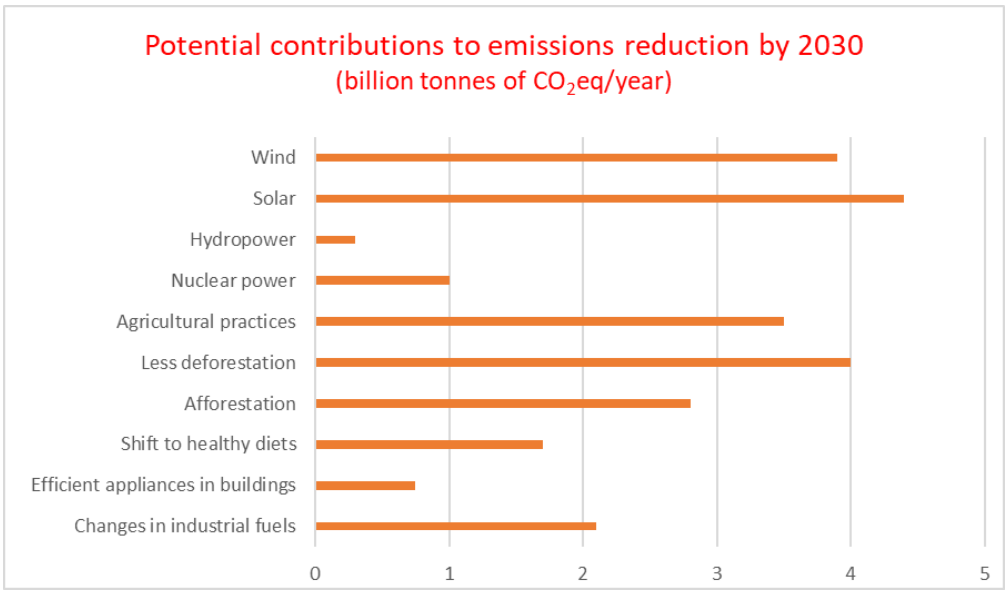
The second reason is cost. The levelised cost of electricity, or LCOE – a concept that measures the average cost of electricity over the lifetime of an asset, and is used to compare energy sources – of nuclear power is, at $168 per megawatt-hour (MWh), five times as high as solar or wind in some countries. Most pertinently, the cost of building a nuclear reactor has increased in recent years, contrary to most technologies and especially in contrast to the prices of wind and solar power.

> In the original IPCC figure, there are at least a dozen measures shown that can contribute more than nuclear power can, and all are a lot cheaper. And safer.

In modern economies, two parameters that really matter are price and scale. A highly expensive energy source whose output is growing at a snail-like pace can hardly be relied upon to address the urgency of global warming. *The Global Tipping Points Report 2023* by Timothy Lenton et al. says, "Five major tipping points [for ecosystems] are already at risk of being crossed due to warming right now and three more are threatened in the 2030s as the world exceeds 1.5°C global warming." To sink billions of dollars into nuclear power in the face of such danger seems foolhardy when safer alternatives that could reduce emissions in greater volume more quickly are now financially more viable and widely available.

How limited the mitigation gains from more nuclear power would be in the near future is evident from Figure 1, adapted from the Intergovernmental Panel on Climate Change's (IPCC) latest *Sixth Assessment Report* (2023). It lists some key measures by which greenhouse gas (GHG) emissions can be reduced, and potentially by how much by 2030 (against a 2015–2019 baseline). In the original IPCC figure, there are at least a dozen measures shown that can contribute more than nuclear power can, and all are a lot cheaper. And safer.

Figure 1: Key GHG Emissions Reduction Options and Potential by 2030



I suspect that even the number given in the figure (1 billion tonnes/year of GHG emissions reduced due to added nuclear power by 2030) is an overestimate. According to Mycle Schneider, lead author of the *World Nuclear Industry Status Report*, "At least 270 [reactors] are going to close down in the next 27 years […] Just to replace the 270 would need 10 new ones a year and that is not happening. In the past two decades, the average rate of construction has been five reactors per year."

This is a point Ramana had made in his 2012 book *The Power of Promise*: "The likelihood of a rapid expansion of nuclear power is very dim." Clearly, as far as this aspect of nuclear power is concerned, nothing much has changed in the intervening 12 years.

Critique of nuclear power

Beyond addressing climate change, *Nuclear Is Not the Solution* is primarily a compelling and comprehensive critique of nuclear power, its technical, economic, and environmental aspects. Ramana addresses nuclear power's considerable risks to the environment and people's health, including cancers and mortality; the implications of the enormous time and costs in generating electricity from nuclear reactors in different countries; and how (private) companies profit while ordinary people pay the costs in terms of higher electricity bills or taxes that are handed over to companies as subsidies in the billions. He points out that the expansion of nuclear power is highly dependent on government support in all countries; that there are strong technical, personnel, and institutional two-way linkages between nuclear power and nuclear weapons; and that there are issues with small modular reactors (SMRs) and other "advanced" reactors.

> This discussion of mortality from nuclear energy raises the question: how does it compare with deaths from fossil fuel combustion? This question is particularly valid in societies such as India or China where coal is the largest energy source.

One can draw attention to only a couple of issues in a review, but I would urge everyone to read this book. Ramana covers the varied facets of nuclear power with the comforting mastery of someone who has written authoritatively on the subject for years. It also makes for easy reading —no mean achievement while dealing with such a complicated subject—and he offers handy metaphors or parallels to explain difficult concepts, such as when discussing the complexity of nuclear accidents.

Cancer, deaths, and nuclear power

This brings us to the major charge against nuclear power, that it poses massive risks to the environment and human health. Ramana presents the hazards in painstaking detail, such as the 30-fold increase in thyroid cancer cases amongst children and adolescents after the Fukushima disaster; and the 19,233 thyroid cancer cases in Ukraine, Belarus, and four regions in Russia between 1991 and 2015 after Chernobyl. Accidents are by definition chaotic, occurring due to reasons that engineers fail to consider, Ramana points out.

In addition to accidents, there are the potential health hazards from nuclear waste, some of which will continue to emit radiation for millions of years. There are also the deaths that will ensue. Extrapolating from a committee's work that statistically quantified the relation between radiation exposure and fatalities, Ramana reveals that 1,800 people would have died from cancer in Japan in the first 10 years of radiation exposure; for Chernobyl, the figure is 34,000 deaths.

This discussion of mortality from nuclear energy raises the question: how does it compare with deaths from fossil fuel combustion? This question is particularly valid in societies such as India and China, where coal is the largest energy source and the development of alternative energy sources could potentially crowd out coal. Estimates of deaths from fossil fuel combustion tend to vary depending on the source, but they are all staggeringly large and their scale is not contested.

For instance, a 2023 paper in *The BMJ* suggested that "an estimated 5.13 million excess deaths per year globally are attributable to ambient air pollution from fossil fuel use." This means that more people die worldwide every month from fossil fuel combustion than from the entire history of nuclear power use. Ramana quotes James Hansen and Pushker Kharecha who wrote that "the use of nuclear power around the world has prevented an average of 1.84 million pollution-related deaths." I do not know whether their number is robust, but this is an important question that Ramana sidesteps by responding in just one paragraph.

SMRs not the answer

That nuclear power is costly, takes ages to build, is dangerous, and faces disapproval from millions of people all over the world begs the question: why do economic and political elites still push for its expansion? This question is addressed in fascinating detail by Ramana through unveiling the tax credits and billions of dollars earned by private companies, sometimes even before a single unit of electricity is produced, and the billions of dollars earned after the fact from the decommissioning of aged nuclear reactors. It is a triumph of private profits over public interest, as Ramana correctly points out.

As large nuclear projects overrun deadlines and budgets and are often closed down for not being viable, political and technocratic elites have now begun to push for small modular reactors (SMRs), often citing climate change as a reason. SMRs, by definition, have a capacity less than 300 MW. The Indian government is pushing for SMRs in collaboration with the private sector.

For instance, the CEO of Tata Consulting Engineers reportedly said a few weeks ago that "the plan was to make 40–50 reactors in less than seven to eight years." Linking SMRs to climate change, the Minister of State for Atomic Energy mentioned them in 2022 as "clean energy options in tune with PM Modi's roadmap for a clean energy transition through bold climate commitments." A government press handout described them as "flexible in design, require smaller footprint, and [a] mobile and agile technology."

> The Russian small modular reactor took 12.7 years to build, and even in China, it took 10 years to build. To talk blithely of "40–50 reactors in less than 7–8 years" is ludicrous.

Reading such official handouts, often in the business press, a lay reader would get the feeling that one could easily build and install SMRs next to the gram panchayat office, break a coconut, and get them up and running.

Nothing could be further from the truth. As Mycle Schneider said in a recent interview in the *Bulletin of Atomic Scientists*, as of December 2023, there were just four SMRs operating in the world, two apiece in China and Russia. The Russian SMR took 12.7 years to build, and even in China, it took 10 years to build. To talk blithely of "40–50 reactors in less than 7–8 years" is ludicrous and reveals shoddy, uncritical reporting.

Any media person who reports on nuclear power in India or edits a publication needs to read this book. Ramana points out that SMRs have all the drawbacks and hazards of conventional reactors. They are very costly as a source of energy. They are more costly per unit of electricity generated because of the capital costs involved, and produce more hazardous waste per unit of electricity produced than anything else. Whereas they have less radioactive material than conventional reactors and less energy is released if there is an accident, the possibility of there being many more of them, and that companies plan to build many in close proximity at one site to save infrastructural costs carry the danger of an accident in one SMR damaging another unit.

That SMRs (and nuclear power in general) are being pushed as a part of the "clean energy transition" brings us back to the question contained in the book's title: is nuclear power the solution to climate change? Its high cost relative to other energy sources, the time it takes to build reactors, and the trend in the rest of the world other than China (57 more reactors closed down in the last 20 years than started, a net negative 57) suggests that nuclear power will be a marginal player for the predictable future. At the end of the day, the Earth's system responds to global emissions, in which nuclear power will at best make a small dent.

At most, one could say that nuclear power could play a role in the energy transitions of particular countries in the medium term. For that reason, one wishes the book had presented the experience of two countries in some detail, one whose nuclear generation had expanded in the past and the other where it will in the near future. The first is France, which of all the industrialised countries has had the greatest share of electricity generation from nuclear power, over 70% in the past. It seems to have declined by 129 TWh between 2010 and 2022, for a range of reasons, but was still an impressive 294 out of 466 TWh (63%) in 2022. As the Ukraine conflict constrained its gas supply, France's electricity from nuclear power rose to 338 out of 519 TWh in 2023, with renewables producing 84 TWh, hydropower 55 TWh, and coal a mere 0.9 TWh (Statistical Review of World Energy 2024: 56).

> Nuclear power now contributes just 5% of China's electricity production, but trends reveal that China's electricity generated from nuclear power is four times what it was 10 years ago: 111 TWh in 2013 and 434 TWh in 2023.

Even more than France, one needs to discuss China, where there are, according to reports from the Beijing-based media house Caixin, 56 reactors currently operating, with a further 10 each approved in 2022 and 2023, and 11 reactors approved a month ago. Ramana quotes a study to say that "the more a country invested in nuclear power, the less it tended to invest in renewables, and vice versa" (p. 79). While that may generally be the case, it does not seem so in China, where over half the world's nuclear reactors have been built in recent years, and yet clean energy investment in China – overwhelmingly the largest source of renewable power in the world – in 2023 alone totalled US$890 billion, larger than the gross domestic product (GDP) of Switzerland.

Nuclear power presently contributes just 5% of China's electricity production, but examining trends reveals that China's electricity generated from nuclear power is four times what it was 10 years ago: 111 TWh in 2013 and 434 TWh in 2023 (Statistical Review of World Energy 2024: 53). One suspects that nuclear power will contribute non-trivially at the margins in China as it seeks to expand electrification of its transport and other sectors. What may actually unfold remains to be seen, but by far the most important player in the world in global warming and in terms of its energy transition, China warrants more elaborate discussion.

Amplifying the risks

What further clinches the issue about the role of nuclear power is the direct connection between nuclear energy and nuclear weapons. Ramana discusses three inter-related aspects: technical overlaps, shared personnel and expertise between nuclear energy and nuclear weapons, and institutional imperatives. He writes, "The connection between nuclear energy and nuclear weapons derives from the fact that any technology capable of enriching uranium-235 from 0.7 per cent to 3 per cent can further enrich it, to levels of concentration needed to produce nuclear weapons. This […] was the underlying technical reason for concern about Iran's centrifuge programme."

Enriched uranium was used in the Hiroshima bomb. With plutonium too, countries can generate electricity, but also use it to make or test nuclear bombs, as India and North Korea have. The possibility of numerous small modular reactors proliferating in many countries increases the risk of more actors acquiring nuclear weapons (pp. 172, 223), a scary prospect in a world riven by conflict.

> It is outrageous that elites are opportunistically using climate change to push a technology that would amplify the risk of annihilation. Greater, swifter, and cheaper emissions reductions can be achieved by a range of other measures.

In the 1970s and 1980s, tens of thousands marched the streets against nuclear weapons in towns large and small in Europe. The potential horrors of nuclear warfare made luminaries from different walks of life speak up. For instance, the famed Marxist social historian E.P. Thompson in *Protest and Survive* penned 'A Letter to America', in which he wrote that even with prior warnings and effective safety measures, 20 million, or one-third of the British population, would die in the event of a nuclear war. Such concerns prompted novelist Gabriel Garcia Marquez to say in his Nobel Prize acceptance speech in 1982, “The more prosperous nations have succeeded in accumulating sufficient destructive power to annihilate one hundred times over not only every human being who has ever existed but every living creature ever to have graced this planet of misfortune.”

It is outrageous that, 40 years later, elites are opportunistically using climate change to push a technology that would amplify the risk of annihilation. Greater, swifter, and cheaper emissions reductions can be achieved by a range of other measures. The world needs to address climate change urgently, but we do not need to put humanity at risk to do so.

Nagraj Adve is a member of ‘Teachers against the Climate Crisis’ and the author of Global Warming in India: Science, Impacts, and Politics *(Eklavya, 2022).*