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Monitored this issue:

Nuclear in India's Energy Debate: Insights from people's perceptions and experiences of nuclear energy in India.

Prerna Gupta

The Indian government has announced ambitious plans to triple nuclear energy capacity by 2030. According to the Long-Term Low Emission Development Strategy (LT-LEDS) submitted to the United Nations Framework Convention on Climate Change (UNFCCC), India aims to triple its nuclear power capacity by 2032.[1] The Union Minister of State for Atomic Energy, Jitendra Singh, recently announced plans to commission 20 new nuclear reactors to meet this target.[2]

However, every new nuclear project in India has met with opposition from the public. Post the Fukushima accident this opposition intensified with massive protests erupting in the vicinity of locations chosen for new nuclear reactors, especially the Koodankulam power plant in Tamil Nadu and the Jaitapur plant in Maharashtra.[3] These protests were met with violent oppression from the state, sometimes leading to the deaths of protestors.[4] Such resistance has continued. The most recent protests were focused on a proposed power plant in Rajasthan and once again resulted in violent clashes between the police and protesters.[5]

People protesting nuclear energy have raised concerns about a range of safety and health risks based on their experiences and observations. For instance, in Jaitapur, the public pointed out the plant was being cited in an earthquake-prone zone.[6] Similarly, in Koodankulam, community members voiced concerns about the safety of the reactor because they were aware of substandard equipment being imported from Russia and substandard cement for construction being supplied by a local contractor.[7]

However, any concerns raised by people regarding nuclear energy are dismissed by the nuclear establishment as "emotional" and "unscientific" responses.[8] Those opposing nuclear projects are also dubbed as anti-national. For instance, all 8,856 residents of a village near Koodankulam were labelled "enemies of the state", and charges of sedition were used to suppress dissent.[9]

In my PhD research, I aimed to provide a more nuanced understanding of how people in India perceive nuclear energy. My work explores public perceptions of the risks and benefits associated with nuclear energy in the country. I conducted national surveys to identify trends and gain insights into these perceptions. I also added depth to the study with case studies—one on uranium mining in Jadugoda and another near India's oldest nuclear power plant in Tarapur. These case studies highlight the experiences of local communities living near nuclear facilities. Using insights from risk studies, I explored the social and political factors that shape how nuclear energy institutions operate in India.

This research was conducted in collaboration with Prof. M.V. Ramana, Prof. Terre Satterfield, and Prof. Milind Kandlikar at the University of British Columbia. Consequently, I use "we" and "I" interchangeably throughout this work to reflect the collaborative nature of the project. Following are some of the key insights from my thesis.

1. Risk Perception of Nuclear Energy in India

Nuclear energy is perceived as a high-risk technology everywhere. Studies conducted in the United States, Sweden, Japan, Norway, Australia, the UK, Chile, and Jordan, have shown that people across the world perceive nuclear energy as a risky technology.[10] Even in France, where nuclear energy accounts for a very high proportion of the total electricity generated, people perceive the risk from nuclear energy as high.[11] Studies have also found that the French public's perception of risk from nuclear energy is as high as that of the American public.[12]

This study is one of the first to explore public perceptions of nuclear energy risks in India. We compared perceptions of risk and benefit for nuclear energy with other major energy technologies in the country. We carried out a survey with a diverse sample of 1,100 participants from five Indian states—Uttar Pradesh, Rajasthan, Tamil Nadu, West Bengal, and Maharashtra—conducted in five major regional languages. The results show that nuclear energy is perceived as the riskiest, with a mean risk score of 3.4, significantly higher than the average risk score of 2.67 across all technologies (fig. 1). In contrast, nuclear energy's perceived benefit is among the lowest, with a mean score of 3.3, below the average benefit score of 3.47.

In Global North studies, the perception of risk and benefit for an energy technology is often inversely related, meaning that if people perceive a high risk from a technology, they tend to see it as providing lower benefits, and vice versa. For instance, if nuclear energy is perceived as highly risky, people in those contexts are more likely to view it as offering minimal advantages or benefits. This inverse relationship suggests a trade-off in people's minds: technologies that seem safer are viewed as more beneficial, while those that seem riskier are seen as less advantageous.

In contrast, our findings reveal that perceived benefits for all energy technologies are generally high, with smaller differences compared to perceived risks as shown in fig 1. This is probably because in energy-scarce situations in developing countries, the benefits of energy technologies are perceived as high, irrespective of their risks.

Statistical analysis shows that nuclear energy's perceived benefits are same as from traditional energy sources like oil and coal. However, it is viewed as offering lower benefits than renewables, hydro and natural gas.

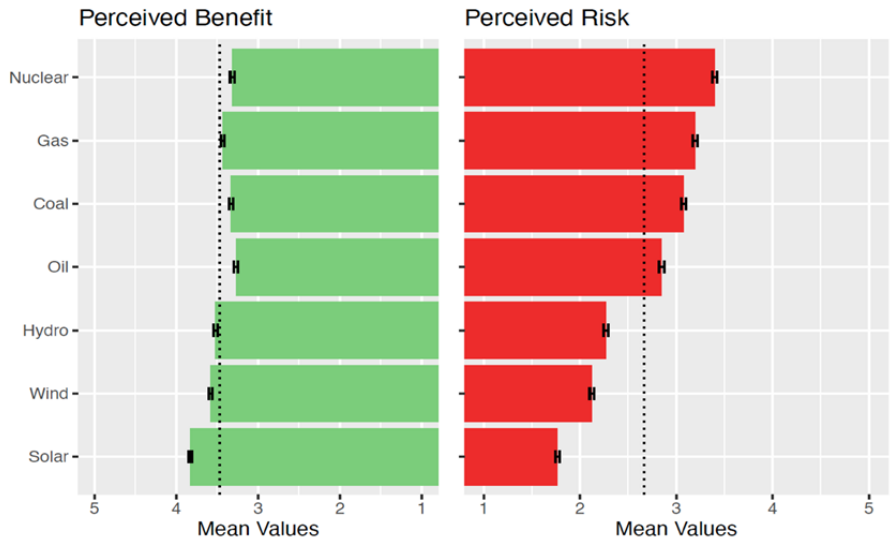

Figure 1. Bar charts showing mean perceived risk and mean perceived benefit for various energy technologies. Dotted line represents mean benefit and mean risk across all technologies.

We also calculated a net benefit score for all energy technologies by subtracting the perceived risk scores from the perceived benefit scores. Renewables had the highest net benefit score, followed by hydroelectric power. In contrast, nuclear energy had the lowest net benefit score, dipping into negative territory, indicating that its perceived risks outweigh its perceived benefits. This trend is illustrated in Figure 2.

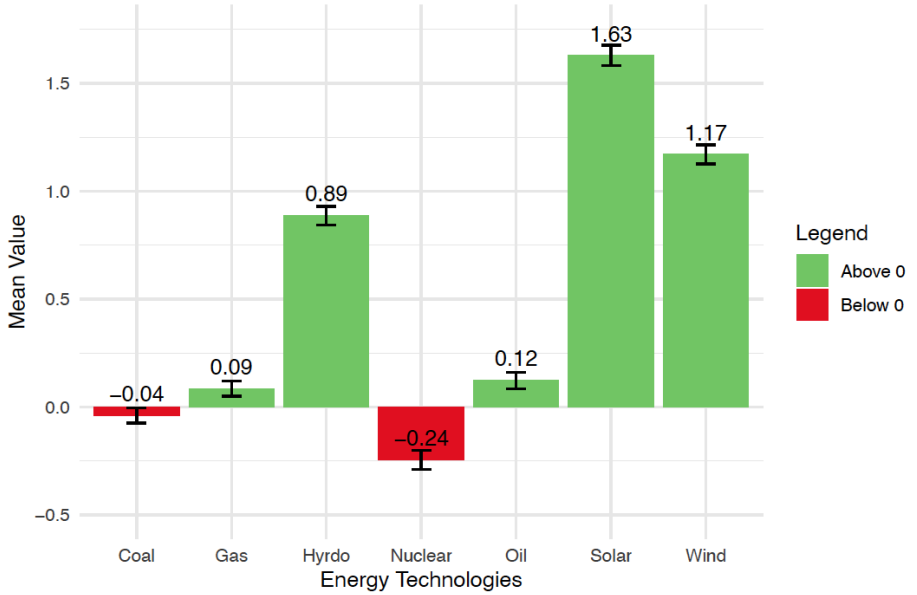

Figure 2. Bar charts showing net benefit (perceived benefit – perceived risk) from all energy technologies

2. Factors Influencing Risk Perception of Nuclear Energy in India

Further, we were interested in what factors influence the risk perception of nuclear energy in India. Large scale energy projects are seen as development projects in a developing country like India. However, the state's idea of development has been challenged especially by environmental movements in India, which generally have a very large rural base and have been at the forefront of raising questions that are at once environmental, political, and economic in character.[13]

To address this, we drew from the work of Madhav Gadgil and Ramachandra Guha on environmental movements and ecological histories in India and,[14] developed a new economic and political value scale to identify distinct values as they are relevant to the risk perception of nuclear energy (and other energy technologies) in India.

Two main groups emerged in our research with distinct ideas on development:

Nationalist Development (Ndevelop): This group's values (in orange) strongly emphasize national development, national pride, economic prosperity and job opportunities. They are more positively inclined toward centralisation, large industries, and the global economy. However, they show less concern for the potential negative impacts of nuclear energy like displacement, pollution, and health risks.

People-Centered Development (Pdevelop): The values of this group (in teal) seem to prioritise the environment over development and exhibit more concern regarding impacts on national beauty, displacement, pollution, and health risks due to nuclear energy. This group is negatively correlated to national and community pride.

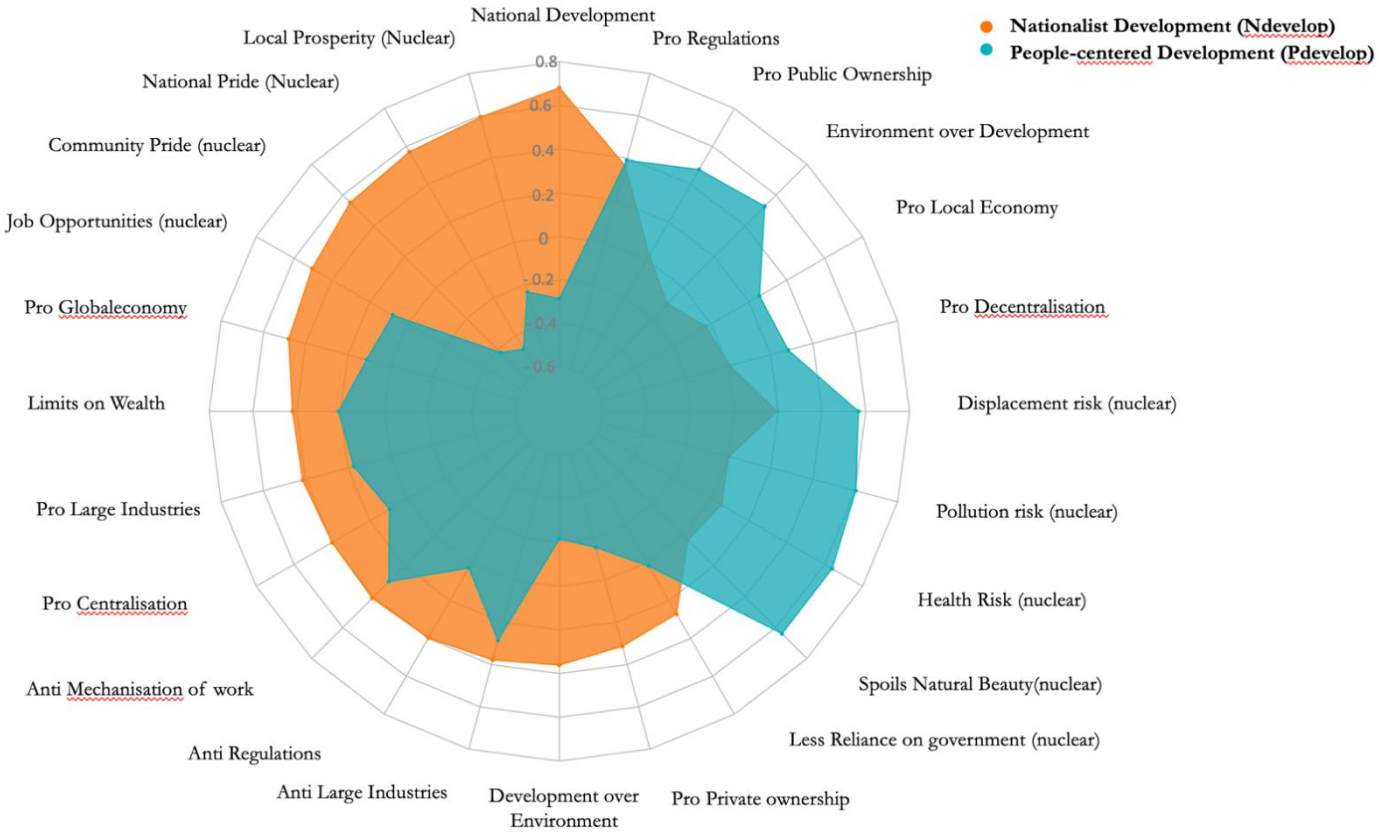

Fig 3. Two Distinct Groups with Differing Development Values

We conducted statistical analysis, including linear regression, to examine the impact of these values on risk perceptions of nuclear, solar, and coal energy. The results show that these values have significant impact on the perception of risk, benefit and net benefit from these energy technologies.

Values centered on people-focused development were significantly and positively correlated with perceived risks for all three energy sources, with the strongest correlation observed for coal. This implies that people higher on people-centered development values see higher risks from solar, coal and nuclear. Conversely, nationalist development values, which emphasise national pride and economic growth, were positively correlated with perceived net benefits from solar and coal but not with nuclear energy. In other words, the persistent narrative by the Indian state portraying nuclear energy as a source of national pride and development has not resonated with the public. People-centered development values were negatively correlated to net benefits, reflecting concerns about health and pollution risks from all three energy technologies.

Experiencing Nuclear Energy in Tarapur

In this case study, I focus on the experiences of people living near the Tarapur nuclear power plant in Maharashtra, India. Announced in 1960, Tarapur ended up being India's first nuclear plant and began producing energy in 1969 when two reactors became operational. Through the experiences of people living near the Tarapur Atomic Power Plants (TAPS), I explore the disjunctures between the state's narrative about nuclear energy and the local community's lived realities.

Since India's independence, nuclear technology has symbolized national development and modernization, reflecting aspirations of industrialization and self-sufficiency.[15] India's first Prime Minister Jawaharlal Nehru laid special emphasis on the importance of nuclear energy for the newly independent Indian state.

Over time, the theme of national development has persisted with subsequent prime ministers. In 1970, Prime Minister Indira Gandhi asserted that developing countries like India could leap over several intermediate and not-so-essential stages of development through nuclear energy.[16] In 2009, Prime Minister Manmohan Singh, who championed the Indo-US nuclear deal, asserted that nuclear energy was essential for economic growth and energy security.[17] These arguments were then echoed by the nuclear department officials as well. In a recent talk, former Chairman of the Atomic Energy Commission of India, K.N. Vyas, emphasized the importance of nuclear energy in delivering environmental benefits and promoting local development. He highlighted the potential of nuclear power projects to create jobs and drive community development, arguing that public concerns about nuclear risks are often misplaced.[18]

We conducted 18 interviews with residents and workers in five villages in a 5-kilometre radius of TAPS to explore people's experience of the power plant. In interviews around the Tarapur atomic power plant several people said that the narrative of national development had resonated deeply with the previous generations in the nearby villages when the plant was proposed in the 1960s. At the time of independence, people were eager to contribute to the development of the country and many voluntarily gave up their lands. However, over the years, this has turned into immense disillusionment. They gave up their traditional livelihoods but gained little in terms of jobs and development.

The disillusionment is exemplified by the rehabilitation of two villages of Popharan and Akkarpatti displaced by the development of Unit 3 and 4 of the power plant in 2002. Virendra Patil, a resident of Popharan took us around two villages showing the conditions of rehabilitation provided by the power plant management. According to him, 1,750 people were displaced. After much struggle, 1,250 of these people have been rehabilitated, leaving the rest to fend for themselves. The promises of employment were not fully realized, with many only finding contract work at the plant.

As we walked around the village, he showed us the poor state of the houses, roads, marketplace, and infrastructure for electricity and water. Many houses like the ones shown in the pictures here remain abandoned due to their poor quality of construction. These villages flood severely during monsoon.

Fig. 4 a & b. Abandoned houses in the rehabilitated village of Popharan due to poor construction. Photos by Sandeep S.

Figure 5 a&b Rehabilitated village of Popharan during Monsoon. Photos by Kalpana's family.

During our visit in October 2022, the monsoon season was just ending. A resident Kalpana showed us how water had left marks all over her house, spoiling the furniture and walls. She recounted how, during the worst of the monsoon, her sons had to carry her and their children out of the house to prevent them from drowning. Overcome with emotion, she asserted, “It would’ve been better if they had killed us there (in our old village). Here we are facing so many difficulties. They have committed a huge injustice towards us… I challenge them (*NPCIL officials*) to come live in my place for 20 minutes.”

Fig 6. Kalpana, Resident of Popharan. Photo by Sandeep S.

Residents near the Tarapur power plant do not believe nuclear power is a clean and safe energy source, citing various environmental and livelihood risks such as a reduction in fish catch. Many fishers have abandoned their traditional livelihood as it is no longer economically sustainable. Furthermore, rehabilitation has put them more than 10 km away from the ocean.

Fig 7. Fishers at Chinchani beach near the Tarapur Atomic Power Plants (TAPS). Photo by Sandeeep S.

Contract workers experience a lack of safety at work as they don't get the same health benefits or medical attention as permanent workers. A contract worker Harkesh Tamhore spoke to us and told us that in the case of a workplace injury, "there is a problem to even call an ambulance. They give first aid and then tell us it's not our responsibility anymore. Now it's your responsibility."

Fig 8: Harkesh Tamhore,Contract Worker at TAPS. Photo by Sandeeep S.

Neeraj Raut who lives nearby and has consistently reported on the power plant for the last 15-20 years asserts that the emergency preparedness of NPCIL is an abstract thing which the management asserts is perfect but in practise it doesn't exist. The management does not share any plans for emergency situations in case of an accident and never answers the locals or journalists regarding their concerns.

Fig 9. Neeraj Raut, journalist who has consistently reported on the Tarapur Plant asserts, "theoretically, the emergency preparedness for NPCIL Unit 1 to 4 is perfect here(in Tarapur), but if you happen to see the practical, it is absolutely zero."

There is a general lack of engagement with the local communities. Residents of Ghivali, Tarapur, Uchheli, and Dandi remember officials checking them and their children for radiation exposure, taking fish and local food samples over the years, but never sharing the results or making any effort to make this information accessible to villagers. This runs counter to democratic rights as a local resident and former *sarpanch* (elected village head), Jitendra Raul put it, "If this technology is

for the good of the people, then what do they have to hide? No, they are just making a fool of us. If they are doing something for us, something to protect my future then I should know! …I should be able to decide if what you are doing for me is right or wrong, this is my right in a democracy. This is not happening in the (nuclear) department. This is true everywhere in the world, not just in India."

Fig 10. Jitendra Raul, Resident and former sarpanch (elected village head), Navi Delwadi

3. Reason and Risk : Challenging the expert and public divide in the risk debates on uranium mining in India

For the last two decades, roughly from the period following the nuclear weapon tests conducted by the country in May 1998, India's oldest uranium mines have been mired in controversy. These mines located on the Adivasi (or Indigenous) land are suspected of having caused adverse health effects among mine workers and the inhabitants of the villages nearby.

Some people, mine workers and activists around the mines are convinced that the radiation from the mines and the tailing ponds are the source of the ill-health they have observed in the area over generations. The nuclear establishment officials (UCIL and other affiliated government officials) dismiss these claims as "myths" rather than "facts", which they, as the scientific-technical authority, claim to hold in this controversy.

Often in public discourse, there is a distinction made between objective assessment of risk by experts and subjective – value or emotion-based perception of risk by the public. This case study employs discourse analysis to challenge this objective-subjective characterisation by three arguments: First, risk definitions and assessment methodologies used by experts are not as unanimous as often perceived; instead, experts argue and dispute each other's definitions. Second, people's perceptions of risks are not merely based on values and emotions, devoid of any cognitive assessments. They make judgements based on their past and present social experience of institutions that are involved in making and managing risks. Third, (technical) experts do not exist in contexts free of politics and are not immune to the politicisation of risk controversies. They use these political narratives to deflect and assign blame in a manner that protects their social order and worldview.

These arguments are expanded upon in my thesis. To illustrate the nature of these conflicts, one notable dispute between experts arose in the late 1990s, during the peak of the controversy. The nuclear establishment claimed that regular radiation readings showed no increase in background radiation levels since mining began and that radiation levels remained well within the standard limit of 1 mSv per year. However, Dr Surendra Gadekar, an independent physicist, challenged the Uranium Corporation's calculations of average radiation exposure and recounted an interesting incident highlighting his concerns.

"One day while we were doing data collection during the survey Dr Jha *(establishment expert)* himself arrived and complained that we had been publicizing falsehood with regard to radiation readings in the neighbourhood…The upshot of the discussion was that I agreed to accompany him and take joint readings… Just outside his office, was a pile of rocks. The readings there were three times higher than the ones we had been taking. I asked him why he did not take readings near this pile or many other piles spread all over Jadugoda. His answer was that this was mine overburden rock and readings near such piles were bound to be higher."[19]

Dr Gadekar believed this was the crux of the controversy, observing that since radiation levels vary greatly within short distances and times, it was easy to get widely varying numbers and different averages. He argued what matters to people's health is that averages should reflect where people spend most of their time. He further found that some of the houses were made of mine overburdened rock that was sold by UCIL for cheap and calculated that the annual radiation dose for an individual living in such a house would exceed the annual limit by at least 50%.

Secondly, I argue that people make risk decisions based on their lived experiences. Local residents and activists in Jadugoda have raised concerns about UCIL's (Uranium Corporation of India Limited) management practices, which they have observed firsthand. The 1998 documentary *Buddha Weeps in Jadugoda* captured troubling examples of UCIL's negligence. It included footage of leaking drums containing yellowcake (slightly processed powdered uranium) handled by barehanded workers, barefoot teenagers playing with these drums, and dust from open tailing ponds blowing into nearby villages. Mineworkers testified to not being provided gloves or proper masks, among other unsafe practices.

These practices have shaped local perceptions of the mines as harmful to health and the environment. Residents have reported an increase in health issues. For example, a midwife with decades of experience noted an increase in abnormal births and miscarriages.[20] Mineworkers also reported slow-healing wounds from injuries sustained at work.[21] Dopan Majhi, a 65-year-old village head in Tilaitand, remarked, "When UCIL started its operations, a lot of my contemporaries were employed there. They are all dead now".[22] These experiences have created a collective social memory that fosters suspicion of UCIL's practices and opposition to the mines in the area.

Finally, I argue that the nuclear establishment in India does not act as a politically neutral expert in these situations; rather, it actively politicizes controversies like those in Jadugoda. Across India, opposition to the nuclear program is often dismissed as "anti-national" by the state and nuclear authorities. In Jadugoda, UCIL officials have implied that reports of deformed children and health impacts are part of a conspiracy to undermine India's nuclear progress.[23]

This framing serves to "other" the Adivasi communities, who occupy the lowest rungs of India's social hierarchy, while the nuclear establishment remains at the pinnacle of political and

institutional power. Since the time of Prime Minister Nehru, nuclear technology has been a central pillar of India's nation-building narrative. Labeling opposition as anti-national allows the establishment to shift blame onto Adivasis and delegitimize their concerns, thereby maintaining control over the risk controversy.

4. Conclusion

Several critical insights about nuclear energy in India emerge from the evidence presented across all chapters. Firstly, nuclear energy is consistently perceived as the least favourable energy source among all alternatives. It is regarded as the riskiest energy technology, with low perceived benefits. Our survey and case studies further reveal that the experiences of those living near nuclear facilities do not inspire confidence in this technology. Residents near these sites perceive high levels of risk and have low trust in the management, particularly due to the opaque nature of its operations.

Secondly, the public's perception of the risks and benefits associated with nuclear energy is multidimensional and heavily influenced by political factors and debates. It is evident that discussions of energy technologies in India are inextricably linked to broader conversations about development and the specific types of development these technologies represent. This is demonstrated in the survey findings as well as in case studies that further highlights the political dimensions that underpin risk debates surrounding nuclear energy. Therefore, it is essential to understand nuclear energy and for that matter any energy technology within its broader political context.

Case studies also point towards the unchanging attitude of the Indian state towards its Adivasi (Indigenous) and rural populations, reminiscent of colonial times, especially concerning displacement and development. The formal scientific community, often acting as an extension of the state, lacks independence and cannot be viewed as a self-correcting, truth-seeking body. This reinforces the need to scrutinise the supposed objectivity of expert risk assessments, as the line between science and state politics is blurred, with technical language often obscuring the underlying politics.

Thirdly, although nuclear energy has historically been associated with national pride and development in India, these concepts do not resonate with the states and populations investigated here. The survey results show that while nationalist development values are positively correlated with perceived benefits from solar and coal, they do not correlate with perceived benefits from nuclear energy. People's experience of living around India's oldest nuclear power plant in Tarapur has also disillusioned them of the promise of development that came with nuclear energy.

This thesis makes a compelling case against nuclear energy and for renewable sources. Complementary studies have consistently demonstrated that nuclear energy is not only economically unfeasible but also ineffective in addressing climate change.[24] Given these findings, India should reconsider its reliance on nuclear power to meet its carbon reduction targets. By opting for a nuclear-free strategy, the country would avoid investing significant resources in a technology that has historically failed to deliver on its promises, both in terms of performance and its impact on communities. Moreover, prioritising renewable energy aligns with the public's preferences and acknowledges the lived experiences of those affected by nuclear facilities, thus fostering more democratic and socially responsive energy policies.

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Framatome wants to expand Russian nuclear fuel production - but will it get a license?

Jan van Evert

The French company Framatome has applied for a license to expand production of nuclear fuel rods for so called VVER reactors at its German plant. The fuel production plant in Lingen, a small town close to the Dutch border, produces special hexagonal fuel rods. These are used in VVER reactors, a Soviet-designed reactor of which there are 19 in use in mostly East European countries. The plant is operated by its subsidiary Advanced Nuclear Fuels (ANF) in collaboration with the Russian company TVEl, a subsidiary fully owned by state-owned Rosatom.

But the license application has caused an avalanche of 11,000 objections since its publication in early 2024. To address these objections, the Lower Saxony Ministry for the Environment organized a meeting of 400 people between November 20-23. However, it remains unclear what decision will be made on the fate of the license and when.Enriched uranium and fuel pellets (used to assemble fuel rods) are still being supplied from Russia to the plant in Lingen to produce fuel for Western nuclear power plants.

Since there are currently no sanctions or restrictions on the import of these products from Russia to the EU, such deliveries continued even after the Russian invasion of Ukraine. The only alternative supplier for these reactors is currently the Canadian company Westinghouse which has a plant in Sweden for this purpose.

Critics worry that granting Russians access to a German nuclear fuel production facility could be exploited by Moscow for industrial espionage or even sabotage, as these people will be employees of the Rosatom state corporation which is actively involved in military operations in Ukraine. Christian Meyer, the Environment Minister who is responsible for deciding on the license application, has repeatedly said publicly that he shares protestors' concerns and takes the security threats very seriously.

The problem can be solved since Framatome is developing its own production technology for VVER fuel rods, but this will only be completed in the period 2025-2028. In the meantime, it will only be able to fulfil its contractual obligations on schedule by using licensed Russian fuel assemblies. But even if the license in Germany is denied, Framatome may still have the opportunity to try to set up a licensed assembly of Russian fuel at its plant in France.

World Nuclear Power Status

Number of Reactors
(as of January 2025)

Nuclear-Free Future Awards laureates announced

Jan van Evert

Beyond Nuclear and the International Physicians for the Prevention of Nuclear War have announced the laureates for the 2025 Nuclear-Free Future Awards. There are three categories: Resistance, Education and Solution. The winner for Resistance is S.P. Udayakumar from India, Márcia Gomes de Oliveira and Norbert Suchanek from Brazil win the prize for Education, and Edwick Madzimure from Zimbabwe is the laureate for Solution.
An Honorary Lifetime Achievement award will be given to teacher, author and anti-nuclear activist, Joanna Macy, and also posthumously to Native American activist and musician, Klee Benally.

The event will be held on Tuesday, March 4, 2025 at The Great Hall at Cooper Union in New York City. More details about the event and the laureates on the Beyond Nuclear site.
The Nuclear-Free Future Awards were founded by German journalist, filmmaker and activist, Claus Biegert, in 1998 and were first held in Salzburg, Austria. Since then, the Awards have travelled the world, honouring the largely unsung heroes of the Nuclear Age who work to end uranium mining and rid the world of nuclear power, nuclear weapons and uranium munitions.