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Saddling the Indian People with a (Radioactive) Law

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India's new thrust to nuclear power prioritises private profit over safety. On liability the 2025 law favours the suppliers and operators over the public. Experience also tells us that the new ambitious targets will not be met, and the dream of the unproven and expensive SMRs will be a chimera.

The Oxford dictionary defines "reform" as a "change that is made to a social system, an organization, etc. in order to improve or correct it". Using that term, as Union Minister of Science and Technology Jitendra Singh, did on multiple occasions (e.g. "marks a historic reform in India's nuclear sector"), when describing the new nuclear legislation passed by Parliament in December 2025 and now on the statute books, can only be described as an Orwellian technique. The changes that could result from this legislation to the nuclear sector will definitely not improve or correct shortcomings. As we outline here, the new legislation instead sets the stage for those private sector entities who choose to get into this business to profit, but at the cost of the public. The cost will be in the form of higher electricity bills and an increased risk of catastrophic accidents. And because they have been talked about as part of this legislation, we emphasize that the so-called small modular nuclear reactor (SMR) designs will not change the basic economic and ecological characteristics of nuclear power.

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The other reminder of George Orwell is in the name. The cruel irony of a bill dealing with a technology that can produce the most destructive of weapons being called SHANTI (Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India) fits the slogan laid out in Orwell's *1984*: "war is peace". The relevance of the activities covered in this legislation to the military is implicitly hinted through the multiple invocations of "national security". Most egregious of these invocations is its use to empower the central government to declare just about anything as "restricted information". The kinds of information that could be withheld from the public is long and could be in different forms ("a document, drawing, photograph, plan, model, or in any other form"); the Right to Information Act of 2005 cannot be used to challenge these restrictions.

Involving the private sector

The ostensible purpose of all these changes is to achieve some far-fetched goals and timelines set by the government for nuclear power capacity, which, in turn, is said to require "active involvement of both the public and private sectors". Let us start with what is entailed in private sector involvement.

The problem with nuclear power for private companies is that building and operating nuclear plants can be financially risky, because of the high cost of building reactors and uncertainties about how long it takes to build them. Consider the experience with some of the reactors in India recently built by the Nuclear Power Corporation (NPCIL): Kakrapar-3 and -4 and Rajasthan-7 and -8. All these reactors were to be put into service in 2015 and 2016, but three of them took more than a decade to build and the fourth is yet to be commissioned.

Construction of the Kakrapar-3 and -4 reactors started in November 2010, and these reactors were declared as operating commercially only in June 2023 and March 2024, respectively. Construction of the Rajasthan-7 and -8 reactors started in July 2011 and September 2011, respectively. Rajasthan-7 started commercial operations in April 2025 and Rajasthan-8 is yet to be completed. All four reactors are based on the Pressurized Heavy Water Reactor (PHWR) design and NPCIL has extensive experience with such reactors.

Delays are not a problem only in India. In other countries, including those where the private sector is building nuclear reactors, construction projects are routinely delayed. For example, in 2003, Finland's Teollisuuden Voima Oyj contracted with France's Areva and Germany's Siemens to build the Olkiluoto-3 nuclear reactor. Construction of the reactor started in 2005 and it was "scheduled to start commercial operation in 2009", but it eventually started commercially operating only in 2023.

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Nuclear reactors are also very expensive. The official cost for Kakrapar-3 and -4 is now estimated at Rs. 22,500 crore, up from Rs. 11,500 crore; Rajasthan-7 and -8 has also nearly doubled from an initial estimate of Rs. 12,300 crore to Rs. 22,900 crore. Again, such cost increases are in line with experiences around the world. One academic study found that 175 of 180 nuclear power projects had exceeded their initial budgets by an average of 117%, and took 64% longer than initially projected.

But even that history is misleading. More recent construction projects have experienced even more extreme cost escalations than the historical pattern. For example, the latest two reactors built in the United States at the Vogtle station ended up costing over $36 billion, much more than the $14 billion estimated when construction of those reactors started. The result of building expensive reactors is costly electricity. According to the Wall Street company Lazard's 2025 estimates, electricity from a new nuclear power plant in the US costs roughly three times the corresponding costs at solar or wind energy plants. In turn, costly electricity means higher power bills for consumers.

Being able to pass on costs and risks to consumers or taxpayers is what enables profit seeking private companies to be able to justify investing in nuclear power to their shareholders. For example, Georgia Power, the utility company building the Vogtle nuclear reactors, saw its profits rise over the period it was building the reactor, precisely because its consumers paid for the construction through increases in their electricity bills.

During the first decade of this millennium, during the heyday of the so-called nuclear renaissance, the U.S. Energy Policy Act of 2005 provided enormous economic incentives, to "reduce the financial risk of investing in advanced nuclear power plants by transferring risk to the public". It is the same kind of thinking that seems to underlie the 2023 NITI Aayog report calling for the government to put in place measures such as "loan guarantees or long-term price contracts" with the aim of "de-risking" nuclear construction projects, in particular so-called small modular reactors.

What happened in the US when the risk was transferred? Following the 2005 Energy Policy Act, US utility companies proposed building more than 30 reactors. But of these, most were cancelled because of high costs. Utilities only started building four reactors. Half of these, the two reactors built in the US state of South Carolina, were abandoned mid-project following huge cost and time overruns, after over $9 billion were spent; electricity customers in South Carolina are still paying every month for that wasted effort. Other utility companies like Duke Energy spent hundreds of millions of dollars on nuclear construction proposals but none of those reactors even advanced to actual construction; again, electricity consumers have been hit with higher bills. Only the two reactors built as part of the Vogtle project were actually commissioned. Involving private companies will not make reactor projects come out on time

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Private companies in India have already profited from nuclear projects. Many companies have received large contracts-for example, newcomer Megha Engineering for Rs. 12,800 crore in 2025.

Even prior to the enactment of the new legislation in December 2025, there was no proscription against the participation of private companies in the nuclear power sector. The Atomic Energy Act of 1962, and as it was amended in 1987, specifies that activities in this sector shall be carried out only by a "government company", which is defined as one in which "not less than fifty-one per cent of the paid up share capital is held by the Central Government". As government officials have clarified in the past, the private sector "can participate in setting up of nuclear power plants as a junior equity partner". But, so far, no private sector entity has chosen to do that.

The history of not a single company coming forward to take any equity in any of the nuclear plants built in the country does raise the question of whether many companies will indeed invest in nuclear reactor projects just because they are allowed to own a majority stake. Even in the weeks after the legislation was passed by Parliament in 2025, one could already see some industry executives talking about their concerns about nuclear power. One corporate official talked about "inherent challenges including extremely high capital cost [and] long gestation periods"; these, in combination with lack of experience were seen as leading to "execution risks and tariff competitiveness". But it is possible that the government can put in so many sweeteners-like the US government did in 2005-that private companies may embark on reactor construction. As in the US, it will be the public that will pay the bills for these adventures.

Liability for accidents

Under the new legislation, in the event of nuclear accidents or disaster, liabilities are to be transferred to the public. This will be done in two ways. First, the liability of the operator of the nuclear plant-which could be either a private company or a public sector company like the NPCIL -is capped. The cap depends on the power level of the reactor, ranging from a mere Rs. 100 crore to a maximum of Rs. 3,000 crore. If an accident were to result in damages more than that amount, then it will be up to the government-namely, the public-to pay. Compare this with what the Japan Centre for Economic Research estimated as the likely cost associated with the Fukushima accident: between Yen 35 and 80 trillion (or between Rs. 20 and Rs. 46 lakh crore). In fact, the maximum liability cap of Rs. 3000 crore is even lower than the $ 470 million that Union Carbide paid for the 1984 Bhopal disaster.

The second way in which private companies are favoured over the public in the new legislation is that companies supplying nuclear reactors, whether domestic or international, are indemnified from any kind of liability. This arrangement is very different from how other hazardous technologies are governed. For example, in the airline industry, companies like Boeing are subject to lawsuits, and have had to pay large amounts to victims of accidents involving the 737-Max aircraft that it designed and supplied, because the design was later found to be defective.

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This is a key difference from the 2010 legislation on liability passed by the United Progressive Alliance government. While the 2010 law did not allow victims of an accident to sue the supplier of a reactor (despite subsequent efforts to back track and renounce this right), it did provide the operator of the nuclear reactor a limited 'right of recourse' in the event of an accident caused by a defect in the design of the nuclear plant. That option no longer exists, which means that a company that supplies a nuclear reactor can escape scot-free even in the event of a disastrous accident resulting from a proven defect in the reactor design. (Reactor designers do make choices that could contribute to catastrophic accidents, for example, in the case of the General Electric reactor design that melted down at Fukushima Daiichi in Japan in 2011.)

The absence of any way to hold a supplier liable creates a "moral hazard". When a company is insulated from financial risk, it views the trade-off between safety and cost differently. Nuclear vendors might make more risky design choices, perhaps because it saves costs, knowing that they won't have to pay anything even in the event of an accident.

The argument for indemnifying suppliers is that international agreements that govern nuclear liability-including the Paris Convention, the Vienna Convention, and the Convention on Supplementary Compensation for Nuclear Damage-call for that practice. These Conventions date back to a period when the US nuclear industry held a virtual monopoly on reactor technology outside of the Soviet bloc, and therefore could force importing countries, especially in western Europe, to agree that they would not hold suppliers and designers liable. Although the US is no longer a dominant player in nuclear reactor export markets, its historical position as a leading supplier has continued to shape nuclear liability conventions-to the detriment of safety and the public.

Unreachable targets

Underlying all this effort of passing this legislation and offering these sweeteners to private companies is a claim about the potential of nuclear energy to meet "the ever increasing energy needs of the country"-as stated in the very first clause of the new legislation. What are the chances of nuclear power meeting these needs?

First some numbers. In 2024, nuclear plants contributed a little under 2.7% of all electricity flowing in India's electricity grids. As a fraction of all energy (i.e., including non-electrified forms of energy consumption), nuclear reactors contributed around 1.5%. In other words, nuclear energy meets very little of the energy needs of the country today. And this has been the case throughout the history of nuclear power in India.

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Contrast this with modern renewables, i.e., excluding large hydropower dams. Although these technologies, in particular solar and wind energy, have been promoted by the government only in recent decades, in 2024 they produced nearly five times as much electricity as nuclear plants. This fraction will only grow. Production of solar and wind energy is expected to accelerate in the coming years, mainly because of rapid declines in cost.

With batteries and other ways of dealing with the variability of renewables also becoming cheaper, nuclear power is bound to be even less relevant in the future, not just in India but globally. This is seen from the decline in the fraction of the world's electricity supplied by nuclear reactors, from a maximum of 17.5% in 1996 to a mere 9% in 2024. In contrast, the share of modern renewables, excluding hydropower, rose globally from under 1% to over 17% during the same period.

Nuclear energy, then, has never been a major source of power in most parts of the world, including in India. But the nuclear industry everywhere has often made projections about rapid increases in how many reactors would be set up around the world, but never have these been achieved. To give but one example, the International Atomic Energy Agency predicted in 1974 that 3,600 gigawatts (GW) of nuclear capacity would "most likely" be installed around the world by 2000, possibly up to 5,300 GW-but the global operating nuclear capacity in 2000 was a mere 350 GW.

In India, the practice of setting lofty targets for nuclear energy production and falling short of them dates back to the 1950s. The current government has announced a long-term mission of achieving a nuclear capacity of 100 GW by 2047, a 100 years after Independence. The first target for nuclear power capacity in the country was set in 1954, when Homi Bhabha, the architect of the Indian programme, predicted that India would have a nuclear power capacity of 8,000 megawatts (MW) by 1980. But, even as of January 2026, the official total capacity of all nuclear power plants in the country is just 7,550 MW (of which around 8 percent of capacity is not operating). The target of 100 GW by 2047 sounds similar to an earlier target from the 1990s: 20,000 MW by the year 2020. But in 2020, India's net capacity was just 6,200 MW, less than a third of the target for that year.

Given this history of failure, the only plausible reason for coming up with such ambitious targets must be to make nuclear energy seem more important than it actually is, or is likely to be in the future. And there is little doubt that nuclear capacity in the country will be nowhere near 100 GW in 2047.

The Chimera of Small Modular Reactors

One frequently heard argument from advocates of nuclear power is that new technologies, in particular so-called small modular reactors (SMRs), will change the picture. SMRs figured in the talking points of Union Minister Jitendra Singh. And, in the 2025-26 Union Budget the government allocated Rs. 20,000 crore for the development of "five indigenously designed SMRs to be operational by 2033 ".

This, too, is an impossible timeline. One can look at two different timelines to get a sense of how long reactor design and construction can take. First, one can look at SMRs that have already been built. Russia's KLT-40S took 13 years from the start of construction to generating electricity, instead of the expected three years. Similarly, the twin-unit HTR-PM reactors in China reached full power operations around 10 years after construction began, with a further year before the units were declared as commercially operating, only to have their output derated subsequently. Both of these designs were based on earlier designs that these countries had experimented with. With new SMR designs, timelines can be expected to be longer.

The Department of Atomic Energy's own SMR design, the Advanced Heavy Water Reactor (AHWR) was first proposed in the 1990s. The DAE marketed this design by talking about its potential for "utilization of thorium on a large scale". In 2003, the director of the Bhabha Atomic Research Centre announced the AHWR's "construction is proposed to be started within 2 years time". And in 2014, Jitendra Singh announced in Parliament that the AHWR is "likely to be functional by 2020". None of that happened - and these delays are emblematic of timelines for SMR designs in other countries too.

Timelines aside, SMRs will also not change the lack of economic competitiveness of nuclear power. The problem for SMRs is that they lose out on what are called economies of scale. Larger reactors are cheaper on a per MW basis because their material costs and work requirements increase more slowly than generation capacity. The cost of electricity from a power plant depends not on the absolute cost but the cost weighted by the power output of that plant. Because of diseconomies of scale, for SMRs that metric turns out to be more, not less, expensive than large reactors. For example, the cost estimate per MW for the now cancelled US project involving six NuScale SMR reactors was around 250% more than the initial per MW cost for the 2,200 MW Vogtle project mentioned earlier. Thus, electricity from SMRs will be more costly than even large nuclear reactors, which are themselves not economically competitive.

A recent estimate of the cost of electricity from SMRs from Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) showed that SMRs are by far the most expensive way to generate power. CSIRO's estimate for the levelized cost of energy for an SMR project starting to deliver power in 2030 was between Australian $322 and 619 per megawatt hour, or roughly Rs. 20 to 37 per kilowatt hour. Electricity from renewable sources of power, solar PV and onshore wind, was found to be far cheaper.

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Nor are SMRs exempt from the usual risks of nuclear power. They too contain radioactive materials in their cores; if and when these materials are expelled into the biosphere, they will be detrimental to the well-being of human beings and flora and fauna. SMRs, like all nuclear reactors, rely on a complex technology, which results in unexpected failure modes, and therefore can undergo accidents leading to radioactive materials contaminating large tracts of land and exposing people to radiation.

Nor do SMRs get rid of the problem of radioactive wastes being produced. That is because, like large reactors, the fission process that produces energy in these reactors will necessarily result in radioactive substances being created within the reactor. Despite decades of

well-funded research, a combination of social and technical problems have meant that there is no demonstrated way of disposing of these radioactive wastes, either from small or large nuclear reactors.

All of this means that one of the fundamental claims of India's 2025 nuclear legislation-that "nuclear energy is a clean and abundant source for electricity and hydrogen production"-is not a valid premise.

Conclusions

Led by Prime Minister Narendra Modi, the Lok Sabha discussed Vande Mataram for 10 hours. But the ruling party allowed only a fraction of that period of time to discuss the nuclear legislation, without really allowing any kind of in-depth examination of the problems identified by many Members of Parliament. As we have argued, the main beneficiaries will be private sector companies that take part in nuclear projects, and the financial and environmental costs of these ventures will be borne by the public.

As the historical record in India and the rest of the world shows, nuclear reactors provide only a small and declining fraction of all electricity and energy used around the world. Newer reactor designs, such as small modular nuclear reactors, will not change this picture.

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