India's Nuclear Energy Expansion in Budget 2025: Policy Implications for the India-US Civil Nuclear Partnership

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I. INTRODUCTION

India's growing energy needs have placed nuclear power at the centre of its long-term strategy for energy security, economic growth, and sustainable development. As the world's most populous country and one of the fastest-growing major economies, India faces an ever-increasing demand for electricity, which necessitates the diversification of its energy mix (Bhattacharyya, 2019). While renewable energy sources such as solar and wind have gained prominence, nuclear energy remains a crucial pillar in India's quest for energy self-sufficiency (Kumar, 2021). The Union Budget 2025 reflects this strategic vision by allocating significant resources toward nuclear infrastructure, research, and development. This budgetary commitment raises critical questions about the role of the India-US Civil Nuclear Agreement (2008) in shaping India's nuclear expansion and whether the agreement has fulfilled its promise of facilitating large-scale nuclear commerce between the two nations (Rajagopalan, 2020).

The India-US Civil Nuclear Agreement, signed in 2008, was a landmark development in India's nuclear diplomacy, ending decades of nuclear apartheid and opening doors for collaboration with global nuclear suppliers. The agreement was expected to unlock foreign investment in India's nuclear sector, enable the transfer of advanced technologies, and allow India to procure uranium from international markets. However, nearly seventeen years later, progress on US-India nuclear commerce remains slow, hindered by multiple obstacles, including India's stringent Civil Liability for Nuclear Damage Act (2010), bureaucratic hurdles, and financial constraints (Bose, 2019). While the agreement established the framework for cooperation, tangible commercial benefits, especially involving American nuclear firms, have remained limited (Narang, 2021). Given this context, the allocations and policy directions outlined in Budget 2025 provide an opportunity to reassess the trajectory of the India-US nuclear partnership and determine whether the financial and policy commitments made by the Indian government can catalyze greater engagement with the United States.

The Budget 2025 makes provisions for expanding India's nuclear energy capacity, with particular emphasis on indigenous reactor development, uranium procurement, and investment in advanced nuclear technologies such as Small Modular Reactors (SMRs) (Government of India, 2025). A key issue to examine is whether India's budgetary priorities align with the objectives of the India-US nuclear deal or whether India is increasingly shifting toward self-reliance and partnerships with other countries, such as Russia and France (Jha, 2023). The budget also raises questions about the viability of US nuclear firms entering the Indian market, given the unresolved liability concerns and competition from other global players. Furthermore, the strategic implications of nuclear energy cooperation between India and the US must be examined in the broader geopolitical landscape, particularly in light of China's expanding influence in the Indo-Pacific and the evolving energy security dynamics in South Asia (Mohan, 2023).

This paper seeks to critically analyze India's nuclear energy expansion as outlined in Budget 2025 and assess its implications for the India-US Civil Nuclear Agreement. By examining budgetary allocations, policy directions, and ongoing challenges in nuclear commerce, this study aims to evaluate whether the agreement has delivered tangible results and what future prospects exist for strengthening India-US nuclear cooperation (Srinivasan and Rajaraman, 2024). The paper will also explore potential policy measures that could enhance collaboration, including reforms in liability laws, new investment frameworks, and technological cooperation in next-generation nuclear reactors (Bhardwaj, 2024).

Ultimately, this analysis will provide insights into whether India's nuclear energy expansion in 2025 signals renewed momentum for the India-US nuclear partnership or underscores the limitations that continue to hinder large-scale commercial cooperation.

Budget 2025 and India's Nuclear Energy Vision: Key Allocations and Policy Priorities

The Union Budget 2025-26 signals a decisive shift in India's energy strategy, with a significant emphasis on nuclear power expansion. Recognizing nuclear energy as a crucial pillar for achieving energy security, economic growth, and environmental sustainability, the government has outlined an ambitious vision to scale up nuclear power capacity to 100 GW by 2047(Government of India, 2025). This initiative aligns with the broader objectives of Viksit Bharat, which aims to reduce India's reliance on fossil fuels while ensuring a stable and reliable energy supply. To achieve this, the budget allocates substantial funding for research and development (R&D), indigenous nuclear reactor technology, and public-private partnerships, with a particular focus on Small Modular Reactors (SMRs) and Bharat Small Reactors (BSRs) (BARC Annual Report, 2024).

The Budget 2025-26 earmarks ₹20,000 crore for the Nuclear Energy Mission, a bold initiative aimed at accelerating the deployment of advanced nuclear technologies. This funding is directed toward the development of at least five indigenously designed Small Modular Reactors (SMRs) by 2033, the expansion of Bharat Small Reactors (BSRs), 220 MW Pressurized Heavy Water Reactors (PHWRs) designed for industrial and captive power generation, investment in next-generation nuclear technologies, including high-temperature gas-cooled reactors for hydrogen production and molten salt reactors utilizing India's abundant thorium reserves, and strengthening research initiatives through institutions like the Bhabha Atomic Research Centre (BARC) and the Department of Atomic Energy (DAE) (DAE, 2025). These allocations underscore the government's commitment to bolstering domestic nuclear capabilities while fostering collaborations with the private sector to enhance efficiency and scalability.

As part of its long-term energy roadmap, the government has launched the Nuclear Energy Mission for Viksit Bharat, a multi-pronged initiative designed to enhance domestic nuclear technology development to reduce dependency on foreign technology, encourage private sector participation by amending the Atomic Energy Act and the Civil Liability for Nuclear Damage Act to create a more conducive investment climate, and streamline regulatory processes for faster approval and commissioning of new nuclear power plants. By implementing these policy measures, the government seeks to remove regulatory bottlenecks that have historically hindered large-scale nuclear cooperation, particularly with international partners like the United States.

The introduction of Bharat Small Reactors (BSRs) marks a significant step toward decentralized nuclear power generation. These reactors, which have a proven safety record, are being upgraded to reduce land and water requirements, making them ideal for industrial power supply. The government's strategy includes encouraging private companies to provide land, cooling water, and capital investment while NPCIL oversees design, quality assurance, and operations, deploying BSRs in key industrial hubs such as steel and aluminum manufacturing zones to support India's decarbonization efforts, and repurposing old coal plants by integrating SMRs, aligning with India's climate commitments under the Paris Agreement (2015) and COP26 (2021). Additionally, the Bhabha Atomic Research Centre (BARC) is spearheading SMR research, ensuring that India remains at the forefront of nuclear innovation while promoting self-reliance.

The budget also prioritizes infrastructure expansion, with a roadmap to increase nuclear power capacity from 8,180 MW (as of January 2025) to 22,480 MW by 2031-32. This will be achieved through the construction of 10 new reactors across Gujarat, Rajasthan, Tamil Nadu, Haryana, Karnataka, and Madhya Pradesh, pre-project activities for 10 additional reactors, with phased completion by 2031-32. A landmark achievement was recorded in September 2024 when the Rajasthan Atomic Power Project Unit-7 (RAPP-7) achieved criticality, marking India's growing capability in indigenous nuclear reactor construction (DAE Press Release, 2024).

To facilitate nuclear expansion, the government is set to introduce key legislative reforms, including amendments to the Atomic Energy Act (1962) to enable greater private sector involvement in nuclear

power projects, modifications to the Civil Liability for Nuclear Damage Act (2010) to address concerns raised by international investors, particularly US nuclear firms, and new regulatory frameworks to expedite project approvals and streamline safety compliance.(Kapur, 2024; Bhardwaj, 2024). These reforms are expected to reduce bureaucratic delays, attract foreign investment, and create a more favorable business environment for nuclear energy growth.

The Union Budget 2025-26 represents a turning point for India's nuclear energy sector. By prioritizing nuclear power expansion through strategic investments, policy reforms, and technological advancements, the government is laying the groundwork for a sustainable and energy-secure future. The Nuclear Energy Mission for Viksit Bharat reinforces India's long-term commitment to nuclear energy, with an emphasis on indigenous innovation and private sector collaboration. Furthermore, these initiatives have significant implications for the India-US Civil Nuclear Partnership, as policy shifts and regulatory changes may revitalize stalled agreements and open new avenues for bilateral nuclear cooperation. With a clear roadmap and substantial budgetary backing, India's nuclear energy expansion is poised to play a crucial role in achieving its net-zero and energy security goals by 2047.

The India-US Civil Nuclear Agreement: A Retrospective on 17 Years of Progress and Challenges

Seventeen years since the signing of the landmark India-US Civil Nuclear Agreement in 2008, it remains both a symbol of strategic transformation and a testament to the persistent complexities of nuclear diplomacy(Bhardwaj, 2024; Rajagopalan, 2021). Heralded at the time as a watershed moment in bilateral relations, the deal was expected to revolutionize India's civil nuclear energy sector while forging a new era of strategic partnership with the United States. The agreement was unprecedented: it ended India's decades-long nuclear isolation and legitimized its status as a responsible nuclear state outside the Non-Proliferation Treaty (NPT). In return, India agreed to separate its civil and military nuclear programs and place its civil reactors under International Atomic Energy Agency (IAEA) safeguards. The anticipation in 2008 was that US firms would quickly gain access to India's nuclear market, triggering a wave of commercial reactor deals, technology transfers, and investment in India's energy infrastructure. Yet, despite the lofty promises and the strategic optimism that accompanied the deal, actual progress on nuclear commerce has remained modest, if not disappointing.

One of the key expectations post-2008 was the flourishing of commercial cooperation between Indian and American nuclear firms, particularly companies like Westinghouse and GE-Hitachi. However, in the nearly two decades since, not a single US-designed reactor has become operational in India, nor has any firm contract materialized that would resemble the scale envisioned during the initial years. Various memoranda of understanding and site agreements, including the proposed setting up of six Westinghouse AP1000 reactors at Kovvada in Andhra Pradesh, have faced repeated delays(DAE Annual Report, 2022). The reasons behind these setbacks are multi-layered and reflect both domestic and international challenges. Chief among them is the Civil Liability for Nuclear Damage Act (CLNDA) passed by India in 2010, which introduced a unique supplier liability clause, contrary to global norms that hold plant operators solely liable for nuclear accidents. This provision generated deep unease among foreign suppliers, especially American firms, which feared exposure to unquantifiable legal and financial risks(Mistry, 2017).

Moreover, the bankruptcy of Westinghouse Electric Company in 2017 further disrupted momentum, though subsequent restructuring under Brookfield Asset Management helped revive discussions. On the Indian side, procedural delays, regulatory hurdles, land acquisition problems, and bureaucratic inertia have contributed to the stagnation of projects. Although the Indian Government has sought to address some of these concerns through a nuclear insurance pool and diplomatic reassurances, US companies remain cautious(Rajagopalan, 2021). In parallel, Russia and France have made greater headway in India's nuclear landscape—Rosatom's Kudankulam reactors are progressing steadily, while EDF has made more tangible commitments toward the Jaitapur project—underscoring the challenges specific to Indo-US commercial nuclear cooperation(DAE Annual Report, 2023).

Despite the slow commercial progress, the agreement has yielded strategic dividends. It marked India's entry into the global nuclear mainstream, leading to nuclear cooperation agreements with over a dozen

countries, including France, Russia, Canada, Australia, and Japan(Kapur, 2015). The agreement also facilitated India's access to nuclear fuel and technology from global suppliers, helping stabilize fuel supply chains for Indian reactors. India's nuclear power production has increased modestly, and the scope for long-term growth has improved due to this normalization. Additionally, the deal has elevated India's international profile and paved the way for its membership in key export control regimes like the Missile Technology Control Regime (MTCR), Wassenaar Arrangement, and Australia Group—although India's bid for the Nuclear Suppliers Group (NSG) still faces opposition, notably from China(Rajagopalan, 2021).

The bilateral nuclear narrative has also been shaped by broader policy shifts in both countries. In the United States, changes in nuclear policy and waning enthusiasm for nuclear energy due to domestic political dynamics, safety concerns post-Fukushima, and a surge in renewable energy investment have diluted the urgency that once characterized the nuclear dimension of the India-US partnership. Meanwhile, in India, the emphasis has shifted toward indigenous reactor technology—especially PHWRs and SMRs—and reliance on foreign vendors has been moderated. This inward shift has been reinforced by concerns over cost overruns, safety, and self-reliance under the broader 'Atmanirbhar Bharat 'framework.

Nevertheless, the 2025 Union Budget and the unveiling of the Nuclear Energy Mission indicate a potential inflection point. With legislative amendments to the Atomic Energy Act and CLNDA under consideration, the possibility of reviving dormant deals such as Kovvada remains open. The inclusion of American firms in new SMR initiatives and collaborations under the Quad framework also offers an opportunity to recalibrate the civil nuclear partnership. If these developments are leveraged effectively, the next phase of the India-US nuclear relationship could be marked less by headline agreements and more by targeted, technologically innovative cooperation.

In retrospect, the 2008 agreement was both a bold leap and a complex bet. While it succeeded in breaking geopolitical barriers and redefining strategic ties, it fell short of catalyzing the promised commercial transformation. The path forward demands pragmatic adjustments, mutual trust, and regulatory clarity. If such efforts are sustained, the India-US civil nuclear partnership can still fulfill the long-term vision it once promised: not only as a tool for clean energy, but also as a pillar of strategic convergence in the Indo-Pacific era.

Advancements in Nuclear Technology: India-US Cooperation in Next-Generation Reactors and Small Modular Reactors (SMRs)

The Union Budget 2025 marks a significant turning point in India's nuclear energy strategy, especially with respect to advanced nuclear technologies and the growing emphasis on Small Modular Reactors (SMRs). At the heart of this policy shift lies a clear strategic intent: to modernize India's nuclear infrastructure while creating new avenues for international technological cooperation, particularly with the United States. While earlier phases of the India-US civil nuclear partnership were hindered by legal, financial, and liability-related barriers, recent developments suggest that next-generation reactors and SMRs could offer a fresh platform for reviving technological collaboration.

In Budget 2025, the Indian government allocated ₹20,000 crore towards the newly launched Nuclear Energy Mission, a substantial portion of which is designated for the development and deployment of SMRs. These reactors, with capacities ranging between 30 MWe to 300 MWe, offer the promise of flexibility, modularity, and cost-effectiveness. Their factory-based manufacturing and scalable design make them especially suitable for India's vast geography and uneven energy demand patterns. Importantly, their ability to be deployed in remote and off-grid locations presents a viable solution for both decarbonization and energy access challenges.

The SMR push also aligns well with India's long-standing expertise in Pressurized Heavy Water Reactors (PHWRs), as well as its recent advancements in thorium-based reactors and fast breeder technologies. However, the domestic SMR ecosystem remains at an early stage, with indigenous designs under development by institutions such as the Bhabha Atomic Research Centre (BARC). This opens a critical window for technological collaboration with countries like the United States, which is among the global leaders in SMR innovation through firms such as NuScale Power and TerraPower.

In this context, the India-US civil nuclear framework—though relatively dormant in recent

years—stands to gain renewed relevance. With the United States actively promoting its advanced nuclear technologies as part of its clean energy diplomacy, India presents a compelling partner for co-development and deployment. Collaborative R&D programs, technology transfer mechanisms, and joint ventures between public-sector entities like the Nuclear Power Corporation of India Limited (NPCIL) and US firms could serve as catalysts for the commercialization of SMRs in the Indian context. Such cooperation would not only enhance India's technological capabilities but also provide the US nuclear industry with a vital export market.

Furthermore, SMR-related collaboration dovetails with broader India-US strategic goals under frameworks such as the Initiative on Critical and Emerging Technologies (iCET), which includes energy innovation as a key pillar. The potential for joint research facilities, pilot projects, and regulatory alignment between the Atomic Energy Regulatory Board (AERB) and the US Nuclear Regulatory Commission (NRC) further strengthens the case for a technology-driven revival of the civil nuclear partnership.

Thus, while previous decades of India-US nuclear engagement were defined by political negotiations and commercial hurdles, the future may well hinge on shared technological ambition. By focusing on SMRs and next-generation reactors, both countries have an opportunity to reshape their nuclear partnership around innovation, sustainability, and global leadership in clean energy technologies.

Future Prospects: Policy Recommendations for Strengthening India-US Civil Nuclear Cooperation

As India continues its ambitious expansion of nuclear energy capacity—aiming for 100 GW by 2047—there is a renewed opportunity to revitalize its civil nuclear cooperation with the United States. Despite the historic significance of the 2008 India-US Civil Nuclear Agreement, the full potential of the partnership remains largely untapped. Persistent legal, regulatory, and commercial hurdles have hindered meaningful collaboration in nuclear commerce. To move forward, both countries must undertake a set of mutually reinforcing policy reforms and strategic initiatives that can create an enabling environment for robust cooperation in nuclear energy.

One of the foremost steps India can take to encourage US investment in its nuclear sector is to address concerns surrounding nuclear liability. The Civil Liability for Nuclear Damage Act (CLNDA), enacted in 2010, has long been viewed by US suppliers as a deterrent to commercial engagement. The act allows the operator of a nuclear facility to have a right of recourse against suppliers in case of a nuclear incident, which deviates from the international norm under the Convention on Supplementary Compensation for Nuclear Damage (CSC), to which India acceded in 2016. Although India clarified in 2015 that supplier liability is not mandatory and that the law allows contractual freedom, US firms remain cautious due to the lack of judicial precedent and ambiguity in interpretation.

To resolve this, India should consider amending the CLNDA or introducing an executive or judicial clarification that further reassures foreign suppliers. A model tripartite agreement involving the Government of India, the Nuclear Power Corporation of India Limited (NPCIL), and US suppliers—clearly delineating the extent of liability and indemnity—could offer a workable compromise. Strengthening insurance mechanisms such as the India Nuclear Insurance Pool and establishing a transparent dispute resolution mechanism would also go a long way in mitigating investor concerns.

In parallel, India must streamline its nuclear trade and regulatory framework. Current procurement procedures are often lengthy, opaque, and heavily centralized. A dedicated single-window clearance mechanism for nuclear energy projects, particularly for foreign collaborations, could improve efficiency and transparency. Moreover, trade regulations concerning the import of nuclear materials, reactor components, and safety equipment should be harmonized with international standards to reduce bureaucratic delays. Closer coordination between the Atomic Energy Regulatory Board (AERB) and international counterparts like the US Nuclear Regulatory Commission (NRC) would help ensure compatibility of reactor design certifications, safety protocols, and licensing processes.

Technology transfer is another area that requires focused policy innovation. While India has made notable progress in indigenizing reactor technology—particularly PHWRs and fast breeder reactors—it still seeks access to advanced technologies such as Small Modular Reactors

(SMRs), molten salt reactors, and high-temperature gas-cooled reactors. US companies like NuScale Power, Westinghouse Electric, and TerraPower are leaders in these technologies. However, export control regimes and intellectual property protections can be barriers to meaningful collaboration. India and the US should work towards bilateral agreements under the existing 123 Agreement that specifically enable joint R&D, pilot projects, and the co-development of next-generation reactor technologies. These arrangements can be structured to include safeguards, non-proliferation assurances, and joint intellectual property rights, thereby aligning commercial interests with strategic trust.

On the Indian side, greater private sector participation will be crucial. Budget 2025's provision to allow public-private partnerships in nuclear power—especially through the Bharat Small Reactors and Bharat SMR programs—is a step in the right direction. However, structural barriers remain due to the Atomic Energy Act of 1962, which currently restricts nuclear energy generation to government-owned entities. While outright privatization may not be politically feasible, India could consider allowing joint ventures between NPCIL and US firms under a revised legal framework, or through special purpose vehicles (SPVs) where regulatory compliance is maintained under Indian law but investment and technical collaboration are liberalized.

In the long-term, the India-US civil nuclear partnership must be envisioned not merely as a bilateral transaction, but as a strategic collaboration aligned with global clean energy transitions and climate commitments. Both nations are committed to net-zero targets—India by 2070 and the US by 2050—and nuclear energy will be essential to achieving these goals. A strategic roadmap for nuclear cooperation could be incorporated into broader frameworks such as the Quad, the Clean Energy Ministerial, and the Initiative on Critical and Emerging Technologies (iCET). Joint centers of excellence, shared training programs for regulatory professionals, and transnational nuclear safety research could enhance both countries' capabilities while fostering institutional trust.

To sum up, the future of India-US civil nuclear cooperation hinges on a deliberate, multi-pronged policy approach. Legal reforms to ease liability concerns, streamlined trade and regulatory procedures, targeted technology partnerships, and long-term strategic alignment are essential pillars of this effort. With decisive leadership and mutual trust, the next phase of the civil nuclear partnership can transcend the limitations of the past and emerge as a cornerstone of the broader India-US strategic relationship in the 21st century.

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