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India's Nuclear Energy Strategy: Balancing Security, Diplomacy, and Sustainability

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Abstract

India's nuclear energy strategy is a multifaceted approach that balances security, diplomacy, and sustainability. This study explores the complex interplay between India's nuclear policy, energy security, and international relations. India's nuclear journey, rooted in the visionary leadership of Homi Bhabha, evolved from advocating disarmament to pursuing strategic autonomy. Nuclear energy plays an important role in India's energy security by providing a reliable, low-carbon, and base-load power supply. India's engagement with global nuclear governance frameworks exemplifies a nuanced approach to balancing compliance and sovereignty. This study examines India's domestic energy policy framework, nuclear doctrine, and the geopolitical dimensions of its nuclear and energy strategy. India's focus on thorium as a fuel source adds a distinctive dimension to its nuclear diplomacy, reinforcing its role as a norm entrepreneur. This study also highlights the challenges faced by India, including public perception, international legal and market barriers, and economic and technological constraints. The conclusion emphasizes the need to integrate nuclear policy within India's comprehensive energy and foreign policy frameworks, enhance international cooperation, and advance sustainable, secure, and inclusive nuclear energy development. This study recommends a diversity in stakeholders which involves the government, industry, and civil society to realize India's vision of a secure, clean, and resilient energy future.

Keywords: *Diplomacy, Nuclear Energy Study, Security*

Introduction

Currently, ten new nuclear reactors are operational in India. By the centenary of its independence, the nation aspires to augment its nuclear energy capacity tenfold, thereby enhancing energy self-reliance and facilitating sustainable growth. India is also opening the nuclear sector to private entities, thereby creating unprecedented opportunities in the fields of energy and technology.[2] Nuclear energy and international relations are intricately interconnected, making them critical areas of research. This study explores the multifaceted dimensions of nuclear energy and examines its role in shaping international power dynamics, nonproliferation efforts, and global energy security issues. It also delves into India's unique position and policies in this complex area.

India's nuclear energy journey is deeply rooted in the complex interplay between scientific ambition, ethical considerations, and geopolitical realities. The origins of Indian nuclear policy can be traced back to the visionary scientific leadership of Homi J. Bhabha[3], who spearheaded India's early nuclear program with a distinct focus on peaceful nuclear applications and national self-reliance.

From 1944 to 1998, India maintained a firm stance advocating for nuclear disarmament and

non-weaponization. They asserted that nuclear technology's primary role was as a tool for energy independence and economic development, rather than armament. India's nuclear policy has evolved gradually, shaped by shifts in global security, technological goals, and regional geopolitical issues. This evolution signified a move from idealistic promises to a more pragmatic approach.

Importance of Nuclear Energy in India's Energy Security

India's rapidly expanding economy necessitates a reliable, stable, and scalable energy source to meet its growing energy demand. In contemporary international relations, energy security is pivotal, particularly because geopolitical uncertainties often compromise steady fuel supply chains that are frequently derived from politically unstable areas. An energy mix that balances cost, sustainability, and geopolitical prudence is essential to achieve this objective in the long term. Nuclear energy provides a low-carbon base-load power supply that can satisfy these requirements.

Moreover, nuclear power plays a dual role: it is crucial for both energy sustainability and serves as an epitome of India's technological maturity and strategic autonomy in the geopolitical arena.[4]

India's Position in Global Nuclear Governance

India's engagement with the global nuclear governance regime embodies a nuanced balance between asserting its sovereign nuclear capabilities and fulfilling its international and diplomatic responsibilities.

(a) Nuclear Energy and India's Energy Security Strategy: Given India's massive and growing energy demand, diversifying its energy portfolio is a strategic imperative. Nuclear energy plays a critical role in this diversification by offering dependable, low-carbon alternatives that complement the intermittent nature of renewable sources. While renewables, such as solar and wind, are integral to India's energy future, their inherent variability necessitates reliable baseload power, which nuclear energy effectively provides.[6] In the context of geopolitical uncertainties and supply risks associated with fossil fuels, nuclear power secures India's energy independence and reduces its vulnerability to external supply disruption.

(b) Environmental Sustainability and Nuclear Energy: Empirical analyses support the Environmental Kuznets Curve and load capacity curve hypotheses in the Indian context, linking economic development and environmental quality improvements to strategic energy choices. Nuclear power positively influences ecological indicators by curtailing carbon footprints and providing cleaner energy than fossil fuels. This role is increasingly relevant as India commits to ambitious emission reduction targets within the Sustainable Development Goals (SDGs), particularly SDG 7 (affordable and clean energy) and SDG 13 (climate action). Compared with other clean energy options, nuclear energy offers advantages in terms of the scale and consistency of power generation, thereby enabling a smoother transition to a sustainable energy mix. The effects of global warming on efficiency can be observed in studies indicating that a 1°C rise in cooling water temperature can reduce the efficiency of pressurized-water reactors by approximately 0.12% to 0.16%.

(c) Regional Security Dynamics and Nuclear Arms Control: The nuclear rivalry between India and Pakistan remains a defining feature of South Asia's regional security architecture. Continual competition perpetuates tensions and raises concerns about nuclear arms races and inadvertent conflict, and efforts to establish confidence-building measures encounter obstacles owing to deep-seated mistrust and strategic competition. The strategic significance of the Indian Ocean heightens the stakes, as nuclear naval forces extend their power and influence beyond national borders, affecting both regional and external players.

(d) Multilateral Frameworks and India's Nuclear Diplomacy: India's engagement with global and regional nuclear governance frameworks exemplifies a nuanced approach to balancing compliance and sovereignty. As a non-signer to the Nuclear Non-Proliferation Treaty (NPT), India faces challenges in fully participating in mecha-

nisms such as the Nuclear Suppliers Group (NSG), which regulates nuclear technology transfers and exports based on stringent, non-proliferation criteria. India's role in these frameworks is unique because it aims to balance its desire for strategic independence with the global expectations. India promotes gradual involvement and shared transparency to build regional nuclear trust and avert destabilizing arms competition in South Asia.

India's Domestic Energy Policy Framework and Nuclear Integration

The domestic political economy of India's energy policy formulation operates within a complex two-level game involving domestic political exigencies and international diplomacy. These dynamics result in policy outcomes that aim to balance short-term developmental demands with long-term strategic and environmental issues.

(a) Nuclear Policy of India: India's nuclear strategy is outlined in its Nuclear Doctrine, which was officially approved by the Cabinet Committee on Security on January 4, 2003.[5] This doctrine outlines a defensive nuclear stance centered on credible, minimal deterrence and stringent civilian oversight.

Core Principles of the policy include:

(i) Credible Minimum Deterrence: India aims to maintain a credible minimum deterrent to safeguard national security without engaging in an arms race.

(ii) No First Use: India follows a No First Use policy, meaning nuclear weapons will only be used in retaliation to a nuclear attack on Indian soil or against Indian forces.

(iii) Massive Retaliation: Any nuclear response to a first strike should be overwhelming and intended to cause unacceptable damage, thereby ensuring the credibility of deterrence.

(iv) Civilian Authority: Only the civilian political leadership, through the Nuclear Command Authority, can authorize nuclear retaliatory strikes, ensuring democratic oversight of nuclear weapons use.

(v) Conditional Use Parameters for Non-Nuclear Weapon States: India pledges not to use nuclear weapons against states without nuclear capabilities.

(vi) Chemical and Biological Weapons Response: Should there be a significant attack on India or its forces using biological or chemical weapons, India reserves the right to respond with nuclear weapons.

(vii) Non-Proliferation Commitments: India enforces strict controls on the export of nuclear and missile-related materials and technologies, engages in Fissile Material Cutoff Treaty discussions, and continues to uphold a nuclear test moratorium. This policy reaffirms India's dedication to global, verifiable, and non-discriminatory nuclear disarmament in a world free of nuclear weapons. The doctrine establishes alternative command structures for retaliatory nuclear strikes in all scenarios,[7] ensuring the continuity of nuclear command authority under various conditions.

This nuclear policy framework positions India as a responsible nuclear power committed to minimal deterrence while maintaining its strategic independence and defensive nuclear capabilities. To support a cohesive energy transition, strategic partnerships and financial frameworks are being developed, emphasizing public-private investments and technological advancements to sustain progress in both the nuclear and renewable energy sectors.

(b) Geopolitical Dimensions of India's Nuclear and Energy Strategy: Strategic Balancing in the Indo-Pacific Region: India's foreign policy adopts a multi-alignment strategy in the Indo- Pacific, seeking to balance relations within the QUAD alliance comprising the US, Japan, and Australia and the BRICS grouping, including China and Russia. India's strategic agility facilitates the maintenance of autonomy while leveraging partnerships to enhance maritime security, technological cooperation, and regional deterrence. Nuclear modernization is a critical component of India's efforts to assert strategic sovereignty within this maritime

domain. The BRICS countries collectively possess approximately 390 gigawatts of operational nuclear power units, with an additional 66 units under construction. They have also established a Nuclear Energy Platform to foster collaboration on advanced nuclear technologies and best practices, aimed at enhancing energy security and developing next- generation reactors. Furthermore, a new BRICS Energy Cooperation Roadmap for 2025-2030 was introduced to guide energy policies, including nuclear energy policy.

Recently, India has initiated discussions to amend the Atomic Energy Act to allow private sector involvement in nuclear power projects. These amendments could potentially allow up to 49% foreign ownership while ensuring that the majority control remains with Indian entities. This policy shift is anticipated to encourage private sector participation in nuclear energy development, akin to the impact of private investment in India's space industry. The objective is to accelerate the growth of nuclear power capacity in alignment with India's broader clean energy goals. ASHVINI, a cartel between the Nuclear Power Corporation of India Limited (NPCIL) and National Thermal Power Corporation (NTPC), received government approval in September 2024. One of its key projects is the Mahi Banswara Nuclear Power Plant, located in Rajasthan. ASHVINI is also engaged in constructing new Pressurized Heavy Water Reactors to expand India's nuclear capacity.

Energy diplomacy and securing international fuel supplies are core facets of India's foreign policy, aimed at diversifying supply sources across strategically important regions, including the Gulf Cooperation Council (GCC) countries, Russia, and Central Asia. These engagements involve pipeline diplomacy, investment in energy infrastructure, and bilateral agreements to secure stable and affordable energy imports from Central Asia. Navigating global energy governance and market dynamics, India's trajectory from being a norm taker to an aspiring norm maker in global energy governance necessitates addressing the challenges arising from international supplier cartels, market competition, and geopolitical multipolarity.

Technological advances and future prospects in nuclear energy include the deployment of advanced nuclear reactors. India is actively investing in cutting edge nuclear technologies, such as Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs), which promise enhanced safety, modularity, and cost-effectiveness. These technologies are poised to address the critical challenges of scalability, operational flexibility, and public acceptance issues. International partnerships play vital roles in technology transfer, training, and research collaborations.

Addressing Challenges related to Waste Management and Proliferation Risks

The growth of nuclear energy inevitably brings up issues related to the secure handling of nuclear waste and the dangers of proliferation. India is adopting thorough strategies to manage nuclear waste safely, focusing on environmental protection and long-term containment methods. The country aims to balance its expansion with nonproliferation commitments, ensuring that peaceful applications are not undermined by strategic needs. Integration with climate and sustainability goals is pivotal, as nuclear power in India's climate initiative significantly contributes to reducing carbon emissions and facilitating the achievement of net-zero targets.

(a) Public perception and political will: Public perception remains a critical barrier to expanding nuclear energy in India. Safety concerns, historical accidents, and infrastructural challenges have all contributed to societal resistance. Overcoming this requires sustained political leadership, transparent communication, and visible safety assurance. Political determination is crucial for advancing policy changes, expediting project approvals, and attracting investments amidst competing development priorities. Previous delays and resistance offer important insights into creating inclusive discussions and strengthening governance systems to enhance public trust.

(b) International legal and market barriers: India navigates complex international legal regimes that restrict access to nuclear technology, especially because of its non-NPT status. Seeking

NSG membership remains a diplomatic priority for India to ease export controls and to expand technology acquisitions. India's efforts to collaborate internationally are hindered by regional tensions, particularly with Pakistan, and conflicting interests among major global powers. These legal and market challenges necessitate strategic diplomatic efforts and the use of existing alliances to ensure access to technology and fuel resources.

(c) Economic and technological challenges: The cost competitiveness of nuclear power vis-à-vis renewables and fossil fuels influences investment decisions. India faces constraints related to skilled workforce shortages and the pace of domestic technology development in the defence sector. To sustainably expand nuclear projects, it is essential to adopt financing models that boost private sector involvement and distribute risks. Advancements in reactor technology and improvements in operational efficiency can enhance economic feasibility and speed up implementation.

India's nuclear energy strategy is distinguished by its significant emphasis on thorium as a fuel source, a concept closely associated with Dr. Homi J. Bhabha, the engineer of India's nuclear program, proposed a three-stage nuclear program that envisioned a transition from uranium to thorium as the primary fuel. Thorium reactors offer the potential to mitigate proliferation risks because thorium-based fuel cycles generate less plutonium, which is a critical component of nuclear weapons. India's decision to pursue thorium as a long-term nuclear fuel aligns with the constructivist perspective, which posits that international relations are shaped not only by hard power or economic interests but also by ideas, identities, and norms. This approach reinforces India's role as a norm entrepreneur on the international stage, influencing new paradigms of civilian nuclear program development. Concurrently, India's nuclear trajectory is consistent with the "Realist" theory of international relations, which emphasizes power and security. India's nuclear capability serves as a deterrent in a region with nuclear-armed neighbors, such as China and Pakistan, and the thorium program, while focused on peaceful applications, provides the country with strategic flexibility. India's preference for thorium over uranium is integral to its broader strategy for managing critical resource shortages in the energy sector. Given India's relatively limited uranium reserves, reliance on imported uranium could lead to dependence on foreign suppliers, often accompanied by geopolitical constraints that could affect the supply. By prioritizing thorium, a resource abundant in India, the nation reduces its dependence on critical external resources, thereby minimizing its vulnerability to global supply chain disruptions and geopolitical pressures. This strategy aligns with India's overarching goal of resource self-sufficiency, as evident in its energy, defense, and industrial policies. In essence, India's thorium strategy extends beyond mere fuel selection; it embodies a broader philosophy of ensuring resource independence to maintain strategic autonomy. India's focus on thorium not only highlights its scientific foresight but also adds a distinctive dimension to its nuclear diplomacy. As India advances towards thorium utilization, it has the potential to pioneer a more sustainable and secure nuclear future, influencing both domestic and international nuclear policy.

Conclusion

In the region, ethical obligations to prevent the spread of nuclear weapons and promote disarmament coexist alongside practical security concerns and developmental goals. Looking ahead, it will be crucial to incorporate nuclear policy into India's broader energy and foreign policy strategies to align strategic objectives with global standards and sustainability requirements. Enhancing international cooperation and diplomatic efforts is crucial in this regard. Strengthening diplomatic ties with key partners, such as Russia, the US, and France, will facilitate technology transfer, fuel supply, and participation in global governance. India's ongoing efforts to gain NSG membership and lead in nuclear diplomacy should focus on transparency and responsible management. Building regional confidence and working

towards cooperative threat reduction, especially with Pakistan, are crucial for reducing nuclear risks and terrorism threats, thereby promoting strategic stability in South Asia. Advancing sustainable, secure, and inclusive nuclear energy development requires investment in advanced nuclear technologies and robust waste management systems to support this sustainable growth. Public awareness programs and policy reforms are essential for overcoming domestic opposition and infrastructure challenges. Consequently, it is crucial to align the expansion of nuclear energy with India's goals for achieving net-zero emissions and addressing climate change. To achieve a secure, clean, and resilient energy future for India, it is essential to adopt a collaborative approach that includes the government, industry, and civil society.

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