



## Private Sector's Role in India's Nuclear Future

*This editorial is based on “[Having private participation in India’s nuclear energy](#)” which was published in *The Hindu* on 01/10/2024. The article brings into picture the Indian government's plan to involve the private sector in nuclear energy expansion, while highlighting the legal challenges posed by the Atomic Energy Act of 1962 and regulatory uncertainties surrounding nuclear liability laws.*

**For Prelims:** [Nuclear energy sector](#), [Atomic Energy Act of 1962](#), [Nuclear Power Corporation of India Limited](#), [Civil Liability for Nuclear Damage Act of 2010](#), [Russia-Ukraine conflict](#), [Renewable energy capacity](#), [International Atomic Energy Agency](#), [Nationally Determined Contribution](#), [Fukushima](#), [Pressurized Heavy Water Reactor](#), [Nuclear Suppliers Group](#).

**For Mains:** Potential Advantages of Private Sector Involvement in India's Nuclear Sector, Major Issues Related to Increased Private Participation in India's Nuclear Sector.

In **July 2024**, the Indian government announced plans to expand the **country's nuclear energy sector**, proposing partnerships with the **private sector** for research and development of small reactors and new nuclear technologies. This initiative aims to support India's ambitious goal of achieving **500 Gigawatts of non-fossil fuel-based energy generation by 2030**. However, the current legal framework, primarily governed by the [Atomic Energy Act of 1962](#), poses significant challenges to private sector involvement in nuclear energy.

The existing legislation restricts nuclear power development and operation to the central government, with the **Department of Atomic Energy** and the [Nuclear Power Corporation of India Limited](#) maintaining overarching control. Recent attempts to challenge these restrictions have been dismissed by the [Supreme Court](#), citing the need for stringent safeguards in atomic power exploitation. Additionally, pending legal challenges to the [Civil Liability for Nuclear Damage Act of 2010](#) introduce further regulatory uncertainty. As India seeks to attract substantial private investment in the nuclear sector, it must navigate these legal and regulatory hurdles while ensuring robust oversight and public accountability.

### Why is Prioritizing the Nuclear Energy Sector Crucial for India?

- **Energy Independence in a Volatile Global Market:** Coal accounts for India's for **55% of the country's energy needs** and India's coal import rose by **5.7% to 75.26 million tonnes (MT)** in the first quarter of 2024.
  - The global energy market has seen significant volatility in recent years, exacerbated by events like the [Russia-Ukraine conflict](#) and **Middle East tensions**.
  - The price of a barrel of oil is likely to fluctuate between **USD 70** and **USD 100** for most of 2024, impacting India's energy import bills significantly.

- Nuclear energy offers a **path to greater energy independence**. This is particularly crucial as **India's primary energy demand could surge to 1150-1600 Mtoe by 2040, a 30-60% jump from 2019 levels**.
- **Climate Change Mitigation and International Commitments:** India has pledged to reduce its **carbon intensity by 45% from 2005 levels by 2030** and to achieve net-zero emissions by 2070.
  - [India is the 3rd largest emitter of CO2](#) in the world after China and the USA.
    - Nuclear power, being a clean energy source, can play a crucial role in mitigating CO2 emission.
- **Addressing Base Load Requirements and Grid Stability:** As India rapidly expands its [renewable energy capacity](#) (added **15 GW of new solar capacity in the first half of 2024, setting an all-time record**.), the intermittent nature of solar and wind power **poses challenges to grid stability**.
  - The **record peak power demand of 240 GW in May 2024** highlighted the need for reliable base load power.
  - Nuclear energy, with its high capacity factor ( **nearly 2 times more than natural gas and coal units**, and almost **3 times or more reliable than wind and solar plants**).
    - It can provide the necessary baseload to complement renewables.
- **Job Creation and Economic Growth:** Prioritizing the nuclear energy sector can significantly contribute to job creation and economic growth in India:
  - The nuclear industry **creates high-skilled, long-term jobs in various fields, including engineering, construction, operations**, and research and development.
    - A typical nuclear power plant generates about **400 to 700 permanent jobs**.
  - The development of a robust nuclear energy sector can also **boost related industries, such as advanced manufacturing, materials science, and nuclear medicine**.

## What are the Potential Advantages of Private Sector Involvement in India's Nuclear Sector?

- **Increased Investment and Faster Project Completion:** Private sector participation could significantly **boost investment in India's nuclear sector**.
  - The government's recent announcement in July 2024 aims to attract nearly **USD 26 billion** in private investments.
  - This influx of capital could **accelerate project completion times**, addressing India's growing energy demands more rapidly.
  - Data from the [International Atomic Energy Agency](#) shows that the median construction time for nuclear plants in India has historically been **just over 14 years**.
    - Private sector efficiency could potentially reduce this to 5-7 years.
    - Faster project completion would help India progress towards its goal of **500 GW of non-fossil fuel energy capacity by 2030**, up from the **current 178 GW (as of September 2024)**.
- **Technological Innovation and R&D Advancements:** Private sector involvement could spur innovation in nuclear technology, particularly in areas like **small modular reactors (SMRs) and advanced fuel cycles**.
  - The government's proposal in **Budget 2024-25**, for developing **Bharat Small Reactors (BSR) and Bharat Small Modular Reactors (BSMR)** could benefit from private R&D capabilities.
  - The global **SMR market is projected to reach \$18.8 billion by 2030**, presenting a significant opportunity for India to become a key player with private sector innovation.
- **Cost Reduction and Improved Efficiency:** Private sector participation could lead to significant cost reductions in nuclear power generation.
  - Currently, according to the **Nuclear Energy Agency** the **levelized cost of electricity (LCOE)** for nuclear power in India is estimated to be around **48.2 USD/MWh** when calculated at a **3% discount rate**.
    - With private sector efficiencies, this **could potentially decrease by 15-20%**.
  - With India aiming to add **18 nuclear power reactors** with a capacity of 13,800 MWe by 2031-32, the private sector can play a key role in cost reduction.
- **Enhanced Energy Security and Reduced Carbon Emissions:** Private sector participation could accelerate India's nuclear power capacity addition, contributing to **enhanced energy**

## security and reduced carbon emissions.

- Nuclear energy is the fifth-largest source of electricity for India which contributes about **3% of the total electricity generation in the country**
  - With private investment and efficiency, this could **potentially increase to 5-10%**.
- This expansion would significantly **reduce India's dependence on fossil fuels** and help in achieving its **Nationally Determined Contribution (NDC) targets**.
  - Over the past 50 years, the use of nuclear power has **reduced CO2 emissions by over 60 gigatonnes**, nearly two years' worth of global energy-related emissions. (**International Energy Agency**)

## What are the Major Issues Related to Increased Private Participation in India's Nuclear Sector?

- **Regulatory and Legal Challenges:** The **Atomic Energy Act of 1962** currently restricts nuclear power development and operation to the central government, posing a significant barrier to private participation.
  - In September 2024, the Supreme Court of India dismissed a **petition challenging these restrictions**, citing the need for stringent safeguards in atomic power exploitation.
    - The pending challenge to the **constitutionality of the [Civil Liability for Nuclear Damage Act, 2010 \(CLNDA\)](#)** further complicates the legal landscape.
  - These legal hurdles create **uncertainty for potential private investors**. For instance, the **Nuclear Power Corporation of India Limited (NPCIL)** remains **the sole entity authorized to operate nuclear power plants**, limiting private sector roles to supplying components and providing engineering services.
- **Safety Concerns and Public Perception:** The inherent risks associated with nuclear power generation raise significant safety concerns, potentially amplified by private sector involvement.
  - The memory of disasters like **Chernobyl (1986)** and **Fukushima (2011)** continues to influence public perception.
  - In India, protests against nuclear projects, such as those at **Kudankulam and Jaitapur**, highlight the challenge of public acceptance.
  - Ensuring stringent safety standards while allowing private participation will be a **delicate balance to strike**, especially given the **recent global trend towards stricter nuclear safety regulations post-Fukushima**.
- **Financial Viability and Risk Management:** Nuclear power projects are capital-intensive and have long gestation periods, posing significant financial risks for private investors.
  - The **Central Electricity Authority (CEA)** reports that the capital cost of a **Pressurized Heavy Water Reactor (PHWR) nuclear power plant** in India was approximately **₹11.7 crore per MW in 2021-22**, and is projected to rise to **₹14.2 crore per MW** by 2026-27, with construction times often exceeding a decade.
  - Moreover, the **potential for accidents and the associated liabilities under the [The Civil Liability for Nuclear Damage Act, 2010](#)** create additional financial uncertainties that may deter private investment without substantial government guarantees.
- **Technology Transfer and Intellectual Property Concerns:** India's nuclear program has historically relied on **indigenous technology development**.
  - With increased private participation, **especially from foreign companies**, issues of technology transfer and intellectual property protection become crucial.
  - The **2008 India-US Civil Nuclear Agreement** opened doors for international cooperation, but restrictions remain.
    - For example, the **[Nuclear Suppliers Group](#) guidelines still limit certain technology transfers to India**.
    - The **recent controversy over technology transfer in the [Rafale fighter jet deal](#)** highlights the sensitivity of such issues in strategic sectors.
- **Nuclear Fuel Cycle Management and Waste Disposal:** Private participation raises questions about the **management of the complete nuclear fuel cycle**, particularly the sensitive areas of fuel enrichment, reprocessing, and waste disposal.
  - **India's three-stage nuclear program, which aims to utilize its vast thorium reserves**, adds complexity to this issue.
    - The challenge lies in **determining the extent of private involvement while**

### ensuring national security.

- The debate over the location and management of **India's first deep geological repository for high-level nuclear waste** underscores the long-term challenges in this area.
- **International Relations and Non-Proliferation Concerns:** Increased private participation, especially with potential foreign involvement, could complicate India's delicate balance in international nuclear diplomacy.
  - India, not being a signatory to the **Non-Proliferation Treaty**, operates under special arrangements with the **International Atomic Energy Agency (IAEA)**.
  - As of 2019, **14 of India's nuclear reactors are under IAEA safeguards**.
  - Expanding private participation might **require renegotiation of these arrangements** and could raise new non-proliferation concerns.
  - The recent tensions over **Iran's nuclear program** and the **scrutiny faced by countries like Saudi Arabia** in their nuclear energy pursuits highlight the complex geopolitical dimensions of nuclear technology proliferation.

## How can India Promote Balanced and Effective Private Sector Participation in its Nuclear Sector?

- **Phased Legislative Reforms:** India could implement a staged approach to amending the **Atomic Energy Act of 1962**, gradually allowing private participation.
  - The first phase could focus on **permitting private investment in non-critical areas** such as equipment manufacturing and maintenance services.
    - A **Niti Ayog** panel has recommended that the government can consider **lifting its ban on foreign investment in its nuclear power industry**.
  - This could be followed by **allowing minority private stake in nuclear power plants**, with the government retaining majority control.
  - The final phase could **explore options for majority private ownership** in new projects, subject to stringent regulatory oversight.
    - Additionally, private participation could also be expanded to include **nuclear waste management**, guided by the '**polluter pays principle**.' as identified in the 1996 case of **Indian Council of Enviro-Legal Action vs Union of India**
  - This approach aligns with the government's recent push for private sector involvement announced in the **2024-25 Union Budget**, while addressing the Supreme Court's concerns about calibrated exploitation of atomic power.
- **Establishment of an Independent Nuclear Regulatory Authority:** India should expedite the establishment of an independent nuclear regulatory authority, separate from the Department of Atomic Energy.
  - This was proposed in the **lapsed Nuclear Safety Regulatory Authority Bill of 2011**, which could be revived and updated.
  - The new authority would oversee safety standards, licensing, and operations for **both public and private entities in the nuclear sector**.
- **Public-Private Partnership (PPP) Models:** Develop specialized PPP models for the nuclear sector, drawing from successful examples in other infrastructure sectors.
  - These models could include **Build-Operate-Transfer (BOT) arrangements** for new nuclear plants, with private entities constructing and operating the facilities for a fixed period before transferring them to the government.
  - Another option could be **Operations and Maintenance (O&M) contracts** for existing plants.
  - The recent success of **PPP models in India's space sector**, such as the **LVM3 project**, provides a template that could be adapted for the nuclear sector.
- **Risk Mitigation and Insurance Mechanisms:** Establish a comprehensive nuclear insurance pool to address liability concerns under the Civil Liability for Nuclear Damage Act, 2010.
  - This could build upon the existing **Indian Nuclear Insurance Pool (INIP)**, which currently has a capacity of ₹1,500 crore.
  - The government could work with **international reinsurers** to increase this capacity, making it more attractive for private investors.
  - This approach has been successfully used in the **UK's Hinkley Point C project**, where the government provided a **Euro 2 billion guarantee**.

- Such measures would make nuclear projects more bankable for private investors.
- **Technology Collaboration and Indigenization Programs:** Implement structured programs for **technology transfer and indigenization**, similar to the successful offset policy in the defense sector.
  - Setting up **Nuclear Technology Parks**, similar to the successful IT parks model, to foster collaboration between public sector entities, private companies, and research institutions.
  - The 2009 collaboration between **L&T and Westinghouse to manufacture nuclear plant components in India** serves as a good example.
- **Skill Development and Human Resource Initiatives:** Launch a comprehensive Nuclear Skill Development Program in partnership with industry and academia.
  - This could include setting up **specialized nuclear engineering programs in IITs and NITs**.
  - Encourage private sector participation in **training programs through tax incentives and grants**.
  - Establish a **Nuclear Innovation Hub**, similar to the **successful Atal Innovation Mission**, to foster research and development in nuclear technologies.
  - These measures would address the projected shortage of skilled professionals in the nuclear sector.
- **Transparent Safety and Performance Benchmarks:** Develop and implement a **transparent system of safety and performance benchmarks** for nuclear facilities, applicable to both public and private operators.
  - This could include regular public disclosures of safety performance, similar to the **US Nuclear Regulatory Commission's Reactor Oversight Process**.
  - Introduce a rating system for nuclear plants based on safety and operational efficiency, incentivizing high performers through **preferential regulatory treatment or financial benefits**.
  - Implement a public engagement program to improve transparency and build trust, drawing lessons from countries like **Finland, which has high public acceptance of nuclear energy**.
  - These measures would address the safety concerns and foster a culture of continuous improvement in the sector.

## Conclusion:

While private sector participation can **accelerate India's nuclear energy expansion** and enhance technological innovation, it requires a careful balancing act. Addressing legal and regulatory challenges, **ensuring safety, and fostering public trust** are essential to unlocking the full potential of private investment while safeguarding national interests. Legislative reforms and robust oversight mechanisms will be crucial in this transition.

### Drishti Mains Question:

Discuss the prospects and challenges of private sector participation in India's nuclear energy program. How can India ensure national security while encouraging technological and financial investment?

## UPSC Civil Services Examination, Previous Year Questions (PYQs)

### Prelims

**Q. In India, why are some nuclear reactors kept under “IAEA safeguards” while others are not? (2020)**

- (a) Some use uranium and others use thorium
- (b) Some use imported uranium and others use domestic supplies
- (c) Some are operated by foreign enterprises and others are operated by domestic enterprises

(d) Some are State-owned and others are privately owned

Ans: (b)

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**Mains**

**Q.** With growing energy needs should India keep on expanding its nuclear energy programme? Discuss the facts and fears associated with nuclear energy. **(2018)**

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