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A large, golden-brown statue of a lion capital, likely the Lion Capital of Ashoka, is positioned in the background. The statue features four lion heads facing different directions, with a central figure that appears to be a lion or a similar animal. The statue is set against a red background.

# Expected EDITORIAL EXPLAINED

*for*

## IAS Mains Examination

13<sup>th</sup> July *to* 18<sup>th</sup> July 2026



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## 1.1. INTERNATIONAL RELATIONS

### 1.1.1. INDIA MUST BUILD PARTNERSHIPS IN THIS AGE OF GLOBAL TURMOIL

#### Why is in news?

PM Modi's recent visit to Australia and New Zealand in rapidly evolving Indo-Pacific geopolitical landscape highlights the transformation of India-Indo-Pacific ties into a Comprehensive Strategic Partnership driven by shared democratic values, concerns over regional security, and expanding cooperation in defence, trade, critical minerals, and emerging technologies.



#### Why Indo-Pacific zone is need of the hour

##### 1. The Indo-Pacific has remain as new centre of global geopolitics

- Rise of China as a military presence as strategic naval and military base and economic influence through multilateral engagement (RECEP, BRI)
- US-China strategic escalation rivalry in indopacific region as reponse to mutual competitive response over trade war.
- South China Sea turmoil over Taiwan Strait tensions for competition over semiconductor technology and supply chains issues.

##### 2. Rules-Based International Order

- India being a member of QUAD always advocates for "Free, Open and Rules-Based Indo-Pacific" maintaining peace and harmony n IndoPacific region.
- Respecting provisions of UNCLOS avoid any unilateral aggression ensuring freedom of navigationand resolves disputes peacefully.

##### 3. India's Economic Security Depends on a Stable Indo-Pacific

- India's trade moves largely through engagement in Indian Ocean, Strait of Malacca, South China Sea in form of bilateral and multilateral relations.
- In recent scenario of fragmented supply chain economic diversification gives viability to Indian econmy dependent on IndoPacific zone.

##### 4. Critical Minerals and Technology Security

- Australia possesses large reserves of Lithium, Cobalt, Nickel and other Rare earth elements consider as strategic critical element.
- Taiwan has remaied in centrestage of competition revolving Semiconductor industry.

#### India–Australia Relations: Current Status

##### 1. Shared Vision for a Free and Open Indo-Pacific

India and Australia support a **free, open, inclusive and rules-based Indo-Pacific**, with emphasis on **UNCLOS, freedom of navigation and peaceful settlement of disputes**. Their shared vision contributes to regional peace, security and stability.

## 2. Comprehensive Strategic and Defence Partnership

Defence cooperation has emerged as a key pillar of bilateral ties through **AUSINDEX, the Malabar Exercise, defence dialogues and maritime cooperation**. Both countries are enhancing interoperability and strengthening Indo-Pacific security.

## 3. Expanding Economic and Trade Relations

Economic ties have grown significantly with the **India–Australia Economic Cooperation and Trade Agreement (ECTA)**, while negotiations on the **Comprehensive Economic Cooperation Agreement (CECA)** continue to deepen trade and investment.

## 4. Critical Minerals and Technology Cooperation

Australia is a key partner in supplying **critical minerals** such as lithium, cobalt and rare earths, which are essential for **EVs, batteries, semiconductors, renewable energy and defence manufacturing**. Cooperation also extends to emerging technologies and innovation.

## 5. Strong People-to-People and Educational Linkages

A large Indian diaspora, growing student mobility, research collaborations and skilled workforce exchanges have strengthened cultural and societal ties. These connections serve as a long-term foundation for the bilateral relationship.

## 6. Robust Multilateral Cooperation

India and Australia work closely in forums such as the **Quad, G20, IORA, East Asia Summit and the United Nations**. Their cooperation promotes a rules-based international order, maritime security and sustainable regional development.

### India–New Zealand Relations: Current Status

#### 1. Shared Vision for a Free and Open Indo-Pacific

India and New Zealand support a **free, open, inclusive and rules-based Indo-Pacific**, with emphasis on **UNCLOS, freedom of navigation and peaceful dispute resolution**. This reflects their shared commitment to regional stability and maritime security.

#### 2. Comprehensive Strategic Partnership

The relationship has been elevated to a **Comprehensive Strategic Partnership (CSP)**, expanding cooperation in defence, maritime security, trade, investment, clean energy, emerging technologies and regional governance.

#### 3. Growing Economic and Trade Cooperation

Both countries are working to strengthen **bilateral trade, investment, supply-chain resilience and business partnerships**. Enhanced economic engagement aims to diversify markets and create new opportunities for sustainable growth.

#### 4. Strong People-to-People and Educational Ties

Education remains a key pillar of the relationship, with Indian students forming one of the largest international student communities in New Zealand. The vibrant Indian diaspora further strengthens cultural, academic and business linkages between the two countries.

### Challenges in Strengthening India–Australia–New Zealand Partnerships

#### 1. Managing China's Strategic Response

Deepening partnerships may invite stronger Chinese geopolitical and economic countermeasures, including increased pressure along the border and in the Indian Ocean.

## 2. Limited Bilateral Trade

Trade volumes remain modest due to market access issues, non-tariff barriers, limited product diversification and low business engagement.

## 3. Geographical Distance and Logistics Costs

Long shipping routes and high transportation costs reduce trade competitiveness and supply-chain efficiency.

## 4. Competition from Other Indo-Pacific Powers

India competes with countries such as Japan, South Korea, ASEAN members and the US for trade, investment and strategic influence.

## 5. Slow Progress in Trade Agreements

Delays in concluding comprehensive trade agreements and regulatory harmonisation constrain the full potential of economic cooperation.

## 6. Global Economic and Geopolitical Uncertainties

Supply-chain disruptions, economic slowdowns and regional conflicts can adversely affect trade, investment and long-term strategic collaboration.

### Way Forward for India–Australia–New Zealand Relations

#### 1. Strengthen the Indo-Pacific Strategic Partnership

Deepen cooperation in defence, maritime security, intelligence sharing and regional stability while preserving India's strategic autonomy through platforms such as the **Quad, IORA, BIMSTEC and the East Asia Summit**.

#### 2. Accelerate Economic Integration and Trade

Fast-track **CECA** with Australia, expand trade with New Zealand, reduce non-tariff barriers and promote investments through initiatives like **Make in India** and the **PLI Scheme**.

#### 3. Build Resilient and Trusted Supply Chains

Enhance collaboration in **critical minerals, semiconductors, logistics and manufacturing**, while promoting technology transfer and domestic value addition under **Atmanirbhar Bharat** and the **Supply Chain Resilience Initiative (SCRI)**.

#### 4. Advance Technology, Innovation and Digital Cooperation

Expand partnerships in **Artificial Intelligence, cybersecurity, digital public infrastructure, start-ups, research and emerging technologies** to strengthen the knowledge-based economy.

#### 5. Lead the Green Energy and Climate Transition

Promote joint initiatives in **renewable energy, green hydrogen, climate resilience, sustainable infrastructure and clean technologies** to support global climate goals and India's net-zero pathway.

#### 6. Deepen People-to-People and Educational Linkages

Strengthen **student mobility, academic collaborations, skill development, research partnerships and diaspora engagement** to build long-term trust and societal connectivity.

## 7. Promote a Rules-Based and Inclusive Regional Order

Coordinate closely in **the G20, United Nations, Quad, IORA and East Asia Summit** to uphold international law, freedom of navigation, disaster resilience and sustainable development across the Indo-Pacific.

### Conclusion

The evolving India–Australia and India–New Zealand partnerships reflect India's transition from a regional power to a key stakeholder in shaping the Indo-Pacific order. Sustained political commitment, economic integration, and strategic cooperation will be essential to transform these partnerships into enduring engines of peace, prosperity, and regional resilience.

**Q.** *"The Indo-Pacific has emerged as the centre of contemporary geopolitical competition." Discuss India's strategic approach towards strengthening partnerships with Australia and New Zealand in this context. 15 Marks*

## 1.1.2. IRAN'S DISRUPTIVE STRATEGY AND ITS GLOBAL CONSEQUENCES

### Context

The recent escalation involving **Iran's actions in the Strait of Hormuz**, attacks on Gulf states, and proxy warfare has heightened concerns over **regional stability, global energy security, and maritime trade**, underscoring the challenge of balancing geopolitical rivalry with economic development.



### Introduction

Iran has pursued a strategy of **proxy warfare, military deterrence, and maritime coercion** to counter Western influence. While it has secured short-term tactical gains, the strategy has deepened its diplomatic and economic isolation, highlighting the relevance of India's balanced and pragmatic approach in West Asia.

### Iran's Disruptive Strategy

#### 1. Proxy Warfare

Iran supports proxy groups such as **Hezbollah, Hamas, the Houthis, and Shia militias** to expand its regional influence, counter the **US and Israel**, and avoid direct military confrontation.

#### 2. Maritime Coercion

Iran uses the **Strait of Hormuz** as a strategic tool by threatening shipping, attacking tankers, and disrupting maritime trade to exert geopolitical and economic pressure.

#### 3. Ideological Resistance

Iran projects itself as a defender of the **Palestinian cause** and an opponent of **Western imperialism**, using the "Axis of Resistance" narrative to enhance its regional influence and domestic legitimacy.

#### 4. Strategic Partnerships

Iran has strengthened ties with **Russia, China, and North Korea** to reduce the impact of Western sanctions, secure economic and military support, and counter diplomatic isolation.

## Why is the Strait of Hormuz Strategically Important?

### Global Significance

- **World's busiest energy chokepoint:** It is one of the most critical maritime routes for transporting oil and natural gas worldwide.
- **Carries around one-fifth of global crude oil trade:** Nearly **20% of the world's seaborne crude oil** passes through the Strait, making it vital for global energy supply.
- **Vital for Qatar's LNG exports:** It serves as the primary route for exporting **Liquefied Natural Gas (LNG)** from Qatar, one of the world's largest LNG exporters.
- **Gateway to Asian markets:** It connects major Gulf oil producers with energy-importing economies such as **India, China, Japan, and South Korea**.

### Importance for India

- **Major source of crude oil imports:** A significant share of India's crude oil imports from the Gulf passes through the Strait of Hormuz.
- **Critical trade corridor:** It facilitates India's trade with West Asia, including energy, fertilizers, and other essential commodities.
- **Energy security:** Any disruption can threaten India's uninterrupted supply of crude oil and natural gas.
- **Connectivity through Chabahar Port & INSTC:** Escalating tensions may hamper the **Chabahar Port** and the **International North-South Transport Corridor (INSTC)**, affecting India's strategic connectivity with **Central Asia and Afghanistan**.
- **Inflation:** Higher oil prices resulting from disruptions increase transportation and production costs, fueling inflation.
- **Shipping costs:** Geopolitical tensions raise freight charges and insurance premiums for ships using the route.
- **Current Account Deficit (CAD):** Costlier energy imports increase India's import bill, widening the Current Account Deficit.

### India's Stand on the Iran Crisis

1. **Strategic Autonomy:** India follows a policy of strategic autonomy, maintaining balanced relations with Iran, Israel, the Gulf countries, and the United States without aligning with any bloc.
2. **Support for Dialogue and Peace:** India consistently advocates de-escalation, restraint, and peaceful resolution of disputes through diplomacy, while opposing further military escalation in West Asia.
3. **Safeguarding Energy Security:** Given its dependence on Gulf energy supplies, India seeks to ensure the uninterrupted flow of crude oil and LNG by diversifying import sources and strengthening strategic petroleum reserves.
4. **Protection of Maritime Trade:** India supports freedom of navigation and secure sea lanes, emphasizing the safety of shipping through the Strait of Hormuz to protect global trade and its own economic interests.

5. Pragmatic Engagement with Iran: India continues to engage Iran based on national interests, particularly through projects like the Chabahar Port and the International North-South Transport Corridor (INSTC), while complying with international obligations and maintaining strong ties with the Gulf Cooperation Council (GCC) and Israel.

### Challenges Faced by India Due to the Iran–West Asia Crisis

1. Energy Security  
Disruptions in the **Strait of Hormuz** can affect India's crude oil and LNG imports, increasing energy costs and supply vulnerabilities.
2. Trade and Supply Chain Disruptions  
Regional instability may disrupt shipping routes, raise freight and insurance costs, and adversely impact India's trade with West Asia.
3. Economic Pressures  
Higher global oil prices can fuel inflation, widen the **Current Account Deficit (CAD)**, increase fiscal pressure, and slow economic growth.
4. Safety of the Indian Diaspora  
Escalating conflict could threaten the safety of millions of Indians residing in West Asia, requiring evacuation and enhanced consular support.
5. Connectivity Challenges  
The crisis may delay projects such as the **Chabahar Port** and the **International North-South Transport Corridor (INSTC)**, affecting India's connectivity with Central Asia and Afghanistan.
6. Diplomatic Challenges  
India's policy of **strategic autonomy** will be tested as it seeks to balance relations with Iran, Israel, the Gulf countries, and major powers while protecting its national interests.

### Way Forward

#### For Iran

- **Shift from coercion to diplomacy:** Iran should prioritise dialogue and peaceful engagement over military coercion and proxy warfare to rebuild regional trust.
- **Reduce dependence on proxy warfare:** Limiting support to armed non-state actors can help reduce regional instability and improve diplomatic relations.
- **Ensure freedom of navigation:** Iran should respect international maritime law and guarantee the safe passage of commercial vessels through the Strait of Hormuz.
- **Reintegrate into the global economy:** Pursuing diplomatic engagement and sanctions relief can attract investment, technology, and trade for economic growth.
- **Expand energy exports through peaceful engagement:** Stable relations with neighbouring countries can help Iran maximise its oil and gas exports and strengthen its economy.

#### For the International Community

- **Encourage dialogue:** Major powers and regional organisations should facilitate sustained diplomatic engagement among all stakeholders.
- **Avoid escalation:** Countries should exercise restraint and refrain from actions that could trigger wider regional conflict.

- **Strengthen maritime security:** Greater international cooperation is needed to secure sea lanes and protect global energy and trade routes.
- **Promote regional confidence-building:** Confidence-building measures, regular dialogue, and security cooperation can reduce mistrust among regional actors.
- **Support negotiated settlements:** Disputes should be resolved through diplomacy, international law, and multilateral institutions rather than military action.

#### For India

- **Continue strategic autonomy:** India should maintain balanced relations with Iran, Israel, the GCC, and major powers while pursuing its national interests.
- **Diversify energy imports:** Expanding energy sourcing from multiple regions will reduce dependence on any single route or supplier.
- **Accelerate renewable energy transition:** Increasing the share of renewable energy will lower vulnerability to external oil price shocks.
- **Strengthen Chabahar Port and INSTC:** Faster implementation of these projects will improve India's connectivity with Central Asia and reduce dependence on traditional trade routes.
- **Enhance naval capabilities in the Indian Ocean:** Strengthening maritime surveillance and naval preparedness will help secure India's sea lines of communication.
- **Deepen partnerships with Iran and GCC countries:** Expanding economic, energy, and strategic cooperation with all regional partners will enhance India's role as a stable and trusted stakeholder in West Asia.

#### Conclusion

Iran's coercive strategy may yield short-term gains but risks long-term isolation and instability. In contrast, **India's strategic autonomy, balanced diplomacy, and commitment to multilateralism** provide a sustainable framework for safeguarding its energy security and advancing regional stability.

**Q.** *The Strait of Hormuz is a critical geopolitical chokepoint with far-reaching implications for global energy security. Discuss its strategic importance and analyse the challenges it poses for India's foreign policy and economic security. 15 marks*

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## 2.1. ECONOMY

### 2.1.1. ETHANOL-BLENDED FUEL

#### Context

India will continue supplying **higher-priced E20 petrol** even when global crude oil prices fall below **\$70 per barrel** to support farmer incomes. While the policy promotes **energy security and ethanol blending**, it raises concerns over **higher consumer costs** and the reliance on **water-intensive sugarcane**, highlighting the need to balance **farmer welfare, consumer interests, and sustainability**.



#### Introduction

India's **Ethanol Blended Petrol (EBP) Programme** is a key component of its energy transition strategy, aimed at reducing crude oil imports, enhancing energy security, lowering carbon emissions, and augmenting farmers' income. However, the continued incentivisation of ethanol production, primarily from **water-intensive sugarcane** raises concerns over **economic efficiency, resource sustainability, consumer welfare, and the food-energy-water nexus**, necessitating a balanced policy approach.

#### Constitutional & Policy Linkages

- **Article 39(b):** Directs the State to ensure that material resources are distributed to serve the **common good**, balancing producer and consumer interests.
- **Article 48A:** Mandates the State to **protect and improve the environment**, encouraging sustainable and resource-efficient energy policies.
- **Article 51A(g):** Imposes a **fundamental duty on citizens** to protect and improve the natural environment, reinforcing the shift towards cleaner fuels.
- **National Policy on Biofuels (2018, amended 2022):** Promotes ethanol blending and advanced biofuels to enhance **energy security, reduce emissions, and support farmers' income**.
- **Ethanol Blended Petrol (EBP) Programme:** Aims to increase ethanol blending in petrol to **reduce crude oil imports, lower emissions, and create a stable market for agricultural feedstocks**.
- **National Green Hydrogen Mission:** Seeks to establish India as a **global hub for green hydrogen**, complementing biofuels in achieving long-term decarbonisation and net-zero goals.

#### Why is Ethanol Promotion Important?

1. **Energy Security: Reduces crude oil imports:** Ethanol blending lowers India's dependence on imported petroleum, improving energy security and saving foreign exchange.
2. **Climate Change Mitigation: Cleaner transport fuel:** Ethanol emits fewer greenhouse gases and air pollutants than petrol, supporting India's climate commitments under the Paris Agreement.
3. **Farmer Income Diversification: Additional source of farm income:** Ethanol production creates a stable market for agricultural feedstocks, helping farmers and reducing sugarcane payment arrears.

- 4. Circular Economy: Converts agricultural waste into biofuel:** Crop residues and other biomass can be transformed into ethanol, promoting resource efficiency and reducing environmental pollution.

### Government's Present Approach

- 1. Administered Ethanol Pricing:** The government fixes procurement prices for ethanol to provide assured and remunerative returns to ethanol producers and farmers.
- 2. Mandatory Procurement by OMCs:** Oil Marketing Companies (OMCs) are required to procure ethanol from distilleries for blending with petrol under the EBP Programme.
- 3. Continued Higher Pricing of E20:** E20 petrol is sold at a higher price than pure petrol even when global crude oil prices decline, ensuring the viability of ethanol blending.
- 4. Farmer Income Support:** The policy seeks to create a stable demand for sugarcane and other feedstocks, helping improve farmers' incomes and reduce sugar mill arrears.
- 5. Promotion of Energy Security:** By sustaining ethanol production and blending, the government aims to reduce crude oil imports and strengthen India's long-term energy security.

### Challenges of the Current Ethanol Policy

- 1. Higher Consumer Cost and Lower Fuel Efficiency**  
Consumers pay more for **E20 fuel despite its lower energy content**, resulting in reduced mileage and higher transportation costs.
- 2. Economic Inefficiency and Market Distortions**  
Administered pricing and multiple intermediaries increase transaction costs, reducing the overall efficiency of the ethanol value chain.
- 3. Unsustainable Dependence on Sugarcane**  
The policy incentivises **water- and fertiliser-intensive sugarcane**, discouraging diversification towards more sustainable feedstocks.
- 4. Food Security and Environmental Concerns**  
Expanding ethanol production from food crops intensifies the **food-versus-fuel dilemma**, distorts cropping patterns, and increases pressure on water and natural resources.
- 5. Limited Impact on Farmers' Structural Problems**  
Higher ethanol prices improve farm returns only marginally, while issues such as poor market access, post-harvest losses, and low productivity remain unresolved.
- 6. Slow 2G Adoption and Barriers Beyond E20**  
While 2G ethanol is more sustainable, high capital costs, tech complexity, and supply chain gaps stall its growth. Additionally, scaling past E20 is limited by a massive feedstock supply deficit and a lack of compatible flex-fuel vehicle infrastructure.

### Alternative Feedstocks for Ethanol

| Feedstock | Advantages            | Limitations          |
|-----------|-----------------------|----------------------|
| Sugarcane | High ethanol recovery | Water intensive      |
| Maize     | Lower water use       | Fertiliser intensive |
| Millets   | Climate resilient     | Lower starch content |

|                                    |                                              |                           |
|------------------------------------|----------------------------------------------|---------------------------|
| Sweet Sorghum                      | Short duration, less water                   | Lower commercial adoption |
| Agricultural residues (2G Ethanol) | No food competition, reduces stubble burning | High technology cost      |

## Global Perspective

### 1. Brazil – Sustainable Sugarcane Ethanol Model

- Brazil meets nearly **50% of its transport fuel demand** through ethanol, primarily from sugarcane.
- **Lesson for India:** Link incentives to **carbon intensity and sustainability**, not just ethanol quantity.

### 2. United States – Diversified Feedstock and Advanced Biofuels

- The U.S. follows the **Renewable Fuel Standard (RFS)**, which promotes both conventional ethanol (corn) and **advanced biofuels** such as cellulosic (2G) ethanol.
- It provides **tax incentives, grants, and mandatory blending targets** to encourage technological innovation and the use of agricultural residues.

## Way Forward

### 1. Shift to Sustainable Feedstock-Based Incentives

Incentivise **2G ethanol, crop residues, and water-efficient feedstocks** instead of uniformly rewarding ethanol produced from sugarcane.

### 2. Promote Climate-Resilient Crop Diversification

Encourage crops such as **sweet sorghum, millets, and maize** to reduce pressure on water resources and improve agricultural sustainability.

### 3. Integrate Biofuel and Agricultural Policies

Align ethanol promotion with **irrigation reforms, crop planning, market infrastructure, and supply chain improvements** to address structural issues in agriculture.

### 4. Strengthen the 2G Ethanol Ecosystem

Support second-generation ethanol through **technology adoption, viability gap funding, residue collection infrastructure, and public-private partnerships**.

### 5. Adopt Resource-Efficient and Market-Oriented Pricing

Link incentives to **water efficiency, carbon footprint, and environmental performance** while ensuring transparent and economically rational pricing.

### 6. Balance Energy Security with Consumer and Food Security

Design ethanol policies that simultaneously safeguard **consumer affordability, food security, farmer welfare, and India's long-term clean energy goals**.

### 7. Roadmap for E100 and Flex-Fuel Vehicles (FFVs)

Establish a legal framework to commercialise E100 by deploying dedicated dispensing corridors. Drive adoption by offering fiscal incentives (like lower GST) on FFVs and implementing production mandates linked to emission norms to build a competitive ecosystem.

## Conclusion

India's ethanol policy must move beyond **quantity-driven blending** to **sustainability-driven production**. A balanced approach that promotes **resource-efficient feedstocks, protects consumer interests, and ensures farmer welfare** will make ethanol blending both **economically viable and environmentally sustainable**.

**Q.** *India's Ethanol Blended Petrol (EBP) Programme is central to achieving energy security and climate goals. However, its current implementation raises concerns regarding consumer welfare, resource sustainability, and agricultural efficiency. Examine. Suggest measures to make India's ethanol policy more sustainable and inclusive. 15 Marks*

## 2.1.2. ATMANIRBHAR NUCLEAR ENERGY

### Context

- Following the 1974 international sanctions, India cultivated complete self-reliance in nuclear technology. Despite the 2008 India-US civil nuclear deal easing uranium imports, the prohibitive costs of Western reactors reinforced India's reliance on its highly cost-competitive indigenous infrastructure to secure long-term energy demands.



### Introduction

- Achieving the *Viksit Bharat 2047* and 2070 net-zero targets requires continuous nuclear baseload power to offset intermittent renewables. Realizing the 100 GW capacity goal by 2047 demands indigenous technological scaling, public-private partnerships, and uncompromising safety protocols.

### Strategic Evolution of India's Nuclear Landscape

- The Legacy of Sanctions:** Embargoes forced a collaborative partnership between the Atomic Energy Commission (AEC) and domestic industrial firms, paving the way for complete design and manufacturing autonomy.
- The Indigenous Cost Advantage:** India currently builds the cheapest nuclear power plants globally, costing approximately \$1,700 per kW.
- Scaling Up Reactor Capacities:** The successful scaling of domestic units from 200 MW to 500 MW, and now to operational 700 MW Pressurized Heavy Water Reactors (PHWRs), demonstrates deep commercial and technological maturity.
- India's Three-Stage Nuclear Programme:**
  - Stage 1:* Utilizes Pressurised Heavy Water Reactors (PHWRs) using natural uranium as fuel.
  - Stage 2:* Transitions to Fast Breeder Reactors using plutonium, marked by the Prototype Fast Breeder Reactor (PFBR) at Kalpakkam achieving criticality in April 2026.
  - Stage 3:* Focuses on thorium-based reactors to ensure long-term, domestic fuel sustainability.

### Current Status of Nuclear Energy in India

- Existing Operational Capacity:** India currently operates 25 nuclear reactors with a total installed capacity of around 8.8 GW spread across 7 distinct nuclear power sites.

- **Future Project Pipeline:** Ongoing construction and planned projects are on track to increase the domestic capacity to nearly 22 GW by 2032.
- **The 2047 Imperative:** Reaching the targeted 100 GW by 2047 requires an accelerated expansion strategy, demanding scaling via massive public and private participation.
- **Small Modular Reactors Push :** The Union Budget 2025–26 allocated ₹20,000 crore under the Nuclear Energy Mission for the research, development, and deployment of Small Modular Reactors (SMRs).

### About Small Modular Reactors (SMRs)

- **Technical Definition:** SMRs are compact nuclear reactors with a smaller generation capacity (typically up to 300 MWe per module) designed for factory-based manufacturing and modular construction.
- **Target Markets:** Positioned to meet the enormous, dedicated baseload demands of artificial intelligence (AI) data centers, localized industrial hubs, and remote region microgrids.
- **Global Context:** More than 120 SMR designs are under development globally, with major nations leading investments, though widespread commercial deployment remains nascent.

### Advantages of SMRs

- **Faster Construction Timelines:** Factory manufacturing minimizes construction delays and mitigates structural cost overruns common in large reactors.
- **Lower Upfront Capital Risks:** Phased, modular investments significantly reduce initial financial risk profiles for private power developers.
- **Flexible Deployment Grids:** Can be directly installed at localized industrial hubs, smaller regional grids, and data centers without demanding vast transmission expansions.
- **Multi-Purpose Applications:** Beyond electricity generation, SMRs efficiently support green hydrogen production, water desalination, and industrial process heating.

### India's Indigenous SMR Programme

- **Reactor Development:** India is actively developing a 200 MWe *Bharat Small Modular Reactor*, a 55 MWe configuration, and a 5 MWth High-Temperature Gas-Cooled Reactor.
- **Budgetary Backing:** The Union Budget 2025–26 allocated ₹20,000 crore specifically targeted for indigenous SMR research and deployment.
- **National Timeline:** The official framework targets the operationalization of 5 indigenous SMRs by 2033 under the *Atmanirbhar Bharat* model.

### Significance of the Domestic Nuclear Ecosystem

- **Unparalleled Cost Leadership:** Restricting scaling to domestic reactors (\$1,700/kW) provides a viable economic baseline and avoids expensive foreign tech.
- **Strategic Decarbonization and Baseload Reliability:** Provides continuous, low-carbon power that stabilizes the grid during non-solar hours, directly facilitating green hydrogen production.
- **Technological Autonomy:** Homegrown PHWRs and fast breeder technologies ensure independence from restrictive global regimes like the Nuclear Suppliers Group (NSG).
- **Economic Scale Effects:** Opening the sector through investor-friendly legislation reduces project execution timelines and lowers per-unit production costs.

- **Global Export Potential:** India's distinct price competitiveness positions it to become a primary exporter of affordable, safe, and efficient nuclear reactors to emerging global markets.

### Core Structural Challenges

- **Regulatory and Statutory Bottlenecks:** The current framework under the Atomic Energy Act is designed for public sector monopolies, requiring modernization to handle private participation and SMR licensing.
- **Capital Intensity and Financing Risks:** Reaching the 100 GW milestone demands an estimated investment of ₹23–25 lakh crore by 2047, presenting massive upfront financial risks.
- **Domestic Fuel Insecurity:** Despite substantial domestic reserves, India produces only about 600 tonnes of uranium annually, maintaining a heavy reliance on imports.
- **Industrial Safety Culture Disparities:** Expanding the nuclear sector introduces vulnerabilities due to prevailing domestic industrial gaps, where construction and operational accidents remain frequent.
- **Public Perception Barriers:** Lingering anxieties from legacy global nuclear mishaps require proactive transparency, community engagement, and robust liability management to avoid local resistance.

### Strategic Way Forward

- **Expedite Regulatory Modernization:** Streamline licensing procedures and introduce SMR-specific safety protocols while updating the legislative framework to facilitate smooth public-private partnerships (PPP).
- **Prioritize Indigenous SMR Deployment:** Focus on operationalizing the 5 planned indigenous SMRs by 2033 rather than importing unproven, untested foreign modular reactor designs.
- **Develop Homegrown Light Water Reactors (LWRs):** Launch a dedicated, well-resourced national programme to develop domestic LWRs to circumvent permanent international enrichment technology barriers.
- **Institute Phased Private Onboarding:** Mandate that new private entrants initially develop a limited number of pilot plants under strict external auditing to build a mandatory, self-sustaining internal safety culture.
- **Secure Long-Term Fuel Pipelines:** Enhance domestic uranium extraction efficiency while strategically diversifying bilateral natural uranium import contracts to ensure an uninterrupted front-end fuel cycle.
- **Scale via Aggressive Skilling Frameworks:** Create institutional coordination and specialized training programmes across universities and research centers to fill the growing workforce gap for advanced nuclear engineering.

### Conclusion

- Reaching the 100 GW target by 2047 hinges on prioritizing indigenous technology over unproven foreign imports and enforcing strict safety standards. This approach guarantees national energy security and positions India as a competitive global nuclear exporter.

**Q.** *With growing energy needs should India keep on expanding its nuclear energy programme? Discuss the facts and fears associated with nuclear energy. 15 Marks*

### 3.1.3. PROMISE OF CHIPS

#### Introduction

Semiconductors are the backbone of the digital economy, powering AI, electronics, automobiles, and defence systems. Amid growing geopolitical competition and supply chain disruptions, India has launched the **India Semiconductor Mission (ISM) Phase-II** with an outlay of **₹1.27 lakh crore** to build a resilient semiconductor ecosystem and emerge as a trusted global manufacturing hub.



#### Why are Semiconductors Strategically Important?

##### 1. Foundation of the Digital Economy

- Semiconductors power critical technologies such as **AI, 5G/6G, IoT, EVs, robotics, quantum computing, and consumer electronics**.
- They are the basic building blocks of the **Fourth Industrial Revolution (Industry 4.0)** and digital transformation.

##### 2. National Security & Strategic Autonomy

- Essential for **defence electronics, missiles, satellites, cybersecurity, and secure communication systems**.
- Indigenous chip manufacturing reduces dependence on imports and enhances **strategic autonomy** during geopolitical conflicts.

##### 3. Economic Growth & Manufacturing Competitiveness

- Strengthens **electronics manufacturing**, attracts high-value investments, and boosts exports.
- Supports flagship initiatives such as **Make in India, Digital India, and the Production Linked Incentive (PLI) Scheme**.

##### 4. Supply Chain Resilience

- The COVID-19 pandemic, **US-China technology rivalry**, Taiwan Strait tensions, and export restrictions exposed vulnerabilities in global semiconductor supply chains.
- Domestic semiconductor capability enhances **supply chain resilience** and reduces dependence on a few countries for critical technologies.

##### 5. Enabling the AI Revolution

- Artificial Intelligence relies on **high-performance processors, GPUs, memory chips, and AI accelerators** for computing power.
- A robust semiconductor ecosystem is essential for India's ambition to become a global leader under the **IndiaAI Mission** and future digital economy.

##### 6. Social Development & Digital Inclusion

- Affordable semiconductor-enabled devices improve access to **digital education, telemedicine, e-governance, and financial inclusion**.
- Expanding the semiconductor ecosystem creates **high-skilled employment**, promotes innovation, and helps retain India's technical talent, reducing brain drain.

## India Semiconductor Mission (ISM) Phase-II

### Objectives of India Semiconductor Mission (ISM) Phase-II

1. **Develop a Complete Semiconductor Ecosystem:** Build end-to-end capabilities in chip design, fabrication, packaging, equipment, materials, R&D, and skilled manpower to create a self-reliant semiconductor industry.
2. **Strengthen Strategic Autonomy:** Reduce dependence on foreign countries for critical semiconductor technologies and enhance India's technological sovereignty and supply chain resilience.
3. **Integrate into Global Value Chains (GVCs):** Position India as a trusted semiconductor manufacturing hub by attracting global investments and becoming a key partner in diversified supply chains under the China+1 strategy.
4. **Promote Innovation and Indigenous Technology:** Encourage domestic R&D, intellectual property (IP) creation, and indigenous semiconductor technologies to build long-term technological competitiveness.

### Major Features

1. **Capital Support:** Provides capital subsidies to semiconductor projects to reduce initial investment costs and encourage manufacturing.
2. **Manufacturing-Linked Incentives (MLIs):** Offers incentives based on actual production and sales to promote sustained manufacturing.
3. **Performance-Based Incentives:** Rewards firms for higher production, commercial sales, and greater domestic value addition.
4. **Support for Indigenous Capabilities:** Encourages the use of domestic components, indigenous technologies, and locally developed intellectual property (IP) to strengthen technological self-reliance.
5. **₹1.27 lakh crore:** A substantially enhanced allocation to accelerate the development of a comprehensive semiconductor ecosystem in India.

### Challenges Before India in Developing a Semiconductor Ecosystem

1. **High Capital Requirement:** Semiconductor fabrication plants require massive investments (US\$10–20 billion+) and have long gestation periods, making financing and risk-sharing difficult.
2. **Technology & Intellectual Property Gap:** India lacks access to frontier technologies such as **EUV lithography, advanced process nodes (<5 nm), and critical semiconductor IP**, which are concentrated in a few countries.
3. **Complex Global Value Chains:** Semiconductor manufacturing involves highly specialised stages—from design to fabrication, packaging, testing, equipment, and materials—making ecosystem development challenging.
4. **Intense Global Competition:** Countries like the US, China, Japan, South Korea, and the EU are offering massive incentives, intensifying competition for investment, technology, and skilled talent.
5. **Skilled Talent Retention:** Despite a strong pool of semiconductor engineers, India faces brain drain due to better research opportunities, higher salaries, and mature innovation ecosystems abroad.

6. Infrastructure & Ecosystem Deficit: Semiconductor fabs require uninterrupted power, ultra-pure water, advanced logistics, and policy stability, areas where India still needs significant improvement.

### Strengthen Global Partnerships

#### 1. Collaborate with the United States

- Deepen cooperation in **advanced chip manufacturing, semiconductor R&D, and supply chain resilience** through initiatives like the **India-US Initiative on Critical and Emerging Technology (iCET)**.

#### 2. Partner with Japan

- Leverage Japan's expertise in **semiconductor materials, manufacturing equipment, and precision engineering** to strengthen India's fabrication ecosystem.

#### 3. Engage with Taiwan

- Collaborate with Taiwan, the global leader in **chip fabrication and foundry services**, for technology transfer, investment, and skill development.

#### 4. Strengthen Ties with South Korea

- Partner with South Korea in **memory chips, advanced packaging technologies, and semiconductor manufacturing**, while encouraging investments by global firms.

#### 5. Enhance Cooperation with the European Union

- Work with the EU on **joint R&D, semiconductor standards, sustainable manufacturing, and workforce development** to integrate into trusted global value chains.

### Way Forward for India's Semiconductor Ecosystem

1. Develop the Entire Semiconductor Ecosystem: Move beyond chip fabrication by strengthening chip design, packaging (ATMP/OSAT), equipment manufacturing, semiconductor chemicals, and raw materials to build an integrated value chain.
2. Invest in Frontier Research & Innovation: Enhance funding for IITs, IISc, semiconductor research centres, and industry-academia collaboration to develop indigenous technologies and intellectual property (IP).
3. Build a Skilled Workforce: Introduce **semiconductor-focused curricula, VLSI training, and advanced manufacturing programmes** to create a globally competitive talent pool.
4. Encourage Private Investment: Ensure policy stability, faster regulatory approvals, quality infrastructure, and predictable taxation to attract long-term domestic and foreign investment.
5. Strengthen Global Partnerships: Collaborate with the US, Japan, Taiwan, South Korea, and the EU for technology transfer, joint R&D, talent development, and supply chain integration.
6. Promote Domestic Demand & Innovation: Leverage initiatives like **Make in India, Digital India, IndiaAI Mission, and PLI Scheme** to create a strong domestic market and encourage indigenous semiconductor innovation.

### Conclusion

The **India Semiconductor Mission Phase-II** marks a strategic shift towards building a resilient semiconductor ecosystem. Sustained investment in technology, talent, and innovation can strengthen India's technological sovereignty, economic competitiveness, and position as a trusted hub in global semiconductor value chains.

**Q.** *The success of India's semiconductor ambitions depends on building an entire ecosystem rather than merely setting up fabrication units. Discuss in the context of the India Semiconductor Mission (ISM) Phase-II. 15 Marks*

## 2.2. INTERNAL SECURITY

### 2.2.1. CYBERSECURITY AND TRANSPARENCY IN CRITICAL INFRASTRUCTURE

#### Context

- A ransomware attack on a **contractor of the Kudankulam Nuclear Power Project (KNPP)** exposed cybersecurity vulnerabilities in India's critical infrastructure.
- Although **NPCIL confirmed that reactor operations were unaffected**, the incident highlighted the need for stronger **cyber resilience, supply-chain security, and timely breach disclosure**.



#### Introduction

As India digitises its critical infrastructure, **cybersecurity has become a key national security priority**. The Kudankulam ransomware incident shows that **critical infrastructure is only as secure as its weakest link**, highlighting gaps in **supply-chain security and cyber incident reporting**.

#### What Happened?

- A **ransomware attack** by the group **World Leaks** allegedly targeted **Reliance Infrastructure**, a contractor involved in **Kudankulam Nuclear Power Project (Units 3 & 4)**.
- **Yotta Data Services** detected suspicious activity on **29 May**, while leaked data reportedly surfaced online on **11 June**.
- **NPCIL** clarified that the **nuclear reactor systems remained unaffected**, stating that only non-critical contractor-related data was compromised.
- The delayed official disclosure highlighted concerns over **incident reporting, transparency, and cyber governance** in critical infrastructure.

#### Key Issues Highlighted by the Incident

##### 1. Vulnerability of Critical Infrastructure

- Even when core operational systems remain isolated, breaches in supporting digital networks can compromise the security of critical infrastructure such as nuclear plants, power grids, and defence installations.

##### 2. Supply Chain Cybersecurity Risks

- The attack on a third-party contractor highlights that weak cybersecurity across vendors and service providers can become an entry point into strategic infrastructure.

##### 3. Opaque Breach Disclosure

- Delayed reporting of cyber incidents undermines transparency, weakens public trust, and hampers timely response and accountability.

#### 4. Weak Incident Response Mechanisms

- Treating cybersecurity as a compliance obligation rather than a strategic priority results in delayed detection, poor damage assessment, and slower recovery.

#### 5. Intelligence Preparation by Adversaries

- Leaked infrastructure layouts, vendor details, and facility information can aid adversaries in planning future cyber or physical attacks despite secure operational systems.

### Why is the Kudankulam Cyberattack Significant for India?

#### 1. Rising Cyber Threat Landscape

- India is among the world's most targeted countries for cyberattacks, with repeated breaches affecting **AIIMS Delhi, airlines, government portals, financial institutions, and power infrastructure**, highlighting growing cyber vulnerabilities.

#### 2. National Security

- Cyberattacks on strategic installations can compromise sensitive information and threaten the security of critical national infrastructure.

#### 3. Economic Stability

- Disruptions to financial systems, energy networks, and essential services can increase economic losses and undermine investor confidence.

#### 4. Public Safety

- Attacks on critical sectors such as healthcare, power, and transport can disrupt essential public services and directly affect citizens' well-being.

#### 5. Strategic Deterrence

- Strengthening cybersecurity is essential to protect India's strategic assets, maintain operational readiness, and deter hostile state and non-state cyber actors.

### Challenges in India's Cybersecurity Ecosystem

#### 1. Inconsistent Breach Disclosure

- The absence of timely reporting and standardised disclosure protocols reduces transparency and delays coordinated incident response.

#### 2. Supply Chain Vulnerabilities

- Weak cybersecurity practices among contractors, vendors, and third-party service providers increase the risk of attacks on critical infrastructure.

#### 3. Limited Cyber Preparedness

- A shortage of skilled cybersecurity professionals and inadequate cyber drills weaken India's ability to prevent and respond to sophisticated cyber threats.

#### 4. Legacy Digital Infrastructure

- Outdated IT systems in many critical installations make them more vulnerable and hinder the adoption of advanced cybersecurity measures.

#### 5. Institutional Coordination Gaps

- Effective cyber incident management requires seamless coordination among agencies such as **CERT-In, NCIIPC, sectoral regulators, infrastructure operators, and private stakeholders**, which remains a challenge.

## Institutional Framework for Cybersecurity in India

### 1. Computer Emergency Response Team – India (CERT-In)

- **CERT-In** is the national nodal agency under the Ministry of Electronics and Information Technology (MeitY) for responding to cybersecurity incidents.
- It coordinates cyber incident reporting, issues security advisories, conducts incident response, and facilitates mitigation measures across government and private entities.

### 2. National Critical Information Infrastructure Protection Centre (NCIIPC)

- **NCIIPC**, established under the Information Technology Act, 2000, is responsible for protecting India's **Critical Information Infrastructure (CII)** from cyber threats.
- It works with sectors such as **energy, banking, telecommunications, transport, government, and strategic industries** to strengthen cyber resilience and risk management.

### 3. National Cyber Security Policy

- The **National Cyber Security Policy** provides a comprehensive framework to secure India's cyberspace by promoting cyber resilience and a secure digital ecosystem.
- It focuses on capacity building, cybersecurity awareness, indigenous capability development, and greater public-private collaboration.

### 4. Digital Personal Data Protection Act, 2023

- The **DPDP Act, 2023** establishes a legal framework for the collection, processing, and protection of personal digital data in India.
- It enhances data governance by imposing obligations on data fiduciaries, safeguarding individuals' privacy, and strengthening accountability in the digital ecosystem.

## Way Forward

### 1. Strengthen Supply Chain Security

- Mandate cybersecurity standards, regular security audits, and vendor risk assessments to secure the entire critical infrastructure supply chain.

### 2. Ensure Mandatory Breach Disclosure

- Introduce time-bound cyber breach reporting and transparent disclosure protocols while balancing national security concerns.

### 3. Enhance Cyber Resilience

- Adopt continuous monitoring, threat intelligence sharing, Zero Trust Architecture, and regular penetration testing to strengthen cyber defences.

### 4. Improve Incident Response Mechanisms

- Establish dedicated cyber crisis management teams, conduct periodic cyber drills, and strengthen digital forensic capabilities for rapid response.

### 5. Build Cybersecurity Capacity

- Invest in skilled cybersecurity professionals, promote public-private collaboration, and encourage indigenous cybersecurity solutions under **Atmanirbhar Bharat**.

### 6. Strengthen Institutional Coordination

- Enhance coordination among **CERT-In, NCIIPC, sectoral regulators, infrastructure operators, and private stakeholders** for an integrated national cyber security framework.

## Conclusion

The Kudankulam incident underscores that **cybersecurity is integral to national security** and must extend across the entire digital supply chain. Going forward, **a resilient, transparent, and future-ready cybersecurity ecosystem** will be essential to safeguard India's critical infrastructure and support its aspirations as a secure digital and nuclear power.

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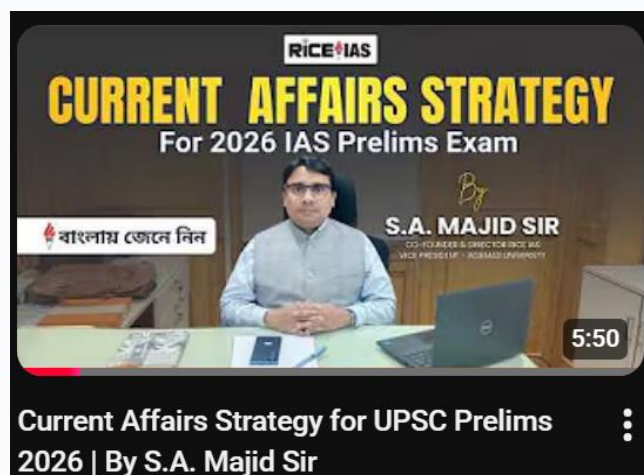
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