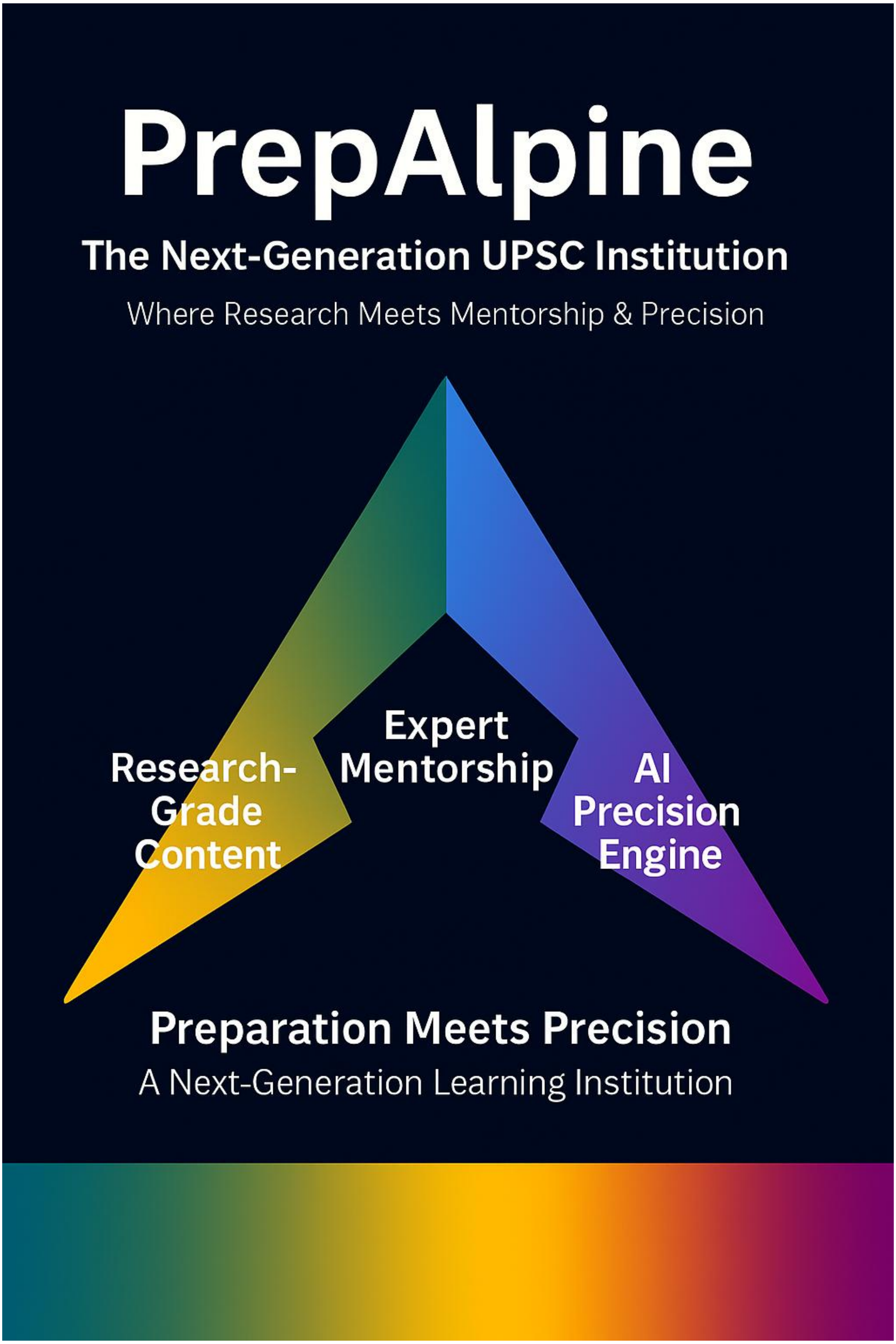
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DAILY CURRENT AFFAIRS DATED 18.05.2026

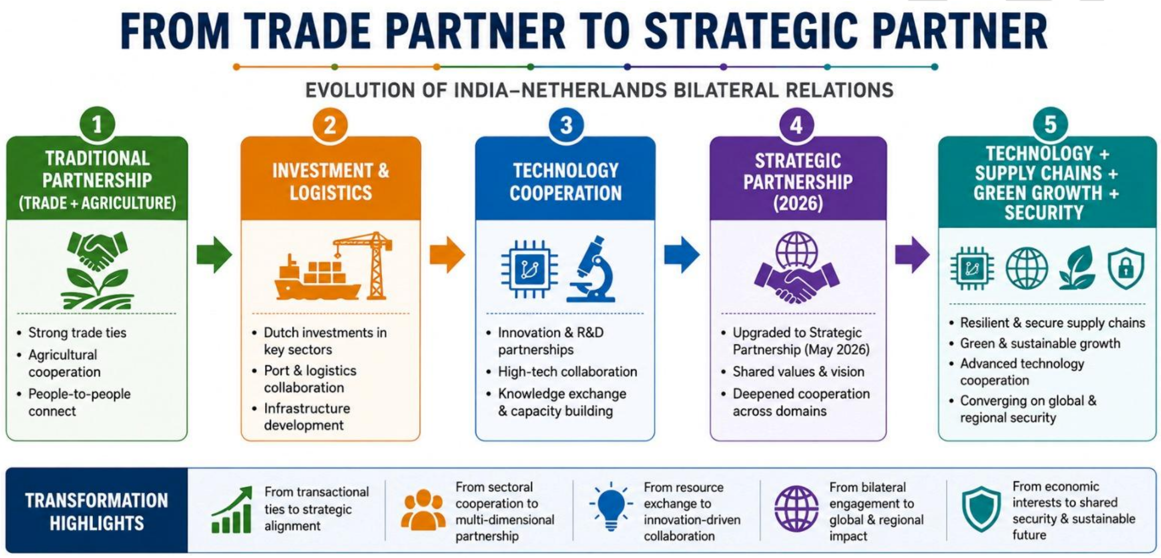
GS Paper II: International Relations

1. India–Netherlands Strategic Partnership (2026): Semiconductors, Critical Minerals and Green Growth

a. Introduction

India and the Netherlands elevated their relationship to a Strategic Partnership during Prime Minister Narendra Modi's visit to The Hague. The two countries adopted a Five-Year Roadmap (2026–2030) and concluded multiple agreements covering semiconductors, critical minerals, renewable energy, water management, migration, and technology cooperation.

A major outcome of the visit was the Memorandum of Understanding between Tata Electronics and ASML, aimed at supporting India's semiconductor manufacturing ambitions.



b. Background

India and the Netherlands have traditionally enjoyed strong economic ties centred on trade, investment, logistics, agriculture, and water management.

In recent years, however, the relationship has expanded into areas of strategic importance such as advanced technology, clean energy, resilient supply chains, and critical mineral security.

The elevation of the relationship to a Strategic Partnership reflects the growing convergence of interests between India and Europe in an era characterised by technological competition, supply-chain diversification, and green industrial transformation.

c. Why the Netherlands Matters for India

The Netherlands occupies a significant position within Europe's economic and technological landscape.

Area	Importance for India
Trade	One of India's leading economic partners in Europe

Investment	Important source of Foreign Direct Investment
Technology	Expertise in semiconductors and advanced manufacturing
Water Management	Global leader in flood control and coastal engineering
Renewable Energy	Expertise in offshore wind and clean technologies
Logistics	Gateway to European markets through world-class port infrastructure

The Netherlands therefore serves not only as a bilateral partner but also as a strategic gateway to wider European economic networks.

Strategic Relevance for India

- Provides access to advanced industrial technologies.
- Serves as a gateway to European markets.
- Supports India's supply-chain diversification efforts.
- Contributes to India's green transition agenda.
- Enhances technological and economic resilience.

d. Key Outcomes of the Visit

i. Elevation to a Strategic Partnership

A Strategic Partnership generally involves:

- Regular high-level political engagement.
- Long-term economic cooperation.
- Collaboration in emerging technologies.
- Security and resilience partnerships.
- Institutional mechanisms for policy coordination.

Significance

The decision reflects:

- India's growing importance in European strategic thinking.
- Europe's search for trusted economic partners.
- Shared interest in resilient supply chains.
- Convergence on sustainable development and green growth.
- Expansion of bilateral relations beyond traditional economic cooperation.

ii. Five-Year Roadmap (2026–2030)

The roadmap establishes structured cooperation in:

- Trade and investment.
- Semiconductor manufacturing.
- Critical minerals.
- Green energy.
- Water management.
- Innovation and technology.
- Skilled mobility.

Importance

The roadmap provides:

- Policy continuity.
- Long-term strategic direction.
- Institutional cooperation mechanisms.
- Measurable objectives and implementation pathways.

e. Semiconductor Cooperation: A Strategic Breakthrough

i. Tata Electronics–ASML Partnership

ASML is the world's leading manufacturer of semiconductor lithography systems.

The company possesses a near-monopoly in:

- Extreme Ultraviolet (EUV) lithography systems.
- Advanced chip fabrication equipment.
- Technologies required for manufacturing cutting-edge semiconductor chips.

Why ASML Is Strategically Important

Modern high-performance processors used in:

- Artificial Intelligence.
- Smartphones.
- Advanced computing.
- Telecommunications.
- Defence systems.

depend heavily on ASML's technologies.

ii. Significance for India

The partnership can contribute to:

- Development of India's semiconductor ecosystem.
- Growth of domestic chip manufacturing.
- Enhancement of advanced manufacturing capabilities.
- Integration into global semiconductor value chains.

Strategic Benefits

Semiconductors have emerged as critical national security assets.

The partnership supports:

- Technology sovereignty.
- Supply-chain resilience.
- Digital security.
- Reduced dependence on external manufacturing hubs.
- Industrial competitiveness.

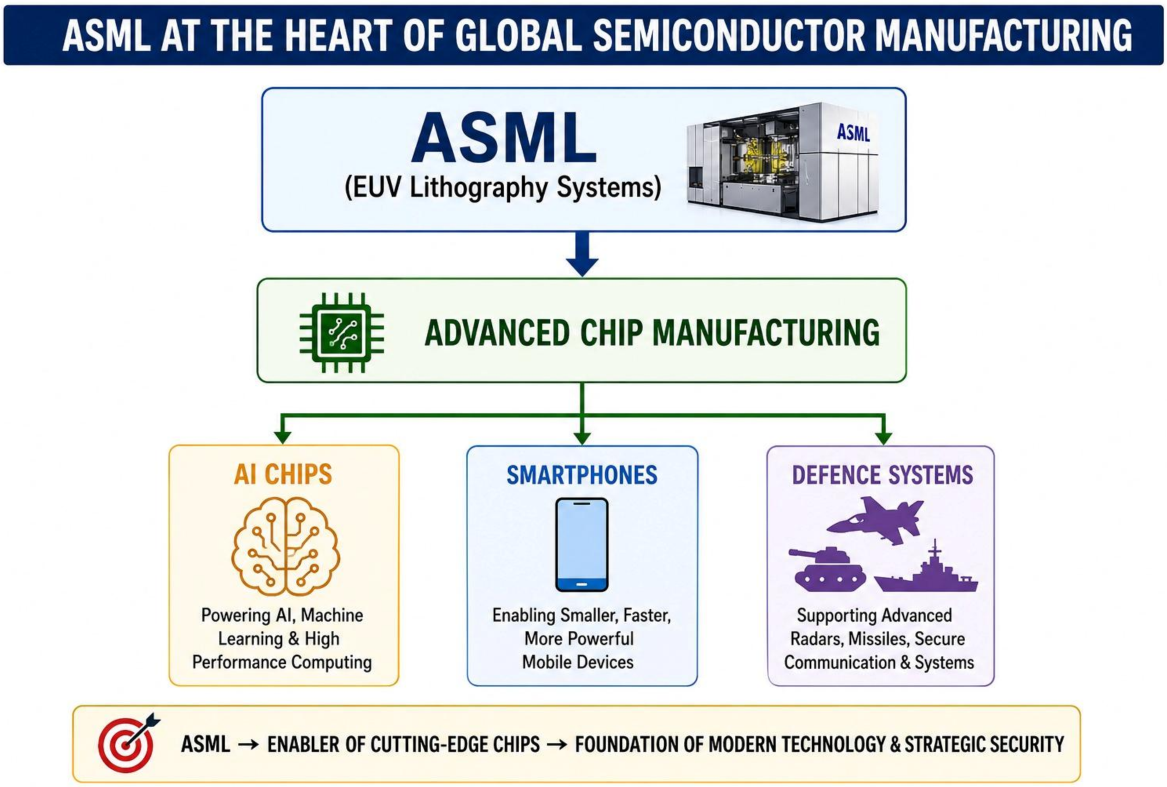
iii. Link with National Initiatives

The cooperation complements:

- India Semiconductor Mission

- Semicon India Programme
- Production Linked Incentive Scheme

These initiatives seek to position India as a major semiconductor manufacturing hub.



f. Critical Minerals Cooperation

i. Strategic Importance of Critical Minerals

The global transition towards clean energy and advanced manufacturing has transformed critical minerals into strategic assets.

Major Critical Minerals

Mineral	**Key Uses**
Lithium	Battery manufacturing
Cobalt	Energy storage systems
Nickel	Electric vehicles and batteries
Rare Earth Elements	Electronics, defence and renewable energy
Graphite	Battery production

ii. Why Cooperation Matters

India's demand for these minerals is expected to rise rapidly due to:

- Electric mobility.

- Renewable energy expansion.
- Electronics manufacturing.
- Defence modernisation.
- Energy storage technologies.

iii. Strategic Significance

Access to critical minerals contributes directly to:

- Energy security.
- Industrial competitiveness.
- Technological self-reliance.
- Strategic autonomy.
- Supply-chain resilience.

g. Renewable Energy and Green Growth Partnership

Areas of Cooperation

India and the Netherlands agreed to strengthen collaboration in:

- Offshore wind energy.
- Green hydrogen.
- Clean technologies.
- Climate finance.
- Energy transition initiatives.

Why the Netherlands Is an Important Partner

The Netherlands has emerged as a global leader in:

- Offshore wind deployment.
- Renewable energy infrastructure.
- Sustainable industrial technologies.
- Green innovation ecosystems.

Relevance for India

The partnership supports India's objectives of:

- Achieving Net Zero emissions by 2070.
- Expanding renewable energy capacity.
- Reducing fossil-fuel dependence.
- Meeting commitments under the Paris Agreement.
- Strengthening energy security.

h. Water Management Cooperation

Dutch Expertise in Water Governance

The Netherlands is internationally recognised for its expertise in:

- Flood control.
- Coastal protection.
- Delta management.
- Urban water systems.
- Climate adaptation strategies.

Importance for India

India faces increasing challenges from:

- Coastal erosion.
- Urban flooding.
- Extreme weather events.
- River basin management issues.

Areas of Potential Cooperation

Dutch expertise can support:

- Namami Gange Programme
- Coastal zone management projects.
- Urban resilience programmes.
- Smart city planning.
- Climate adaptation initiatives.

Strategic Value

- Water management cooperation represents an important example of climate adaptation diplomacy, linking environmental sustainability with economic development and disaster resilience.

i. Migration and Mobility Partnership

i. Objectives

The two countries agreed to deepen cooperation in the movement of skilled professionals, researchers, and students.

Key Goals

- Facilitate skilled workforce mobility.
- Promote higher education collaboration.
- Strengthen innovation partnerships.
- Encourage research cooperation.

ii. Benefits for India

The agreement creates opportunities for:

- Engineers.
- Technology professionals.
- Researchers.
- Students.
- Knowledge-intensive industries.

It also contributes to the development of human capital and innovation ecosystems.

j. Strategic Significance of the Partnership

Supporting India's Semiconductor Ambitions

- Access to advanced semiconductor technologies.
- Strengthening domestic manufacturing capabilities.
- Integration into global chip value chains.
- Enhancing technology sovereignty.

Strengthening Supply Chain Resilience

- Supports friend-shoring strategies.
- Diversifies technology partnerships.
- Reduces concentration risks.
- Strengthens trusted supply networks.

Advancing the Green Transition

- Accelerates renewable energy deployment.
- Promotes green industrialisation.
- Enhances climate resilience.
- Supports long-term energy security.

Expanding Economic Diplomacy

The agreement complements India's engagement with:

- European Union
- Nordic countries.
- Indo-Pacific partners.
- Advanced technology economies.

It demonstrates how economic diplomacy increasingly serves as an instrument of strategic statecraft.

k. Challenges

Continued Technology Dependence

India remains dependent on external suppliers for:

- Advanced semiconductor equipment.
- High-end chip design technologies.
- Precision manufacturing systems.

Critical Mineral Competition

Global competition for critical minerals is intensifying, increasing the risks of:

- Supply disruptions.
- Price volatility.
- Strategic competition.
- Resource nationalism.

Skill Development Requirements

India must significantly expand its pool of:

- Semiconductor engineers.
- Materials scientists.
- Electronics specialists.
- Advanced manufacturing professionals.

Without adequate human resources, technological partnerships may not fully translate into domestic industrial capabilities.

l. Evolution of Bilateral Relations

Traditional Relationship	Emerging Strategic Partnership

Trade-focused engagement	Technology-driven cooperation
Agriculture and logistics	Semiconductors and critical minerals
Water management cooperation	Comprehensive strategic collaboration
Limited geopolitical dimension	Supply-chain and Indo-Pacific cooperation

m. Way Forward

Leveraging the Strategic Partnership

- India should utilise the Strategic Partnership to accelerate domestic technological capabilities and resilient industrial ecosystems.

Semiconductor Development

- Fast-track fabrication projects.
- Promote indigenous chip design.
- Increase semiconductor R&D investments.
- Develop specialised talent pools.

Critical Mineral Security

- Expand overseas mineral partnerships.
- Build strategic reserves.
- Promote recycling and circular economy practices.
- Encourage domestic processing capabilities.

Green Cooperation

- Develop green hydrogen value chains.
- Expand offshore wind collaboration.
- Mobilise climate and sustainability financing.
- Promote clean technology innovation.

Deepening Economic Integration

- Encourage greater Dutch investment.
- Strengthen technology transfer mechanisms.
- Promote industry-academia partnerships.
- Expand innovation ecosystems.

A successful implementation of these initiatives can help transform India from a technology consumer into a technology producer, thereby strengthening both economic security and strategic autonomy.

Conclusion

The India–Netherlands Strategic Partnership marks a shift from a traditional trade-oriented relationship to a technology-driven and resilience-focused partnership. By combining Dutch strengths in semiconductors, water management, renewable energy and logistics with India's ambitions in manufacturing, green growth and strategic autonomy, the partnership can become an important pillar of India's engagement with Europe. Its success, however, will depend on effective implementation, skill development, technology absorption and India's ability to convert external cooperation into domestic industrial capability.

GS Paper II: Current Affairs

2. Energy Storage: The Missing Link in India's Renewable Energy Transition

a. Introduction

India's renewable energy capacity has crossed 283 GW, accounting for more than half of the country's installed electricity capacity. This achievement marks significant progress towards India's clean energy goals.

However, the rapid expansion of solar and wind power has brought renewed attention to a critical challenge: Energy Storage.

As renewable energy sources are inherently intermittent, the success of India's energy transition will increasingly depend on its ability to store electricity efficiently and deploy it when demand arises.

b. Background

India has committed itself to ambitious climate and energy goals, including:

- Achieving 500 GW of non-fossil fuel capacity by 2030.
- Attaining Net Zero emissions by 2070.
- Implementing the National Green Hydrogen Mission.
- Fulfilling the Panchamrit commitments announced at COP26.

The success of these targets depends not only on generating renewable electricity but also on ensuring that such electricity remains available when consumers require it.

c. Why Energy Storage Has Become Critical

The Challenge of Renewable Energy

Unlike conventional thermal power plants, renewable energy generation depends on natural conditions.

Source	Limitation
Solar Energy	Generation stops after sunset
Wind Energy	Output depends on wind availability
Hydropower	Influenced by seasonal water availability
Renewable Mix	Generation often does not coincide with peak demand

The central challenge is that electricity demand remains continuous, whereas renewable generation fluctuates throughout the day.

Demand-Supply Mismatch

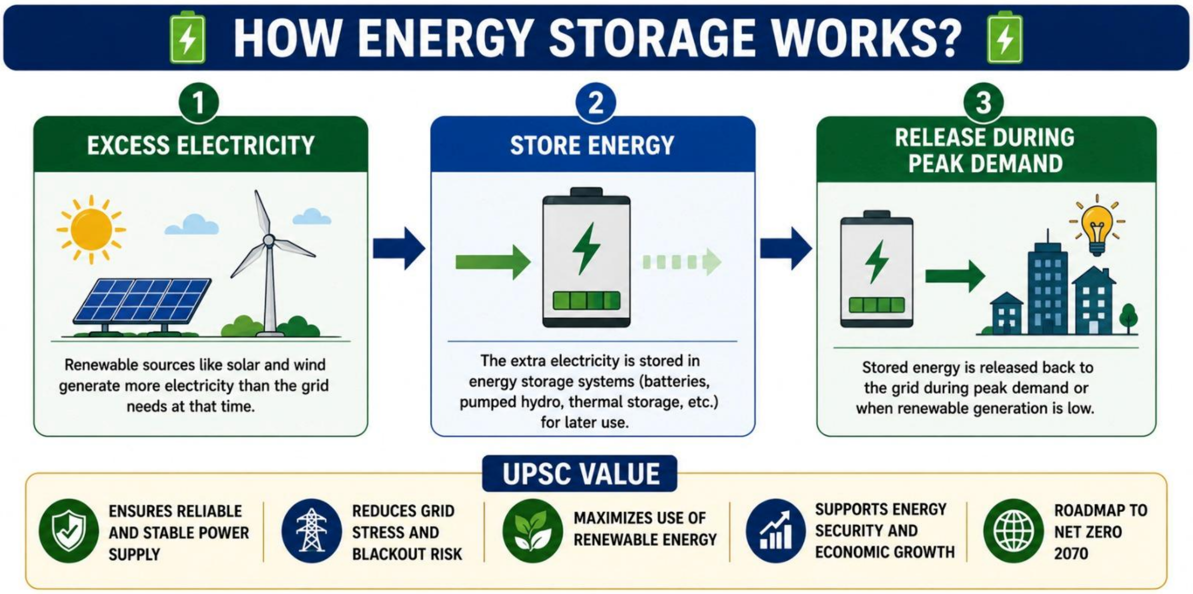
A large quantity of solar electricity is generated during daytime hours when demand may be relatively low. Conversely, electricity demand often peaks during evening hours when solar generation declines sharply.

This mismatch can lead to:

- Grid instability.

- Curtailment of renewable power.
- Continued dependence on coal-based backup generation.
- Increased risk of power shortages during peak demand periods.

Thus, storage has become the essential bridge between electricity generation and consumption.



d. Understanding Energy Storage

i. What is Energy Storage?

Energy Storage Systems (ESS) capture surplus electricity during periods of excess generation and release it when demand exceeds supply.

Three-Step Process

- Storing excess electricity.
- Converting energy into a storable form.
- Releasing stored energy when required.

In effect, storage transforms intermittent renewable energy into reliable and dispatchable power.

ii. Why Storage Matters

- Balances electricity supply and demand.
- Enhances grid flexibility.
- Reduces renewable energy curtailment.
- Improves energy security.
- Supports decarbonisation goals.

e. Major Energy Storage Technologies

i. Pumped Hydro Storage (PHS)

Working Principle

Pumped Hydro Storage operates on a simple principle:

- Excess electricity pumps water from a lower reservoir to an upper reservoir.
- During periods of high demand, stored water is released.
- Flowing water drives turbines to generate electricity.

Advantages

- Mature and proven technology.
- Long operational life.
- Suitable for large-scale storage.
- Supports grid stability.
- Lower operating costs over time.

Challenges

- High initial capital costs.
- Land acquisition challenges.
- Environmental and ecological concerns.
- Long gestation periods.

Why It Matters for India

- Given India's geographical diversity and large-scale storage requirements, Pumped Hydro Storage is expected to become the backbone of long-duration energy storage.

ii. Battery Energy Storage Systems (BESS)

Working Principle

- Battery systems store electricity through electrochemical reactions and release it when required.

Dominant Technology

- The most widely used technology today is the Lithium Iron Phosphate (LFP) Battery.

Advantages

- Rapid response capability.
- High operational efficiency.
- Modular deployment.
- Suitable for both grid-scale and distributed applications.
- Faster installation compared to hydro projects.

Challenges

- Dependence on imported battery cells.
- Critical mineral constraints.
- Recycling and disposal concerns.
- Higher costs for long-duration storage.

Strategic Importance

Battery storage is particularly important for:

- Solar energy integration.
- Decentralised renewable systems.
- Smart grids.
- Electric mobility ecosystems.

f. Emerging Energy Storage Technologies

- **Concentrated Solar Thermal Storage:** Uses molten salts to store solar heat, which can later be converted into electricity.

- **Compressed Air Energy Storage (CAES):** Stores compressed air in underground caverns and releases it to drive turbines when electricity is required.
- **Flywheel Energy Storage:** Stores energy in rotational kinetic energy and is particularly useful for frequency regulation and grid stability.
- **Gravity Energy Storage:** Stores energy by lifting heavy masses and generating electricity when they are lowered.
- **Green Hydrogen Storage:** Surplus renewable electricity is used to produce hydrogen, which can later serve as a long-duration energy storage medium.

Significance

These technologies can support:

- Deep renewable penetration.
- Long-duration storage needs.
- Grid resilience.
- Energy transition flexibility.

g. India's Current Energy Storage Status

i. Existing Capacity

Technology	Installed Capacity
Pumped Hydro Storage	7.2 GW
Battery Energy Storage Systems	0.27 GW

Key Observation

- The contrast between more than 283 GW of renewable capacity and relatively limited storage infrastructure reveals a significant storage deficit.

ii. Future Storage Requirements

- According to projections by the Central Electricity Authority, India's storage requirements will rise dramatically by 2035–36.

Projected Capacity Requirement

Technology	Required Capacity
Pumped Hydro Storage	94 GW
Battery Storage	80 GW
Total Storage Capacity	174 GW

Energy Storage Requirement

Technology	Storage Requirement
Battery Storage	321 GWh

Pumped Hydro Storage	567 GWh
Total	888 GWh

iii. Why Such a Large Requirement?

- Rapid growth in renewable energy.
- Higher share of intermittent generation.
- Rising electricity demand.
- Need for grid flexibility.
- Decarbonisation commitments.

h. The Challenge of Import Dependence

i. Battery Manufacturing Vulnerability

- India currently imports approximately 75–80 percent of lithium-ion battery cells.

Why This Matters

- Battery cells account for nearly four-fifths of total battery storage costs.

ii. Risks Arising from Import Dependence

Geopolitical Risks

- Global battery manufacturing remains concentrated in a small number of countries, creating strategic vulnerabilities.

Supply Chain Risks

- Export restrictions.
- Shipping disruptions.
- Price volatility.
- Resource nationalism.

Economic Risks

- Higher project costs.
- External dependence.
- Reduced energy security.
- Trade deficits.

This creates the possibility of replacing dependence on imported fossil fuels with dependence on imported critical minerals and battery technologies.

i. Global Experience

i. Pumped Hydro Storage

Global installed capacity is approximately 160 GW.

Leading Countries

Country	Capacity
China	66 GW

Japan	21.8 GW
United States	18.9 GW

Europe collectively possesses substantial pumped storage capacity and continues expanding its storage infrastructure.

ii. Battery Storage

Global battery storage capacity has expanded rapidly and is increasingly viewed as a strategic asset essential for:

- Renewable integration.
- Grid reliability.
- Energy security.
- Decarbonisation.

j. Significance of Energy Storage for India

Grid Stability and Reliability

- Maintains supply-demand balance.
- Reduces frequency fluctuations.
- Enhances grid reliability.
- Improves power quality.

Renewable Energy Integration

- Reduces renewable curtailment.
- Enables higher solar and wind penetration.
- Ensures availability of renewable electricity during peak demand.

Energy Security

- Reduces dependence on fossil-fuel peaking plants.
- Enhances resilience against fuel disruptions.
- Improves national energy security.

Climate Commitments

- Net Zero 2070.
- Sustainable Development Goal 7.
- Paris Agreement commitments.
- Green hydrogen deployment.

Without adequate storage infrastructure, large-scale renewable integration would become increasingly difficult.

k. Key Challenges

Economic Challenges

- High upfront investment requirements.
- Limited access to affordable finance.
- Long payback periods.

Technological Challenges

- Dependence on imported technologies.
- Limited domestic manufacturing ecosystem.
- Need for continuous innovation.

Environmental Challenges

- Land requirements for pumped hydro projects.
- Ecological impacts of reservoirs.
- Battery recycling challenges.
- Waste management concerns.

Regulatory Challenges

- Absence of mature storage markets.
- Inadequate pricing mechanisms.
- Need for grid reforms.
- Limited investment incentives.

l. Government Initiatives

Battery Energy Storage System (BESS) Scheme

- Supports grid-scale battery deployment through financial assistance and viability gap funding.

National Programme on Advanced Chemistry Cells (ACC)

- Promotes domestic manufacturing of advanced battery technologies and strengthens supply-chain localisation.

Production Linked Incentive (PLI) Scheme

Encourages investment in:

- Advanced battery manufacturing.
- Clean energy technologies.
- Domestic value addition.

m. Way Forward

Accelerate Domestic Manufacturing

- Develop battery manufacturing ecosystems.
- Promote research and innovation.
- Expand recycling infrastructure.
- Strengthen domestic supply chains.

Scale Up Pumped Hydro Storage

- Fast-track approvals.
- Improve project financing.
- Maintain environmental safeguards.
- Promote state-level participation.

Secure Critical Minerals

- Strengthen international mineral partnerships.
- Build strategic reserves.
- Promote domestic exploration.

- Encourage mineral processing industries.

Promote Circular Economy Approaches

- Battery recycling.
- Resource recovery.
- Waste reduction.
- Sustainable manufacturing.

Create Robust Storage Markets

- Time-of-day tariffs.
- Ancillary service markets.
- Capacity payments.
- Grid flexibility incentives.

Invest in Next-Generation Technologies

- Sodium-ion batteries.
- Flow batteries.
- Green hydrogen storage.
- Long-duration storage systems.

A diversified technology portfolio can improve resilience and reduce long-term dependence on imported technologies.

Conclusion

Energy storage is the missing link that will determine whether India's renewable energy expansion becomes truly reliable, affordable and secure. While solar and wind power can increase clean electricity generation, storage systems such as pumped hydro and batteries are essential to manage intermittency, reduce curtailment and supply power during peak demand. For India, the priority must be to scale up storage infrastructure, reduce import dependence, secure critical minerals and build domestic manufacturing capacity so that the renewable transition also strengthens energy security and strategic autonomy.

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While every effort has been made to balance depth with brevity, please keep the following in mind:

1. Orientation & Purpose

This compilation is curated primarily from the UPSC Mains perspective — with emphasis on conceptual clarity, analytical depth, and interlinkages across GS papers.

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