Prelims Exam Topics

16TH INDIA-JAPAN SUMMIT

Context:

Japanese Prime Minister **Sanae Takaichi** visited India for the **16th India–Japan Annual Summit**.

Key outcomes of 16th India-Japan Summit

- Agreed on remaining technical aspects of the **UNICORN** project, the **first India–Japan defence technology co-development initiative**.
- Expanded **JAIMEX** naval exercises and cooperation in **Maintenance, Repair and Overhaul (MRO)** under **Make in India**.
- **Clean Energy:**
    - Launched the **India–Japan Cooperative Biogas for Growth Initiative** to support India's target of **1,000 biogas plants**.
    - Reaffirmed cooperation on the **Odisha Green Hydrogen and Clean Ammonia Project**.
- Signed the **Energy Resilience Statement** on **Strategic Petroleum Reserves (SPR)**; Japan reiterated support for India's membership in the **International Energy Agency (IEA)**.
- Established an **India–Japan AI Strategic Dialogue** for trusted and secure AI collaboration.

BORJULI WETLAND

Context:

The **Borjuli Wetland** in **Assam** has been notified as a **Biodiversity Heritage Site (BHS)**.

About Borjuli Wetland

- A **freshwater swamp and marsh** ecosystem, serving as a **natural gene sanctuary**.
- Conserves ***Oryza rufipogon***, the **wild progenitor of cultivated rice (*Oryza sativa*)**.
- The wild rice possesses **natural resistance to pests and diseases**.
- **Location:** Sonitpur district, Assam, in the **Brahmaputra River** floodplain.

Biodiversity Heritage Sites (BHS)

- **BHS are legally protected areas** conserving **unique and ecologically fragile ecosystems**.

- **Declared under: Section 37 of the Biological Diversity Act, 2002**.
- **Notified by:** State Governments in consultation with **local bodies**.
- It protects areas with **wild crop relatives, rare species, sacred groves, wetlands, and other biodiversity-rich habitats** outside the protected area network.

VIKRAM-1: INDIA'S FIRST PRIVATE ORBITAL ROCKET

Context:

Skyroot Aerospace has announced the launch window for the maiden test flight of **Vikram-1**, named **Mission Aagaman**.

About Vikram-1

- **Vikram-1 is a multi-stage orbital launch vehicle** for launching **small satellites**.
- **Developer: Skyroot Aerospace**, a Hyderabad-based private space startup founded by former **ISRO** scientists.
- **It** can place payloads of up to **350 kg** into **450 km Low Earth Orbit (LEO)**
- It is built using **lightweight all-carbon composite materials** for high strength and reduced weight.
- It uses **3D-printed rocket engine components**, enabling faster, cost-effective manufacturing and improved design flexibility.
- A successful launch will make **Vikram-1 India's first privately developed orbital rocket** and strengthen India's commercial space ecosystem.

SIANG UPPER MULTIPURPOSE PROJECT

Context:

The proposed **Siang Upper Multipurpose Project (SUMP)** in **Arunachal Pradesh** is facing opposition from local **Adi** and **Galo** tribes over displacement concerns.

About Siang Upper Multipurpose Project

- A proposed **multipurpose hydroelectric and flood-control project** with an **installed capacity of about 11,000 MW**.

- **Location:** Near **Geku village**, **Upper Siang district**, Arunachal Pradesh.
- **River:** To be built on the **Siang River**, which enters India at **Gelling**.
    - The **Siang** joins the **Dibang** and **Lohit** rivers in Assam to form the **Brahmaputra River**.

ESARAS (SARAS AAJEEVIKA)

Context:

The Government highlighted **eSARAS (SARAS Aajeevika)** as a platform that empowers **women-led Self-Help Groups (SHGs)** by connecting rural artisans directly with national markets.

About eSARAS

- **eSARAS** is a **digital marketplace** for products made by **women SHGs, rural artisans, and producer collectives across** India.
- **Developed by: Ministry of Rural Development** under the **Deendayal Antyodaya Yojana–National Rural Livelihoods Mission (DAY-NRLM)**.
- **Objective:**
    - Provide **direct market access** to SHGs.
    - **Reduce dependence on middlemen**.
    - Ensure **fair prices** for artisans.
    - Promote **traditional handicrafts** and **rural entrepreneurship**.

GAGAN (GPS AIDED GEO AUGMENTED NAVIGATION)

Context:

GAGAN became the **first Satellite-Based Augmentation System (SBAS)** to receive certification for operations in the **equatorial region**, enhancing India's aviation navigation capabilities.

About GAGAN

- **GAGAN** is **India's indigenous Satellite-Based Augmentation System (SBAS)**.
- **Developed jointly by: Indian Space Research Organisation (ISRO)** and the **Airports Authority of India (AAI)**.
- **Operational since: 2015**.
- It improves the **accuracy, availability, and integrity** of **GPS/GNSS** signals by providing **real-time correction data**.

- Primarily used for **safe and precise aircraft navigation**, especially during approach and landing.

INS TRIKAND

Context:

The Indian Navy's **INS Trikand** successfully thwarted a piracy attempt on the merchant vessel **MV Golden Arsenal** in the **Gulf of Aden**.

Key Facts

- **INS Trikand** is a **Talwar-class guided-missile stealth frigate** of the Indian Navy.
- **Built by: Yantar Shipyard**, **Kaliningrad, Russia**.

Features

- **Missiles:** Equipped with **BrahMos** supersonic cruise missiles and **Shtil** surface-to-air missile system.
- **Weapons:** Fitted with an **A190 medium-range gun**, **30 mm close-in weapon system (CIWS)**, **torpedoes**, and **anti-submarine rockets**.
- **Speed:** Capable of **over 30 knots**.

MOUNT EREBUS

Context:

Scientists have found that **Mount Erebus** releases volcanic gases containing **microscopic crystals of pure gold**.

About Mount Erebus

- **Location: Ross Island**, **Ross Sea**, Antarctica.
- It is the **southernmost active volcano** in the world.
- It is a **stratovolcano** (composite volcano).
- Forms part of the **Pacific Ring of Fire**, the major belt of volcanoes and earthquakes surrounding the Pacific Ocean.

GREEN AMMONIA AND GREEN METHANOL

Context:

An Indian company signed a **long-term offtake agreement** with leading Japanese firms for the supply of **Green Ammonia** and **Green Methanol**.

Green Ammonia

- **Ammonia (NH_3)** is a **pungent gas**, mainly used in the **fertilizer industry**.
- **Production:** Manufactured using the **Haber–Bosch process**, where **hydrogen** combines with **nitrogen**. In green ammonia, the hydrogen is produced using **renewable energy**.

Green Methanol

- **Methanol (CH_3OH)** is a **colourless liquid**.
- **Applications:** Used to manufacture **formaldehyde, acetic acid, plastics**, and as an **alternative fuel**.
- **Production:** Produced from **low-carbon sources** such as **biomass** or through **carbon capture and renewable hydrogen**.
- It is **flammable**, relatively **costly**, and requires **larger fuel storage** than conventional fuels.

Mains Exam Topics

POLICY ARCHITECTURE FOR INDIA'S ENERGY FUTURE

Context:

The **Indian National Science Academy (INSA)**, through its **Centre for Science, Technology, Innovation and Policy (CSTIP)**, has released a policy brief calling for the adoption of a **unified national energy policy framework** to strengthen India's energy governance and support the clean energy transition.

Why Does India Need a Unified Energy Policy Architecture?

- **Breaking Institutional Silos:** India's energy ecosystem is governed through fragmented ministries and agencies, resulting in disconnected policymaking and inefficient resource allocation.
    - **E.g.,** Coal, petroleum, electricity, renewable energy, and energy efficiency are administered separately despite operating within the same energy system.
- **Creating Integrated Energy Markets:** A unified architecture must align policy, regulation, pricing, and investment to create financially sustainable energy markets rather than isolated sectoral reforms.
    - **E.g.,** Financially weak **DISCOMs** and politically constrained tariff reforms continue to undermine renewable integration despite rising generation capacity.
- **Strengthening Regulatory Governance:** Effective energy transition requires independent and coordinated regulation to balance consumer welfare, investment certainty, and market efficiency.
    - **E.g.,** Greater coordination and autonomy of **CERC** and **SERCs** can enable cost-reflective tariffs, open access, and competitive electricity markets.
- **Managing India's Dual Energy Transition:** India must simultaneously expand reliable baseload power while rapidly scaling clean energy, requiring coordinated planning for legacy and emerging energy systems.
    - **E.g.,** Coal remains critical for grid stability even as solar, wind, battery storage, and green hydrogen expand, necessitating mechanisms to manage **stranded thermal assets** and support coal-dependent regions.
- **Institutionalising Cooperative Energy Federalism:** Since electricity is a **Concurrent List** subject, national energy objectives must be implemented through incentive-based Centre–State coordination rather than administrative centralisation.

- **E.g.,** Performance-linked support under schemes such as the **Revamped Distribution Sector Scheme (RDSS)** can encourage States to undertake tariff reforms, reduce distribution losses, and modernise power infrastructure.

Challenges in Implementing a Unified Energy Policy Architecture

- **Siloed Institutional Governance:** Ministries and agencies pursue competing policy objectives, making integrated decision-making difficult.
    - **E.g.,** The **Ministry of Coal** seeks to maximise domestic coal production, while the **Ministry of New and Renewable Energy (MNRE)** prioritises decarbonisation, often creating policy trade-offs.
- **Grid Integration and Infrastructure Bottlenecks:** Integrating variable renewable energy into an ageing grid requires extensive transmission expansion, storage, and land acquisition, delaying implementation.
    - **E.g.,** Renewable-rich regions require new transmission corridors, but **Right of Way (RoW)** disputes and land acquisition delays slow projects.
- **Technology Dependence and Supply Chain Risks:** The clean-energy transition could replace fossil-fuel import dependence with dependence on critical minerals and advanced technologies.
    - **E.g.,** Large-scale deployment of **Battery Energy Storage Systems (BESS)** increases reliance on imported **lithium**, **cobalt**, and **rare earth elements**.
- **Political Economy of Energy Pricing:** Financial sustainability requires cost-reflective tariffs, but political considerations often favour subsidies and cross-subsidisation.
    - **E.g.,** Financially stressed **DISCOMs** continue to face losses due to subsidised electricity, delayed tariff revisions, and cross-subsidisation between industrial and residential consumers.
- **Just Transition and Federal Asymmetry:** The energy transition creates uneven economic impacts across States, making national consensus difficult.
    - **E.g.,** Renewable-rich States such as **Gujarat**, **Rajasthan**, and **Tamil Nadu** benefit from clean-energy investments, whereas coal-dependent States like **Jharkhand**, **Chhattisgarh**, and **Odisha** face revenue losses, employment challenges, and stranded assets.

Way Forward

- **Establish a Unified Energy Governance Architecture:** Create an apex institutional mechanism to integrate planning across fuels, electricity, climate, and industrial policy while preserving ministerial expertise.
    - **E.g.,** A **National Energy Commission** (or unified **Ministry of Energy**, as proposed by the **Kelkar Committee**) can coordinate policies across coal, petroleum, power, and renewable energy.
- **Undertake Market and Pricing Reforms:** Restore financial sustainability by rationalising tariffs, reducing cross-subsidies, and improving the commercial viability of the power sector.
    - **E.g.,** Implement **Direct Benefit Transfer (DBT)** for electricity subsidies and advance reforms under the **Electricity (Amendment) Bill** to strengthen **DISCOMs** and promote competitive electricity markets.
- **Build a Flexible and Resilient Power System:** Prioritise grid modernisation, storage infrastructure, and digital technologies to support high renewable penetration.
    - **E.g.,** Scale up **Battery Energy Storage Systems (BESS)**, **Pumped Storage Projects (PSPs)**, smart grids, and Green Energy Corridors.
- **Strengthen Domestic Clean Energy Ecosystems:** Reduce external dependencies by building indigenous manufacturing capacity for next-generation energy technologies.
    - **E.g.,** Expand **Production Linked Incentive (PLI)** schemes for **Advanced Chemistry Cells (ACC)**, solar PV modules, electrolysers, and other strategic clean-energy technologies.
- **Institutionalise a Just and Cooperative Energy Transition:** Balance national decarbonisation goals with the developmental needs of States through targeted fiscal support and workforce transition.