

## Today's Prelims Topics

### How Stove Lighters Create Electric Sparks

#### Context

How stove lighters by generating small sparks, ignites gas stoves, making cooking both easy and efficient.

#### What is an Electric Spark?

- A spark is an electric charge flying between two points, where one has a **surplus of electrons** (negative charge) and the other has a **deficiency** (positive charge).
- **Why it happens:**
  - Electrons naturally try to balance themselves between two points of differing charges.
  - If the gap is too wide, electrons can travel through the air by ionizing molecules and creating a conductive path.
  - This creates the visible spark.

#### Role of Piezoelectric Materials in Stove Lighters

- Piezoelectric materials are those materials which generate a surplus and deficiency of electrons when pressure is applied.
- **Structure:** Atoms in piezoelectric materials are arranged in a periodic pattern with two types of ions:
  - **Positive ions** (deficient in electrons).
  - **Negative ions** (surplus of electrons).
- **Behavior under pressure:** Pressure shifts the ions, creating a **negative charge** at one end and a **positive charge** at the other. This makes the material behave like a battery.
- **How Stove Lighters Use Piezoelectricity:**
  - The lighter contains piezoelectric material.
  - When pressure is applied by clicking the lighter:
    - A large charge difference is created, allowing electrons to fly through the air.
    - This creates the visible **spark**.
    - This spark ignites cooking gas, producing the flame.



#### Everyday Example: Lightning

- **How it works:**
  - Clouds accumulate charge as they move and collide.
  - When the charge becomes too intense, it breaks out as **lightning**, creating a pathway through the air for electrons to flow.
  - The spark (lightning) is followed by thunder (sound).

#### Source:

- [The Hindu - everyday stove-lighters](#)

## In Odisha, coal dust is clogging leaves, blocking carbon uptake

### Context

A recent study has found that plants covered in mining dust absorb less carbon per square meter, this leads to emission of more carbon dioxide into the atmosphere.

### About Coal Mining and Dust Pollution

- **Open-cast Mining:**
  - Jharsuguda predominantly employs open-cast mining, which involves removing soil and rocks to access coal.
  - This method is cost-effective but generates more dust than underground mining.
- **Sources of Dust:**
  - Dust is released during **blasting, drilling and transporting coal**.
  - It can spread up to **30 km** from the mining site.
- **Use of Satellite Data for Monitoring:**
  - Researchers used data from satellites like **Landsat and Sentinel** to study dust effects on vegetation.
  - **Methodology:**
    - Dust changes the wavelengths of light reflected by leaves, detectable through satellite imagery.
    - Researchers compared satellite images of areas near and far from coal mines to estimate dust levels.

### Impact of Dust on Vegetation

- **Clogging of Stomata:**
  - Dust settles on leaves, blocking **stomata** (pores used for gas exchange).
  - It impairs **photosynthesis** and reduces plants' ability to regulate temperature.
- **Carbon Absorption:**
  - Plants with dust-covered leaves absorb **2-3 grams less carbon per square meter**.
  - Reduced carbon absorption leaves more **CO<sub>2</sub> in the atmosphere**, worsening global warming.
- **Transpiration Impairment:**
  - Dust obstructs the release of water vapor through **transpiration**, essential for cooling plants.
  - **Impacts:**
    - Plants become hotter, reducing photosynthetic efficiency.
    - Prolonged heat stress can lead to **stunted growth** or **plant death**.

### Proposed Measures to Combat Dust Pollution

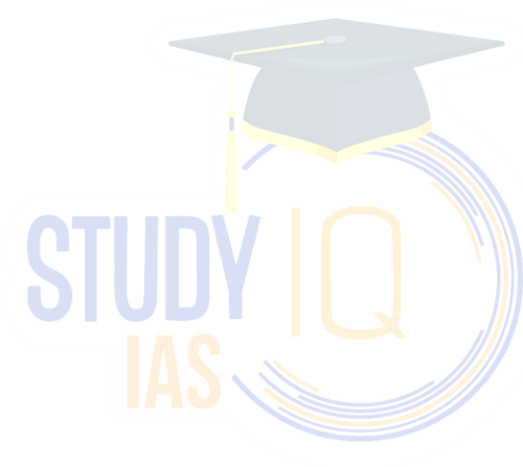
- **Preventive Measures:** Install **dust barriers** and use **water sprays** around mining sites.
- **Policy Interventions:** Enforce stringent regulations to reduce dust emissions.

**Facts**

- India is the **second-largest coal producer and consumer** globally, after China.
- In India **75% of electricity** is generated in coal-fired plants.
- **Top 5 States in terms of total coal reserves in India:** Jharkhand > Odisha > Chhattisgarh > West Bengal > Madhya Pradesh.
- **Reserve Highest:** USA, Russia, Australia, China, **India**
  - India holds the **5th biggest coal reserves in the World.**
- **Highest Production:** China, India, Indonesia, USA, Australia.
- **4 types of Coal are found in India:** Anthracite (Highest grade), Bituminous, lignite, Peat (Lowest grade).

**Source:**

- [The Hindu - In Odisha, coal dust is clogging leaves](#)



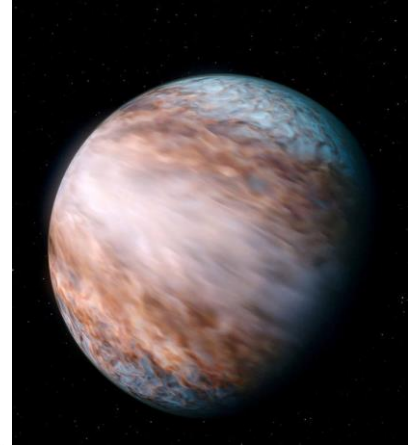
## Supersonic Winds on Exoplanet WASP-127b

### Context

Recently, astronomers detected **supersonic jet-stream winds** at the equator of WASP-127b, recorded as the **fastest winds ever observed on any known planet**.

### About WASP - 127b

- WASP-127b is a gaseous exoplanet located in the **Milky Way galaxy**, approximately **520 light-years** from Earth.
- It orbits a star similar to the Sun.
- **Characteristics of WASP-127b:**
  - **Size and Mass:**
    - **Diameter:** About **30% larger than Jupiter**, the largest planet in our solar system.
    - **Mass:** Only **16% of Jupiter's mass**, making it one of the **puffiest planets** ever discovered.
  - **Orbit Period:** Completes an orbit around its host star in about **four days**.
  - Composed mainly of **hydrogen and helium**, similar to Jupiter in our solar system.
- **Jet-Stream Winds**
  - **Wind Speed:** The jet-stream winds on WASP-127b blow at an astonishing speed of **33,000 km per hour**.
  - These are far faster than the **442 km/h jet streams on Earth** and even the **2,000 km/h winds on Neptune**, the fastest in our solar system.
  - **Type of Wind:** These are **circumplanetary jet winds**, circling the planet's equator.



### Source:

- [The Hindu - Astronomers spot ferocious winds on alien planet](#)

## AI Regulation and Paris AI Action Summit

### Context

Prime Minister Narendra Modi is scheduled to attend the Artificial Intelligence (AI) Action Summit in Paris as **Co-chair** in February, 2025.

### About Paris AI Action Summit

- The summit will be hosted by French President Emmanuel Macron at the Grand Palais in Paris.
- It aims to foster international dialogue on AI, bringing together global leaders to discuss innovation, regulation and the future of AI technologies.
- **The event will focus on 5 key themes:** Public interest in AI, the future of work, innovation and culture, trust in AI and global AI governance.
- **Key Concerns and Challenges:**
  - **Concentration of Power:** Dominance of foundational AI models by a few companies such as, **Microsoft, Alphabet, Amazon, Meta.**
  - **Regulatory Challenges:** Three Major Concerns
    - Privacy violations.
    - System bias.
    - Intellectual property rights violations.
- **India's Stand:**
  - India advocates for overcoming the **weaponization of social media.**
  - It calls for AI to represent **safety and trust**, highlighting the technology's **opportunity for growth.**

### Key Preceding Events

- **Bletchley Park AI Safety Summit (2023):**
  - It focused on "doomsday" AI concerns & Resulted in **25 countries**, including the US and China, signing the **Bletchley Declaration on AI Safety.**
  - **Blatchley Agreement:** It aims to establish a shared understanding of the risks and opportunities presented by advanced artificial intelligence (AI) and commit to working together to ensure its safe development and deployment
- **Seoul AI Summit (2024):**
  - 16 leading AI companies made voluntary commitments for **transparent AI development.**

### Latest Geopolitical Developments

- **US AI Expansion: The Stargate Project:**
  - Major initiative involving OpenAI, Softbank, Oracle, Microsoft, and Nvidia.
  - Investment of **\$500 billion** planned over four years to build AI infrastructure.
- **China's Advancements:** DeepSeek
  - Released a new Large Language Model (LLM) on par with OpenAI's GPT-o1 reasoning model in math, coding and reasoning benchmarks.

### Source:

- [Indian Express - PM Modi Co-chair](#)

## Places in News

### M -23/ March - 23 Rebels captured Goma

- Recently M - 23 rebels captured Eastern Congo's largest city, **Goma**.
- **Origin:** Emerged in **April 2012** when around 300 soldiers of the DRC's national army (FARDC) mutinied.
- It operates in the eastern regions of the **Democratic Republic of Congo (DRC)**, specifically in **North Kivu province**.
- The name "March 23" refers to the **23 March 2009 peace agreement** between the Congolese government and the National Congress for the Defense of the People (CNDP), a rebel group that later evolved into M23.
- M23 has been accused of receiving **military and logistical support from Rwanda and Uganda**.



### About Democratic Republic of Congo (DRC):

- **Bordering Countries:** Angola, Zambia, Tanzania, Burundi, Rwanda, Uganda, South Sudan, Central African Republic and Republic of Congo.
- It is the **2nd** largest country in Africa. (**Largest - Algeria**).
- DRC is rich in minerals, such as **cobalt, gold and coltan**.
- **Important River:** The Congo River - Africa's second-longest river.
- Its capital, **Kinshasa**, is located on the Congo River.

#### Source:

- [The Hindu - M 23](#)

## News in Shorts

### Lezim Dance

- Lezim is a folk dance associated with Maharashtra, traditionally performed during marriage processions and cultural festivals like **Ganesh Chaturthi**.
- It is described as both a **physical exercise** and a dance, with formations in twos, fours or circles.
- Lezim is known for **vigorous movements** like stepping, squatting and jumping, often starting with a slow rhythm and accelerating.
- **Instruments: Lezim**, a wooden mallet with metal pieces that create rhythmic sounds, and **dhol** or **dhalgi** (small drum).



### Chhatrapati Sambhaji Maharaj (1657–1689)

- Sambhaji Maharaj was the **eldest son of Chhatrapati Shivaji Maharaj**.
- He ascended to power in **1681** after a succession battle with his half-brother **Rajaram**.
- He defended Maratha forts against **Mughal emperor Aurangzeb's** expansionist ambitions in the Deccan region.
- He was captured and executed by the Mughals in **1689** for his resistance.

#### Source:

- [Indian Express - LEZIM](#)

### Libia Lobo Sardesai awarded Padma Shri

- Libia Lobo Sardesai, a 100-year-old Goan freedom fighter, was honored with the Padma Shri for her important role in **Goa's liberation struggle**.
- She was born on May 25, 1924, in Portuguese-ruled Goa.
- **Key contribution:** She ran an **underground radio station named Voice of Freedom** with her colleague and later husband, **Vaman Sardesai**, from **1955 to 1961**, during Goa's liberation movement.
  - The station operated under harsh conditions in the **dense forests of the Western Ghats (Amboli)** & regular shifting locations to evade detection.



### Goa in the 1950s

- Portuguese rule in Goa lasted **451 years**.
- Indian efforts to liberate Goa intensified after the Portuguese **assaulted and arrested satyagrahis** in 1954.
- **1955 Economic Blockade:** India closed Goa's borders, cutting off sea, rail, and road links.
- Portuguese imposed "**total censorship**": No materials, even wedding invitations, could be printed or circulated without Portuguese approval.
  - **Local newspapers and Goa Radio spread Portuguese propaganda**, instilling fear among citizens.
- **Operation Vijay:** It was launched on **December 17, 1961**, after **Union Defence Minister V. K. Krishna Menon** asked the Portuguese Governor General to surrender to prevent casualties.

but No response was received.

- It was **India's first integrated tri-service operation**, involving the Indian Navy.
- It led to the liberation of Goa, Daman and Diu from Portuguese rule.

Source:

- [Indian Express - Voice of Goa](#)





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## Editorial Summary

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### Economic Growth Projections for India

#### Context

There are several hurdles in present time for India to achieve GDP per capita from \$2,650 to \$10,000 by 2045.

#### Hurdles in India's Economic Growth

- **Rising Household Indebtedness:** There has been a significant increase in Indian household debt, with borrowing shifting from emergencies and appreciating assets to financing depreciating assets and experiences.
  - This trend has been exacerbated by easy access to credit through EMIs (Equated Monthly Installments) and the influence of e-commerce, which encourages debt-fueled consumption.
  - Such consumption patterns may lead to **unsustainable economic growth** as they shift future growth into the present, ultimately resulting in a payback period that can strain household finances.
- **Challenges in Manufacturing:** Limited diversification in India's export basket and manufacturing capabilities.
  - The strength of Chinese exports poses a challenge for India.
  - While the "China+1" strategy aims to diversify supply chains away from China, India faces significant competition due to China's established manufacturing capabilities, infrastructure, and investment advantages.
  - Additionally, weak domestic demand in China is leading to deflation in export prices, complicating matters for Indian exporters.
- **Global Economic Conditions:** Rising US interest rates and a strong US dollar have created a challenging environment for Indian investments.
  - The yield gap between India and the US is narrow (approximately 2.2%), making Indian assets less attractive to foreign investors.
  - Furthermore, there has been a notable decline in net Foreign Direct Investment (FDI), driven by multinational companies selling stakes in their Indian operations due to prevailing market valuations rather than pessimism about India's prospects.
- **Stock Market Volatility:** Overvaluation in small and mid-cap stocks post-Covid.
  - Lack of investor awareness about historical market cycles, leading to risky behaviors in IPOs and trading.
- **Temporary Consumption Slowdown:** Steps to moderate personal loans are leading to short-term dips in consumption, though aimed at long-term sustainability.

#### What are the Solutions?

- **Encouraging Responsible Borrowing:** Promote financial literacy to discourage excessive debt for depreciating assets.
  - Offer incentives for cash-down purchases over EMIs, encouraging delayed gratification.
- **Boosting Manufacturing Competitiveness:** Enhance infrastructure, logistics, and ease of doing business to attract more investments under the China+1 strategy.
  - Focus on skill development and technology adoption to increase productivity.
- **Strengthening Export Resilience:** Diversify export products and markets to reduce dependency on specific sectors or regions.
  - Collaborate with global supply chains and enter into favorable trade agreements to boost export competitiveness.

- **Attracting Stable Investments:** Stabilize macroeconomic fundamentals to attract FDI.
  - Strengthen investor confidence through policy predictability and reduced red tape.
- **Promoting Long-Term Stock Market Stability:** Educate retail investors about market cycles to prevent speculative bubbles.
  - Implement tighter regulations for IPO valuations to maintain transparency and investor trust.
- **Addressing Consumption Slowdowns:** Strengthen consumer confidence through job creation, rural development, and targeted stimulus for key sectors like MSMEs and real estate.
- **Policy and Structural Reforms:** Implement tax reforms to simplify compliance and attract businesses.
  - Invest in research and development to foster innovation and technological advancement across industries.
- **Leveraging Demographic Dividend:** Focus on education, healthcare, and job creation to harness the potential of India's young workforce.
  - Encourage entrepreneurship and self-reliance among the youth through government initiatives like Startup India.

### Conclusion

By addressing these challenges strategically, India can aim for sustainable and inclusive growth, setting the stage for a \$10,000 GDP per capita by 2045.

Source: [Indian Express: The Quality of Growth](#)



## Detailed Coverage

### India's Petroleum Industry

#### Context

Recently the Rajya Sabha passed a bill named **Oilfields (Regulation and Development) Amendment Bill in 2024** to ensure policy stability for oil and gas producers, and enable single license for all hydrocarbons.

#### Formation of Petroleum

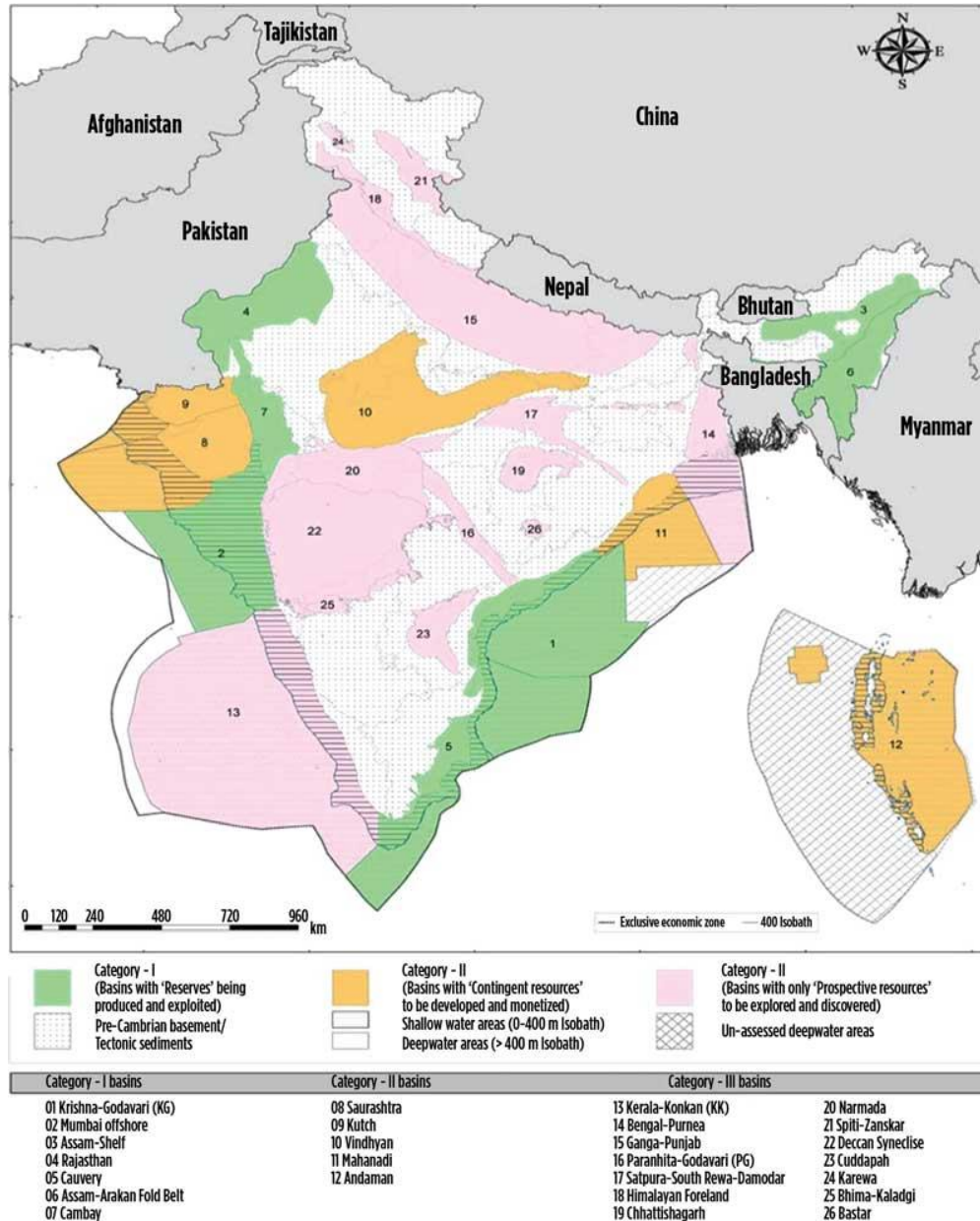


- Crude oil, or petroleum, forms over millions of years through the transformation of organic material in sedimentary environments.
- The process begins with the accumulation of microscopic organisms, such as algae and zooplankton, in marine settings where oxygen levels are low, preventing complete decomposition.
- As these organic-rich sediments are buried by additional layers, they undergo compaction and chemical changes, leading to the formation of a waxy substance called **kerogen** within a type of sedimentary rock known as **shale**.
- With increased burial depth and temperature, kerogen further breaks down into hydrocarbons, resulting in the generation of crude oil and natural gas.
- The primary rock types associated with this process include:
  - **Source Rocks:** Organic-rich shales where kerogen is generated.
  - **Reservoir Rocks:** Porous and permeable rocks, such as sandstones or carbonates, where hydrocarbons migrate and accumulate.
  - **Cap Rocks:** Impermeable rocks, like shales or evaporites, that trap hydrocarbons in the reservoir rocks, preventing them from escaping to the surface.

#### Fact

- India's petroleum industry began in 1867 with the drilling of the **first oil well in Digboi, Assam**.

## Petroleum Basins in India



India has 26 sedimentary basins, covering around 3.14 million square kilometers.

- **Category I:** Basins with proven reserves and active commercial production.
  - **Bombay High Basin (Western Offshore):** India's largest offshore oil field located in the Arabian Sea.
  - **Krishna-Godavari Basin (Andhra Pradesh):** Known for its significant offshore and onshore reserves.
  - **Cambay Basin (Gujarat):** One of the oldest and most productive onshore basins in India.
  - **Assam-Arakan Basin (North-East India):** Produces oil and natural gas; Digboi has India's first oil refinery.
- **Category 2:** Basins with known hydrocarbon accumulations but currently lacking commercial production.
  - **Rajasthan Basin (Barmer Region):** Produces oil from fields like Mangala, Bhagyam, and Aishwarya.
  - **Cauvery Basin (Tamil Nadu):** Produces both oil and gas.
  - **Mahanadi Basin (Odisha):** Known for its natural gas reserves.

- **Category 3:** Basins with indications of hydrocarbons but requiring further exploration.
  - Himalayan Foreland Basin, Ganga Basin, and other regions where exploratory activities are ongoing.

### Challenges Associated

- **High Import Dependency:** India imports over 80% of its crude oil requirements, making it vulnerable to global supply disruptions and price volatility.
- **Rising Domestic Demand:** With rapid economic growth, India's oil consumption is projected to increase by 300,000 barrels per day in both 2024 and 2025, intensifying the strain on existing infrastructure and increasing import reliance.
- **Infrastructure Constraints:** The current infrastructure may struggle to accommodate the surging demand, necessitating significant investments in refining and distribution networks.
- **Financial Pressures on Refiners:** Companies like Bharat Petroleum Corporation Limited (BPCL) have reported lower-than-expected profits due to reduced marketing margins and losses in the liquefied petroleum gas (LPG) segment.
- **Geopolitical Risks:** Sanctions and geopolitical tensions can disrupt supply chains. For instance, recent U.S. sanctions on Russia have increased shipping costs, affecting oil trade with India.
- **Transition to Renewable Energy:** Balancing the growing energy demand with environmental sustainability requires substantial investment in renewable technologies and a strategic shift from conventional fossil fuels.

**Significance of Indigenous Petroleum Production and Energy Security:** Reduces dependency on imported crude oil, mitigating risks from global supply disruptions and price volatility.

**Economic Savings:** Lowers the import bill, helping reduce the current account deficit and strengthening the economy.

**Employment Generation:** Promotes job creation in exploration, refining, and allied industries, especially in resource-rich regions.

**Revenue for the Government:** Generates revenue through royalties, taxes, and profit-sharing mechanisms, boosting public finances.

**Global Positioning:** Establishes India as a key player in the global energy market and enhances geopolitical leverage.

### Government Initiatives To Bolster The Petroleum Sector

- **Pradhan Mantri JI-VAN Yojana:** Supporting bio-ethanol projects such as second generation and third generation plants for sustainable fuel production.
- **Strategic Petroleum Reserves:** Enhancing energy security through storage facilities.
  - In India, the SPR is primarily located at three underground storage facilities in **Visakhapatnam, Mangalore, and Padur (Karnataka).**
- **Ethanol Blending Program:** Promoting biofuels to reduce dependence on fossil fuels and curb emissions.
  - The government has a target of achieving **20% ethanol blending in petrol by 2025-26.**
- **City Gas Distribution Network Expansion:** Expanding piped natural gas (PNG) and compressed natural gas (CNG) infrastructure by covering 733 districts in 34 states/UTs covering almost 100% of the mainland area and almost 100% of total geographical area of the country.
- **Energy Security Initiatives:** Investing in overseas exploration and acquisition of oil blocks.

### Moving towards Greener Fuels

- **SATAT Initiative (Sustainable Alternative Towards Affordable Transportation):** Invites potential investors to set up Compressed Biogas (CBG) production plants.
  - The aim is to make better use of agricultural residue, cattle dung, and municipal solid waste, and provide farmers with an additional source of revenue.
- **Mission Green Hydrogen:** Promoting green hydrogen production to reduce carbon footprint.
  - According to the Ministry of New and Renewable Energy, a global demand of over 100 MMT of Green Hydrogen and its derivatives like Green Ammonia is expected to emerge by 2030.
  - Aiming at about 10% of the global market, India can potentially export about 10 MMT Green Hydrogen/Green Ammonia per annum.
  - The production capacity targeted by 2030 is likely to leverage over ₹8 lakh crore in total investments and create over 6 lakh jobs.
  - Nearly 50 MMT per annum of CO<sub>2</sub> emissions are expected to be averted as a result of the various Green Hydrogen initiatives under the Mission.
  - Achievement of Mission targets is expected to contribute to India's energy security and reduce a cumulative ₹1 lakh crore worth of fossil fuel imports by 2030.
- **National Bio-Energy Programme:** Focused on bio-energy production and reducing waste.
- **Hydrocarbon Exploration and Licensing Policy (HELP):** Encouraging private investment in exploration and production.

### Way Forward for India's Petroleum Sector

- **Attracting Investments:** Collaborate with global companies for joint exploration and production (E&P) of oil and gas assets.
  - Establish a stable tax regime and provide tax breaks to attract private investments in the sector.
- **Promoting Industry-Academia Collaboration:** Foster partnerships between academic institutions and the petroleum industry to leverage cutting-edge research and bridge the gap between theory and practice.
  - E.g., MoU between the Directorate General of Hydrocarbons (DGH) and Wadia Institute of Himalayan Geology for AI/ML application in exploration activities in Upper Assam.
- **Encouraging Sustainable E&P Practices:** Support sustainable oil production initiatives like Oil India Limited's partnership with the Assam State Biodiversity Board and IUCN.
  - E.g., Conducting studies on the impact of oil production on Dibru Saikhowa National Park and developing an adaptive production plan.
- **Strengthening Oil Spill Management:** Utilize advanced technologies like oil-zappers for efficient spill control.
  - Train industry personnel on spill prevention and response protocols to minimize environmental damage.
- **Mitigating Community Impact:** Conduct impact assessments during project planning to understand and address potential effects on local communities' health, livelihoods, and overall well-being.

Source: **PIB: India's Petroleum Industry**