Strengthening India's Energy Security

This editorial is based on "For Energy Security, A Redesign," published on 04/08/2025. Despite commendable progress in renewable energy, it highlights India's energy security strategy and emphasizes the need for simplifying energy regulations, improving existing coal infrastructure, and accelerating the shift towards renewable energy to ensure sustainable growth and decarbonization.

For Prelims: Renewable energy, PM-KUSUM, Electric buses, Faster Adoption and Manufacturing of Hybrid and Electric Vehicles, International Solar Alliance, COP29, UJALA scheme, Production-Linked Incentive (PLI) scheme.

For Mains: India's Energy Landscape: Related Challenges & Way Forward

Energy security in India has traditionally focused on **access, reliability, and the affordability of fossil fuels**. However, in light of **global warming** and India's commitment to **net-zero emissions by 2070**, this perspective is now too limited. India needs to follow a **two-track energy path:** one focusing on reducing **fossil fuel consumption** (coal, oil, and gas) and the other on **expanding renewables** (solar, wind, and bioenergy). Achieving this requires not only conserving fossil fuel use but also simplifying and aligning the energy regulatory system for greater efficiency.

How is India Progressing Toward Energy Security?

- **Rise in Installed Power Capacity and Energy Mix:** As of June 2025, India's total installed power capacity has reached 476 GW.
  - Thermal power contributes **240 GW (50.52%) of India's total installed capacity**, primarily driven by coal.
  - Non-fossil fuel sources, including renewables and nuclear, **constitute 49% (235.7 GW) of the total installed capacity**.
    - **Renewable energy** accounts for 226.9 GW (47.7%) of total capacity, placing India 4th globally.
    - According to IRENA RE Statistics 2025, **India ranks 4th in wind power and 3rd in solar power capacity.**
  - This shift reflects a **diverse energy mix** aimed at ensuring energy security while reducing fossil fuel dependence and supporting **India's decarbonization and Paris Agreement commitments**.
- **Advancement in Power Supply:** India has made remarkable progress in enhancing the reliability and consistency of its power supply.
  - Power shortages have **dropped from 4.2% in 2013-14 to 0.1% in 2024-25**, reflecting substantial progress in ensuring a reliable and consistent power supply to meet the growing demand.
    - Under the **Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGYA)**, **India**

achieved 100% village electrification by April 2018, making electricity accessible to remote areas across the country.
    - Initiatives such as **Tata Power's solar micro-grids, which aim to electrify 10,000 villages**, play a crucial role in ensuring energy access in remote areas.
        - These decentralized solutions are **critical to making energy accessible** and affordable to all.
- **Electrifying the Mobility Sector:** India is leveraging clean energy to decarbonize its transportation sector, aiming for 30% **electric vehicle (EV)** penetration by 2030.
    - Electric buses and **Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME II) schemes** have enhanced urban public transport while reducing emissions.
        - The **PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) Scheme** builds upon these developments.
    - The **Indian EV battery market is projected to surge** from USD 16.77 billion in 2023 to a remarkable USD 27.70 billion by 2028.
- **Strategic Petroleum Reserves (SPR):** To enhance energy security, India has invested in SPR to safeguard against disruptions in global oil supply.
    - India's SPR capacity, managed by the **Indian Strategic Petroleum Reserves Limited (ISPRL), aims to store up to 5.33 million metric tonnes of crude oil**.
    - This reserve provides a cushion against supply shocks, **stabilizing the market during global crises**, such as geopolitical tensions or natural disasters that may disrupt oil flows.
    - **Expanding and diversifying these reserves will strengthen India's energy security** and reduce vulnerability to external supply disruptions.
- **Global Energy Diplomacy as a Pillar of India's Energy Security:** India's global leadership in renewable energy is showcased through initiatives such as the **International Solar Alliance (ISA)** and its active push for equitable energy funding at **COP29** in Baku.
    - At COP29, India raised concerns over unilateral actions by developed nations, stressing the need for shared responsibility and equitable distribution of resources to tackle global energy and climate challenges.
    - The **ISA's 'Towards 1000' strategy aims to unlock USD 1 trillion in solar investments by 2030**, significantly contributing to global renewable energy efforts.

What are the Major Challenges Impeding the Growth of India's Energy Sector?

- **Dependence on Coal and Other Fossil Fuels:** Despite the progress in renewable energy, India's energy mix is still heavily dependent on coal, which constitutes a significant portion of the country's power generation.
    - This **ongoing reliance on coal is a major challenge**, as it not only hampers efforts to decarbonize the energy sector but also results in high emissions, which undermine India's global climate commitments, including achieving net-zero emissions by 2070.
    - The Government of India **proposes to add a minimum of 80 GW of coal-based capacity by 2031–32**, which runs counter to the nation's drive toward renewable energy.
- **Regulatory Hurdles Hindering Energy Expansion:** While India has made impressive progress in renewable energy capacity, the pace of growth has slowed in recent years.
    - This is primarily due to regulatory complexities, with **multiple compliance requirements** across different government departments creating delays in the approval processes.
        - For instance, a **1 MW solar plant may require over 100 licenses** and multiple approvals, slowing down the growth of the sector.
    - India's energy sector is plagued by the absence of a single executive authority with nodal responsibility and accountability for the entire energy system.
        - The **multiplicity of regulatory agencies and departments creates coordination problems** and results in fragmented decision-making.
- **Limited Domestic Solar Manufacturing Capacity:** India's goal to scale up solar energy capacity faces challenges due to limited domestic production capabilities in key solar materials, such as **solar wafers and polysilicon**, which are crucial for manufacturing solar modules.

    - The country is **currently reliant on imports, particularly from China**, for these critical materials. This exposes India to risks related to supply chain vulnerabilities and **cost fluctuations in foreign markets**, undermining efforts to achieve energy independence.
    - **China controls 75–95% of the global solar PV supply chain**, including 91% of polysilicon and over 97% of wafers, making it the primary supplier worldwide.
        - India **continues to depend on China for over 50% of its solar cells** and modules, with imports valued at nearly USD 4 billion in FY2024.
- **Inadequate Grid Infrastructure for Renewables:** A major hurdle in scaling up renewable energy is the lack of infrastructure to accommodate the intermittent nature of solar and wind power.
    - While India is making progress with the addition of renewable energy capacity, its grid infrastructure needs a significant overhaul.
    - Inadequate **Battery Energy Storage Systems (BESS)**, makes it difficult to store excess energy during periods of high generation, which is critical for ensuring a consistent supply.
        - As of December 2024, India's cumulative installed battery energy storage capacity stood at approximately 442 MWh.
        - However, this **remains inadequate to meet the projected need of 82.37 GWh energy storage by 2026–27**.
- **Financing and Investment Issues:** The financing of renewable energy projects continues to be a challenge, especially when it comes to attracting long-term investment.
    - While the **Reserve Bank of India (RBI)** has included renewable energy in priority lending, the sector still requires further steps to attract low-cost foreign capital.
    - The government's initiatives, **including PLI (Production Linked Incentive) and SPECS (Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors)**, are promising, but they need to be supplemented with stronger administrative levers and better land laws to create a conducive environment for investment.
- **Energy Access Inequality:** While universal village electrification has been achieved, there are still gaps in energy access, particularly in remote and rural areas. A significant portion of India's rural population continues to face issues with energy quality and affordability.
    - Additionally, **there is a lack of energy-efficient technologies in rural areas**, which increases energy consumption and leads to higher costs.
        - A study by the **Council on Energy, Environment and Water (CEEW)** found that one-third of households experienced at least one of the supply quality issues—**long blackouts, low voltages, or appliance damage due to voltage fluctuations** particularly in states like UP, Jharkhand, Assam, Bihar, and Haryana.
    - According to the **India Residential Energy Survey (IRES) 2020**, about 2.4% of Indian households remain unelectrified, with the **majority located in rural regions of** Uttar Pradesh, Madhya Pradesh, Rajasthan, Haryana, and Bihar.
- **Land Acquisition and Environmental Concerns:** Renewable energy projects, particularly solar parks and wind farms, require vast amounts of land. This has led to land acquisition issues and conflicts with local communities.
    - Moreover, **environmental concerns, such as the impact on biodiversity and migratory bird patterns**, especially with wind farms in ecologically sensitive regions like the **Western Ghats**, are also challenges that need careful management.
    - Ongoing **protests have erupted in Barmer, Rajasthan**, where villagers have protested against the **illegal cutting and burning of Khejri trees** by solar power companies.

What are the Key Initiatives Shaping India's Energy Transition?

- **Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME)**
- **Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)**
- **Green Energy Corridor (GEC)**
- **National Solar Mission (NSM)**
- **National Biofuels Policy and SATAT**
- **International Solar Alliance (ISA)**

What are the Key Strategies for Advancing India's Energy Security and Transition?

- **Encouraging Policy Reforms and Better Implementation:** Current policy frameworks and administrative processes need streamlining to encourage **renewable energy investments and ensure smooth project execution.**
    - India **should focus on simplifying regulatory processes**, especially concerning land acquisition, approvals, and compliance.
    - The implementation of streamlined legislation and administrative reforms will foster an attractive investment climate, thereby supporting the country's green energy goals.
        - **Fast-track offshore wind deployment** by creating a centralised project clearance cell, seabed leasing policy, and viability gap funding mechanisms.
        - **Promoting sustainability in the coal sector through enhanced policy measures** in the field of carbon capture technologies.
- **Upgrading EPC (Engineering, Procurement, and Construction) Capabilities:** The EPC capability in India is currently insufficient to scale up solar and wind projects at the pace needed to meet energy goals.
    - India needs to **build stronger EPC capabilities** to handle large-scale renewable energy projects.
    - This includes training skilled labor, improving technological expertise, and investing in large-scale project management to accelerate the execution of renewable projects.
- **Modernizing Grid Infrastructure:** Upgrading to smart grids is crucial to handle the fluctuating nature of renewable energy.
    - Investments in **smart meters, predictive maintenance systems, and improved transmission networks** will help ensure the reliable integration of renewable power into the grid, balancing supply and demand effectively.
    - Integrate **EV charging with grid stabilization through vehicle-to-grid (V2G) technologies**, managed load scheduling, and smart charging infrastructure.
        - EVs can act as mobile energy assets, improving grid flexibility and enabling distributed storage.
- **Land Acquisition Reforms:** The acquisition of land for large-scale renewable projects is often slowed down due to **regulatory issues and land use conflicts, especially with agricultural land.**
    - **Reforms in land acquisition laws are essential** to streamline the process and facilitate the faster implementation of renewable energy projects.
    - The government should explore policies that ease the conversion of agricultural land for energy generation purposes without undermining food security.
        - **Promote agro-PV systems that allow simultaneous crop cultivation and solar generation** on the same land, especially in semi-arid and smallholder regions. It reduces land-use conflict, supports farm income, and fosters distributed clean power generation.
- **Attracting Long-Term Investment:** The renewable energy sector requires long-term capital investments, which are often difficult to attract due to financing challenges.
    - India should enhance **efforts to create a conducive environment for long-term investments**, particularly by focusing on attracting foreign capital.
        - Strengthening policy stability, improving investment protection, and offering fiscal incentives for renewable energy projects can help draw in much-needed capital.
    - **By incentivizing foreign investment, particularly "patient capital"**, India can attract the necessary resources for large-scale projects
- **Advancing Green Hydrogen for a Clean Energy Future:** Green hydrogen is a critical component of India's decarbonization efforts, but it is heavily dependent on green electricity from renewables.
    - India should **focus on scaling up green hydrogen production** by leveraging its abundant solar energy resources.
    - Supporting green hydrogen infrastructure and **creating incentives for industries such as steel, fertilizer, and refineries to adopt hydrogen** as a clean fuel source can reduce dependency on fossil fuels and move India closer to its net-zero target.
- **Exploring Small Modular Reactors (SMRs) for Clean Nuclear Energy: Small modular**

reactors (SMRs)** offer a promising **nuclear technology that provides scalable and safer clean energy solutions.** With lower initial investment requirements than traditional nuclear plants, SMRs are well-suited for developing economies like India.
    - By **collaborating with countries such as the US**, which are advancing in SMR technology, India can diversify its energy mix while ensuring low emissions.
    - Additionally, SMRs have the potential for off-grid applications, making them ideal for powering remote areas.
- **Energy Transition-Linked Green Sovereign Bonds:** India can issue Energy Transition-Linked Green Sovereign Bonds to fund clean energy projects.
    - These bonds, l**inked to measurable energy transition goals** like renewable capacity growth and reduced coal dependency, **would attract sustainable investments**.
    - They offer long-term, low-cost financing for renewable energy infrastructure and grid modernization, **aligning with India's 2070 net-zero target** while enhancing energy security.
- **Expanding Waste to Energy (WTE) Plants:** Expanding WTE plants is a promising solution to address both waste management and energy generation in India.
    - With the growing amount of municipal and industrial wast**e, WTE plants can play a critical role in reducing landfill use** while providing a sustainable energy source.
    - To further enhance energy security, **India should mandate energy circularity in industrial clusters**.
        - This includes encouraging industries to reuse waste heat, recycle process gases, and co-locate waste-to-energy units which **can significantly reduce its reliance on conventional energy sources** and will promote a more sustainable industrial ecosystem, and contribute to its decarbonization goals.
- **Fostering Collaboration Between Public and Private Sectors:** Leveraging PPP models for transmission upgrades, battery storage systems, offshore wind, and smart grid development can fast-track infrastructure expansion while ensuring commercial viability.
    - **Structured risk-sharing frameworks and long-term revenue c**ertainty are key to attracting private capital. Institutional capacity-building and regulatory clarity will make PPPs more scalable and efficient in the energy sector
    - India's transition to renewable energy **requires investments in infrastructure, technology, and workforce skills**.
        - Both sectors must work together to meet India's energy security and decarbonisation goals, with a focus on long-term strategies.

Conclusion

India's path to energy security lies in **simplifying regulations, modernizing infrastructure, and boosting investment in renewable energy.** By enhancing domestic manufacturing, adopting new technologies like green hydrogen, and fostering public-private collaboration, India can reduce its dependence on fossil fuels. The **push towards "Energy Atmanirbharta"** will drive the country's decarbonization efforts and help secure a sustainable and self-reliant energy future, contributing to the **achievement of SDG 7 (ensuring access to affordable, reliable, sustainable, and modern energy for all).**

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. With reference to the Indian Renewable Energy Development Agency Limited (IREDA), which of the following statements is/are correct? (2015)

1. It is a Public Limited Government Company.
2. It is a Non-Banking Financial Company.

Select the correct answer using the code given below:

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Ans: (c)

Mains

Q. “Access to affordable, reliable, sustainable and modern energy is the sine qua non to achieve Sustainable Development Goals (SDGs)”.Comment on the progress made in India in this regard. **(2018)**

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