India's Renewable Energy Transition

This editorial is based on "A blueprint for RE ambitions" which was published in The Financial Express on 11/07/2024. The article highlights India's urgent need for a smooth transition to renewable energy, emphasizing the importance of addressing challenges in land acquisition, infrastructure, policy consistency, grid integration, financing, and domestic manufacturing to meet ambitious clean energy targets.

For Prelims: India's Renewable Energy Capacity, National Solar Mission, Global Biofuel Alliance, India-US Clean Energy and Climate Partnership, Environmental, Social, and Governance, Green bonds, Solar Energy Corporation of India, International Renewable Energy Agency, Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA), Green Energy Corridor (GEC), National Smart Grid Mission (NSGM) and Smart Meter National Programme, Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles, International Solar Alliance, Surya Ghar Muft Bijli Yojana

For Mains: Factors Driving India's Renewable Energy Transition, Major Roadblocks to India's Renewable Energy Transition.

India is embarking on an ambitious journey to expand its renewable energy (RE) capacity, aiming for **500 GW by 2030 and potentially 1 TW by 2035**. This push is driven by the need to meet growing energy demands while transitioning away from fossil fuels to combat climate change. The country has made significant progress, with an installed **RE capacity of 191 GW** as of May 2024, including **85 GW of solar power.** This growth has been fueled by government initiatives like the National Solar Mission.

However, achieving these lofty goals faces several challenges. These include **land acquisition issues, inadequate power evacuation infrastructure, inconsistent policies, grid integration problems,** and the need for massive investments of USD 350-400 billion over the next decade. India needs to work diligently and strategically in this regard to realize its renewable energy ambitions and meet its climate commitments.

What Factors are Driving India's Renewable Energy Transition?

- **Energy Security and Independence:** India imports over **80% of its oil needs,** making it vulnerable to global price fluctuations and geopolitical tensions.
    - Renewable energy offers a path to reduce this dependence. For instance, India's solar capacity growth to **85 GW in 2023** has already started reducing fossil fuel imports.
- **Economic Competitiveness:** Renewable energy, particularly solar, has become cost-competitive with conventional sources.
    - For instance, in **December 2020, Gujarat Urja Vikas Nigam's (GUVNL)** (Phase XI) auction for 500 MW of solar projects set a record for the lowest tariff of **₹1.99 (~USD0.025)/kWh..**
        - This economic advantage is driving both public and private sector investments in

renewables.

- **Climate Change Commitments:** At COP26, India committed to reducing projected carbon emissions by **1 billion tonnes by 2030 and achieving net-zero emissions by 2070.**
    - These commitments necessitate a rapid transition to renewables. The target of 500 GW non-fossil fuel capacity by 2030 is a direct outcome of these climate goals.
- **Job Creation Potential**: The renewable sector offers significant employment opportunities.
    - According to a CEEW-NRDC report, India can potentially create about **3.4 million jobs (short and long term) by installing 238 GW solar and 101 GW new wind capacity** by 2030
    - The government's focus on domestic manufacturing through initiatives like the **PLI scheme for solar modules** aims to capitalize on this job creation potential.
- **International Cooperation and Pressure**: India's leadership in the **International Solar Alliance** and partnerships like the Global Biofuel Alliance and India-US Clean Energy and Climate Partnership have accelerated knowledge sharing and technology transfer.
    - These collaborations also bring international attention and pressure to meet stated goals.
- **Water Scarcity**: Thermal power plants require significant water resources. In water-stressed regions, renewables offer a more sustainable alternative.
    - For example, **Maharashtra's push for solar power** is partly driven by recurring droughts affecting thermal power generation.
- **Investor Pressure and ESG Considerations:** Global investors are increasingly prioritizing Environmental, Social, and Governance (ESG) **factors.**
    - This has pushed Indian companies and the government to accelerate renewable energy adoption.
    - For instance, India issued **USD 6.11 billion o**f green bonds in 11 months of 2021. It was the strongest issue since the first issue in 2015, reflecting this trend.

What are the Major Roadblocks to India’s Renewable Energy Transition?

- **Land Acquisition Hurdles**: The scale of land required for RE projects is immense. For instance, **a 1 GW solar plant needs about 2,000 hectares.**
    - Recent conflicts include protests **in Rajasthan's Jaisalmer district** against large solar parks encroaching on grazing lands.
        - These issues highlight the complex interplay between development needs and local community rights.
- **Stranded Asset Risk and Threat to Coal Sector Workers:** India has significant investments in coal-based power plants.
    - India has **8 stranded** coal-based thermal power plants, as of April 2023, according to Institute for Energy Economics and Financial Analysis (IEEFA).
    - The rapid RE transition could lead to an increase in the number of stranded assets, **creating economic and social challenges**, particularly in coal-dependent regions like **Jharkhand and Chhattisgarh.**
    - Also, the RE sector demands different skill sets, creating a mismatch with the existing workforce in conventional energy sectors like coal.
        - **Coal India Limited** alone employs over **270,000 people.**
- **Grid Integration and Stability Issues:** As RE penetration increases, grid stability becomes a major concern.
    - Example, In Tamil Nadu, early onset of wind power generation has faced challenges as **Tangedco (Tamil Nadu Generation and Distribution Corporation**) curtailed production to **ensure grid stability**
    - The implementation of forecasting and scheduling regulations by states like **Gujarat and Tamil Nadu** is a step towards addressing this, but challenges persist.
- **Intermittency and Storage Challenges**: The variable nature of RE sources necessitates large-scale storage solutions.
    - Recent study indicates that by 2030, India would need **38 GW of four-hour battery storage and 9 GW of thermal balancing power projects** for the cost-efficient and reliable integration of 450 GW of renewables.
    - The first large-scale **battery storage tender (1000 MWh) by** Solar Energy Corporation of India **in 2021** is a step forward, but scaling up remains a challenge.
- **E-waste and End-of-Life Management**: With the massive deployment of solar panels and

batteries, e-waste management is becoming a critical issue.
    - According to the International Renewable Energy Agency, India is projected to become the **fourth-largest producer of** solar panel waste **by 2050.**
    - India **currently lacks a comprehensive policy for solar panel recycling,** though MNRE has drafted rules in 2022.
        - The absence of large-scale recycling facilities poses environmental risks.
- **Geopolitical Resource Dependencies:** India's RE transition heavily depends on critical minerals like lithium, cobalt, and rare earth elements, predominantly controlled by a few countries. For instance:
    - China processes **80% of the world's rare earth elements.**
    - The Democratic Republic of Congo supplies **70% of global 'mined' cobalt.**
    - This dependency creates **vulnerabilities in India's RE supply chain**, potentially impacting national security and economic sovereignty.
- **Biofuel Land Use Dilemma**: India's ambitious biofuel targets **(20%** ethanol blending **by 2025)** compete with food production.
    - For example, the **push for ethanol production** has led to increased sugarcane cultivation, which is water-intensive.
    - This creates a **complex food-water-energy nexus challenge**, particularly in water-stressed states like Maharashtra.
- **Climate Change Impacts on RE Infrastructure**: Ironically, climate change itself poses risks to RE infrastructure:
    - **Increased** cyclone frequency in coastal areas threatens offshore wind projects.
    - Changing precipitation patterns affect hydropower potential, as seen in the **2021 Uttarakhand floods** damaging multiple hydro projects.
- **Urban Planning and RE Integration**: India's rapid urbanization presents unique challenges for RE integration. It is exemplified by **lack of uniform building codes for** rooftop solar **across cities.**
    - Limited open spaces in dense urban areas restrict large-scale RE projects, as seen in **Mumbai's struggles with solar adoption.**

What are the Major Government Initiatives Related to Renewable Energy Transition?

- Pradhan Mantri Sahaj Bijli Har Ghar Yojana (SAUBHAGYA)
- Green Energy Corridor (GEC)
- National Smart Grid Mission (NSGM) and Smart Meter National Programme
- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME)
- International Solar Alliance (ISA)
- Surya Ghar Muft Bijli Yojana

What Measures can India Adopt to Ensure a Smoother Transition to Renewable Energy?

- **Floating Solar Revolution**: India can harness its vast **aquatic spaces by developing large-scale** floating solar projects on reservoirs, lakes, and coastal areas.
    - This approach would preserve valuable land while reducing water evaporation and algae growth.
    - Integration with **existing hydroelectric infrastructure could create combined power generation systems,** maximizing energy output.
    - By focusing on floating solar, India can significantly boost its RE capacity while addressing land scarcity issues.
- **Land Leasing Revolution**: To address land acquisition hurdles, India could implement a "Solar Farming" model:
    - Introduce **long-term land leasing programs** where farmers retain ownership while earning steady income from RE projects

    - Also, develop agrivoltaic systems that allow agricultural activities beneath elevated solar panels.
- R**enewable Energy Special Economic Zones (RE-SEZs):** Establishing dedicated zones with streamlined regulations and **incentives for RE manufacturing** and R&D can accelerate India's transition.
    - These RE-SEZs would create **end-to-end RE ecosystems**, from raw material processing to finished product assembly.
    - By attracting global RE companies and fostering domestic innovation hubs, India can **position itself as a manufacturing powerhouse in the RE sector.**
        - This approach would not only boost the economy but also ensure a robust domestic supply chain for RE technologies.
- **Workforce Transition From Coal to Clean Energy**: Launch a "**Green Collar**" initiative to retrain coal sector workers for RE jobs
    - Establish **RE manufacturing hubs in coal-dependent regions** to create alternative employment.
    - Implement **a phased transition plan with clear timelines** to allow for gradual workforce adaptation
- **Blockchain-Powered Decentralized Energy Trading:** Implementing peer-to-peer energy trading platforms using blockchain technology can revolutionize India's energy market.
    - This system would **enable prosumers to sell excess energy directly to neighbors or the grid**, increasing overall grid flexibility.
    - By incentivizing small-scale RE adoption, this approach can accelerate distributed energy resource deployment across the country.
        - The decentralized nature of this system would also enhance grid resilience and reduce transmission losses.
- **Vertical Axis Wind Turbines (VAWTs) for Urban Environments**: Promoting the adoption of **VAWTs in cities** can unlock urban wind energy potential.
    - These turbines are more suitable for **turbulent urban wind patterns** and can be integrated into existing urban infrastructure like buildings and bridges.
    - VAWTs also **reduce the visual impact and noise pollution** associated with traditional **wind turbines**, making them more acceptable in densely populated areas.
    - This urban wind energy strategy can complement rooftop solar installations, diversifying India's urban RE mix.
- **Green Hydrogen Highways:** India can create a network of green hydrogen production and distribution centers along major transportation corridors.
    - These "Green Hydrogen Highways" would **use excess renewable energy to produce hydrogen**, which can then fuel long-haul trucks and buses.
    - The system could include hydrogen filling stations, storage facilities, and dedicated hydrogen-powered public transport.
        - This initiative would address the challenge of storing renewable energy while simultaneously **decarbonizing the transportation sector.**
- **Solar Thermal Oases:** Developing large-scale concentrated solar power (CSP) plants in arid regions, integrated with greenhouse agriculture, could create **"Solar Thermal Oases".**
    - These facilities would **use excess heat from CSP for desalination,** providing water for crops grown in adjacent greenhouses.
    - The controlled environment of the greenhouses would **allow for year-round cultivation of high-value crops.**
        - This synergistic approach addresses energy, water, and food security challenges simultaneously.
- **Waste-to-Energy Circular Parks:** Creating integrated waste management and energy production facilities, or "Waste-to-Energy Circular Parks", could revolutionize both sectors.
    - These parks would combine various technologies like **anaerobic digestion, gasification, and pyrolysis t**o handle different waste streams.
    - The energy produced would power the facility itself and feed into the grid, while byproducts like **biochar could be used in agriculture.**
        - This holistic approach turns waste management from a cost center into an energy and resource generator.

Drishti Mains Question:

What strategic measures can India adopt to ensure a smooth and effective transition to renewable energy while addressing economic and social challenges?

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)**
