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THE ROAD MAP TO MUSSORRIE...

MAINS IMPACT– 2025 – 13/11/2024

WIND ENERGY IN INDIA

SYLLABUS:

GS 3 > Environment & Ecology > Global warming > Renewable energy

REFERENCE NEWS:

- Recently, the Tamil Nadu government introduced the "**Tamil Nadu Repowering, Refurbishment and Life Extension Policy for Wind Power Projects - 2024**," which has faced opposition from wind energy generators, resulting in a judicial stay.
- The policy aims to **modernize Tamil Nadu's aging wind energy infrastructure**, improve efficiency, and maximize the state's wind energy potential.
- Tamil Nadu has been a leader in wind turbine installations since the 1980s. The state currently has the second-largest installed wind energy capacity in India, totaling 10,603.5 MW. Nearly half of the 20,000 wind turbines in Tamil Nadu are smaller than 1 MW in capacity.

MORE ON NEWS:

- "Tamil Nadu Repowering, Refurbishment, and Life Extension Policy for Wind Power Projects—2024" has faced significant opposition from wind energy generators due to the following reasons:
 - **High Development Charges:** The policy imposes a charge of **₹30 lakh per MW for repowering or refurbishment**. When combined with the costs of evacuation infrastructure and maintenance, this significantly increases the financial burden on generators.
 - **Restrictive Energy Banking Provisions:** The policy limits energy banking to 50% of the power generated during windy months and **raises banking charges from 14% to 16%**. This restricts operational flexibility and affects financial sustainability.
 - **Mandatory Repowering for Older Turbines:** Turbines **older than 20 years** must be repowered or refurbished, even if operational. This requirement places a disproportionate financial strain on smaller generators who may struggle to justify the investment.
 - **Infrastructure Costs:** Generators must fund substation upgrades and feeder enhancements to handle increased power output, further adding to the economic strain.

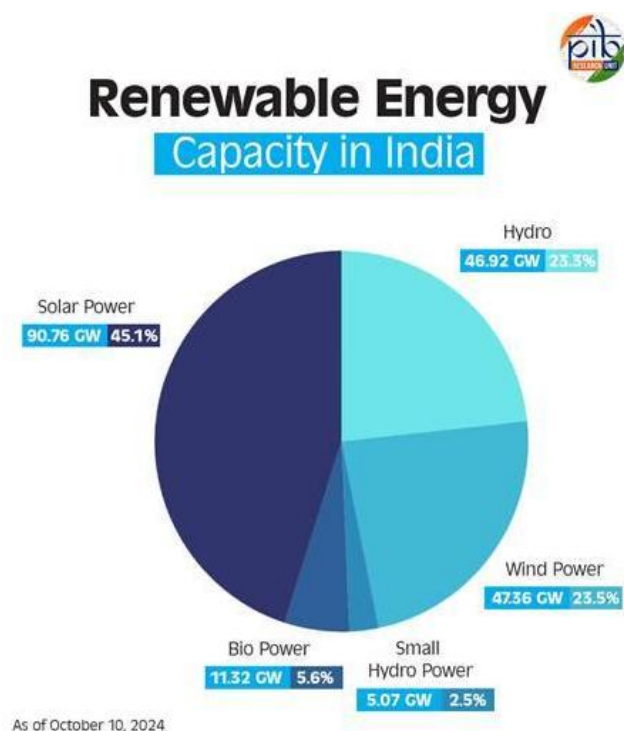
- **Lack of Incentives:** The policy **does not provide sufficient financial support or incentives** to offset the costs of repowering and refurbishment, making projects commercially unviable.

These provisions, while aimed at modernizing wind energy infrastructure, have been criticized for **their impracticality and financial implications**, prompting generators to seek revisions for a **more balanced and sustainable policy**.

Repowering involves **replacing older wind turbines** (more than 15 years old or under 2 MW) with new, **more efficient models**. **Refurbishment** may include measures such as **increasing the turbine height, changing blades, or upgrading gearboxes** to enhance energy generation.

CURRENT STATUS:

- India is **ranked fourth globally** in installed wind energy capacity.
- The National Institute of Wind Energy (NIWE) notes a potential of **1,163.86 GW at 150 meters above ground** and **695.51 GW at the normal turbine height of 120 meters**.
- Key contributors including **Gujarat, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, and Andhra Pradesh** account for **93.37%** of the country's wind power capacity installation.



SIGNIFICANCE OF WIND POWER FOR INDIA

Wind power plays a pivotal role in India's energy landscape, offering numerous benefits that align with the nation's environmental, economic, and energy security objectives.

- **Combating Climate Change:**
 - India's Intended Nationally Determined Contributions (INDCs) under the Paris Agreement emphasize reducing carbon emissions and increasing the share of non-fossil fuel-based energy. Wind energy, as a clean and renewable source, is integral to achieving these targets. By expanding wind power capacity, India

can significantly lower greenhouse gas emissions, contributing to global climate change mitigation efforts.

- **Enhancing Energy Security:**
 - India imports approximately 90% of its primary energy requirements, making it vulnerable to global energy market fluctuations. Diversifying the energy mix with wind power reduces dependence on imported fossil fuels, thereby enhancing energy security and stabilizing the economy against external shocks.
- **Leveraging Geographical Potential:**
 - The National Institute of Wind Energy (NIWE) has assessed India's wind power potential at 695.50 GW at 120 meters above ground level. Additionally, with a coastline of about 7,600 km, India has substantial prospects for offshore wind energy development. These resources, if harnessed effectively, can substantially contribute to the nation's energy supply.
- **Meeting Rising Energy Demands:**
 - India faces chronic energy shortages, and initiatives like FAME-II and Make in India are expected to increase electricity demand. Wind energy offers a scalable solution to meet this growing demand sustainably, supporting industrial growth and the transition to electric mobility.
- **Promoting Inclusive Growth:**
 - The cost of wind energy has decreased significantly, with tariffs reaching as low as ₹2.43 per unit in Gujarat in 2017. This affordability makes clean energy accessible to a broader population, including economically disadvantaged communities, fostering inclusive growth and reducing energy poverty.
- **Aligning with Government Policies:**
 - India has committed to sourcing 50% of its electricity from non-fossil fuel sources by 2030. These policy targets underscore the government's dedication to transitioning towards a sustainable energy future, with wind power as a cornerstone of this strategy.

GOVERNMENT INITIATIVES:

- **National Offshore Wind Energy Policy (2015):** This policy facilitates the development of offshore wind energy projects within India's Exclusive Economic Zone (EEZ), aiming to harness the vast offshore wind potential along the coastline.
- **National Wind-Solar Hybrid Policy (2018):** It provides a framework for large grid-connected wind-solar photovoltaic (PV) hybrid systems, optimizing the use of transmission infrastructure and land resources.
- **Green Energy Corridor Project:** This initiative focuses on strengthening the transmission network to integrate renewable energy sources, including wind, into the national grid, ensuring efficient power evacuation.

- **Policy for Repowering of Wind Power Projects (2016, Revised in 2023):** The policy encourages the replacement of older wind turbines with modern, higher-capacity units to enhance efficiency and energy output.
- **Foreign Direct Investment (FDI):** The government permits 100% FDI under the automatic route for renewable energy projects, including wind energy, to attract international investments.
- **Accelerated Depreciation and Generation-Based Incentives (GBI):** These fiscal incentives are designed to encourage investment in wind energy by offering tax benefits and financial rewards based on energy generation.

CHALLENGES:

- **Location-Specific Potential:**
 - Optimal wind power generation requires high wind speeds, predominantly found in seven states: Gujarat, Rajasthan, Maharashtra, Tamil Nadu, Madhya Pradesh, Karnataka, and Andhra Pradesh. This geographic concentration limits widespread adoption.
- **High Capital Investments:**
 - Establishing wind farms involves substantial capital expenditure, estimated between ₹6.8 to ₹7.2 crore per megawatt (MW). This high upfront cost can deter investors.
- **Grid Connectivity Issues:**
 - Inadequate transmission infrastructure and limited power storage facilities hinder the integration of wind energy into the national grid, affecting reliability and efficiency.
- **Unviable Tariffs:**
 - Competitive bidding has driven tariffs as low as ₹2.44 per unit, challenging the financial viability for companies operating in the sector.
- **Project Execution Delays:**
 - The involvement of multiple agencies, including the Ministry of New and Renewable Energy (MNRE), Indian Renewable Energy Development Agency (IREDA), state electricity boards, and regulatory commissions, complicates and delays project implementation.
- **Land Acquisition Challenges:**
 - Securing land for wind projects is complex due to competing land uses and regulatory hurdles, often leading to delays and increased costs.
- **Infrastructure Limitations:**
 - Many rural areas lack roads capable of transporting large turbine components, such as blades exceeding 100 feet, adding to logistical challenges and costs.
- **Policy and Regulatory Hurdles:**
 - Frequent policy changes and lack of consensus among stakeholders have impeded sector growth, creating uncertainty for investors and developers.
- **Technological Constraints:**

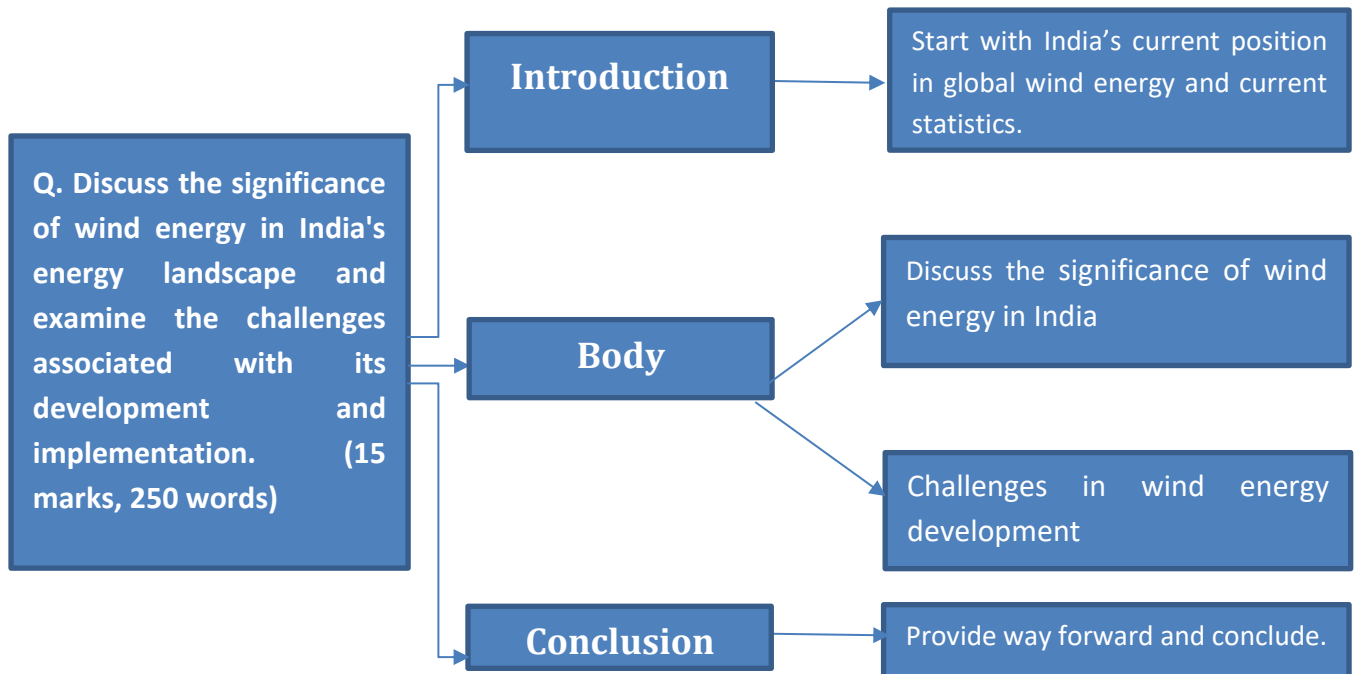
- India's wind energy sector has been slow to adopt advanced technologies, such as larger turbines and offshore installations, limiting efficiency and capacity expansion.
- **Environmental and Social Concerns:**
 - Wind projects can face opposition due to potential impacts on local ecosystems and communities, necessitating careful planning and stakeholder engagement.

WAY FORWARD:

- **Efficient Storage Facilities:** Encourage research in indigenous storage solutions like lithium-ion batteries, pumped hydro, and green hydrogen to improve the reliability and integration of renewable energy sources.
- **Strengthen Power Purchase Agreements (PPAs):** Revamp and strengthen PPAs to ensure favorable terms for developers, making renewable energy projects more bankable and financially sustainable.
- **Explore Full Potential:** Encourage wind energy development in low wind speed areas and offshore regions to maximize the country's wind energy potential.
- **Robust Grid Infrastructure:** Expedite the Green Energy Corridor Project to integrate renewable energy efficiently and reduce grid congestion with dedicated transmission infrastructure.
- **Capital Cost Reduction:** Reduce customs duties on imported wind turbine components and promote domestic manufacturing to lower costs and create employment opportunities.
- **Simplify Land Acquisition:** Implement a single-window clearance system and prioritize the use of degraded or non-agricultural land to reduce conflicts and delays.
- **Adopt Advanced Technologies:** Deploy larger, efficient turbines and explore innovative solutions like floating turbines to harness offshore wind potential.
- **Decentralized Wind Energy:** Support small-scale and community-based wind projects with subsidies or net metering to enhance energy access in rural and remote areas.
- **Policy Stability and Reforms:** Maintain consistent and long-term policies while addressing regulatory bottlenecks to attract investors and ensure smooth project execution.
- **Involve Local Communities:** Engage local communities in projects and provide training programs to equip them with skills for employment in the wind energy sector.
- **Focus on Offshore Wind Energy:** Streamline approvals and develop port infrastructure to facilitate offshore wind projects, leveraging public-private partnerships.
- **Climate-Resilient Infrastructure:** Design wind energy systems to endure extreme weather events, ensuring their sustainability and reliability.
- **International Collaboration:** Collaborate with global leaders like Denmark and Germany for technology, funding, and expertise, and utilize mechanisms like the Green Climate Fund for large-scale wind energy projects

PRACTICE QUESTION:

Q. Discuss the significance of wind energy in India's energy landscape and examine the challenges associated with its development and implementation. (15 marks, 250 words)

APPROACH:**MODEL ANSWER:**

India ranks **4th globally** in installed wind energy capacity, with a total of **47.36 GW**, contributing **23.5% of the country's total renewable energy capacity of 200.43 GW (as of October 2024)**. The National Institute of Wind Energy (NIWE) notes a **potential of 1,163.86 GW at 150 meters above ground** and 695.51 GW at the normal turbine height of 120 meters. This underlines the critical role of wind energy in India's renewable energy mix and its transition to a sustainable energy future.

Significance of Wind Energy in India

- 1. Combatting Climate Change:** Wind energy is central to India's INDC targets under the Paris Agreement, aiming to source 50% of electricity from non-fossil fuel sources by 2030.
- 2. Enhancing Energy Security:** Reduces dependency on fossil fuel imports (90% of primary energy imports), insulating the economy from global energy price volatility.
- 3. Meeting Rising Energy Demands:** Initiatives like FAME-II and the push for electric mobility are driving higher electricity demand, which can be met sustainably through wind energy.

4. **Promoting Inclusive Growth:** The falling tariffs of wind energy (as low as ₹2.43/unit in Gujarat, 2017) have made renewable energy affordable for economically weaker sections.
5. **Leveraging Geographical Potential:** With a coastline of 7,600 km and high wind speed zones in states like Gujarat, Tamil Nadu, and Karnataka, India has immense onshore and offshore potential.
6. **Aligning with Global Leadership in Renewables:** India's leadership in the International Solar Alliance is complemented by its advancements in wind energy, boosting its stature in global climate diplomacy.

Challenges in Wind Energy Development

1. **Location-Specific Potential:** Wind energy generation is limited to specific states with high wind speeds, restricting widespread adoption.
2. **High Capital Costs:** The initial investment is significant, estimated at ₹6.8–₹7.2 crore per MW, deterring investors.
3. **Grid Connectivity Issues:** Limited transmission infrastructure and storage facilities reduce the reliability of wind power integration.
4. **Land Acquisition Challenges:** Regulatory hurdles and competing land uses lead to delays and higher costs, especially in land-scarce regions.
5. **Policy Uncertainty:** Frequent changes in policies and lack of a uniform regulatory framework discourage private sector investment.
6. **Technological Constraints:** Lack of advanced technologies such as floating turbines and large-capacity offshore installations restricts efficiency and capacity expansion.
7. **Environmental and Social Concerns:** Projects face opposition due to potential disruptions to local ecosystems and community livelihoods.

Government Initiatives

- National Offshore Wind Energy Policy (2015)
- National Wind-Solar Hybrid Policy (2018)
- Green Energy Corridor Project
- Policy for Repowering of Wind Power Projects (2016, Revised 2023)
- Accelerated Depreciation and Generation-Based Incentives (GBI)

Way Forward

- **Develop Efficient Storage Solutions:** Invest in indigenous storage technologies like lithium-ion batteries and green hydrogen.
- **Strengthen Grid Infrastructure:** Expedite projects like the Green Energy Corridor to reduce grid congestion and ensure efficient evacuation.
- **Encourage Offshore Wind Development:** Develop port infrastructure and streamline regulatory approvals to harness offshore potential.
- **Promote Technology Upgradation:** Encourage the adoption of larger and more efficient turbines, including floating technologies.
- **Facilitate Land Acquisition:** Implement a single-window clearance system for land and promote the use of degraded lands.
- **Enhance Policy Stability:** Maintain consistent policies with long-term clarity to attract sustained private sector investments.
- **Foster International Collaboration:** Collaborate with global leaders like Denmark and Germany for technology transfer and funding.

Wind energy is pivotal to India's renewable energy goals, addressing climate change, energy security, and economic growth. However, overcoming challenges related to high costs, limited infrastructure, and policy bottlenecks is essential. A collaborative approach involving stakeholders, technological innovation, and supportive government policies can ensure wind energy becomes a cornerstone of India's sustainable energy future.