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DAILY EDITORIAL ANALYSIS

TOPIC

INDIA NEEDS A GRID REVOLUTION FOR CLEAN ENERGY TRANSITION

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Context

- As **India's renewable capacity** grows faster than transmission and storage infrastructure, there is a need for grid integration ensuring reliable, affordable electricity.

About Power Infrastructure and Grid Integration in India

- India has emerged as one of the fastest-growing clean energy markets globally.
- India is steadily changing its **electricity mix with 297 GW of non-fossil capacity deployed**, a lot more solar and wind capacity under development and ambitious ambitions ahead.
  - However, renewable energy integration is not only about adding solar panels and wind turbines.
- **Grid integration** is the **ability of the electrical system** to absorb, transmit, balance and reliably supply electricity generated from fluctuating renewable sources.
- Solar and wind generation fluctuates with weather and time of day unlike conventional power plants.
  - It **requires a modern grid** supported by transmission networks, storage, flexible generation and efficient power markets.
- Thus, India's energy transition is increasingly shifting from **capacity addition to capacity utilisation and integration**.

Current Status and Significance of the Grid

- India's non-fossil sources now account for a significant share of electricity generation, and their contribution has occasionally crossed **50% during daytime hours**.
- It demonstrates the growing maturity of renewable energy deployment.
- A robust and modern grid is significant because it can:
  - Ensure stable energy supply under changeable renewable generation;
  - Transfer power from areas with high renewables to areas with high demand;
  - Reduce clean energy curtailment
  - Lower the overall cost of fulfilling rising electricity demand;
  - Improve energy security and lessen dependence on fossil fuels.
- The continuing transmission expansion in India, which includes **renewable energy evacuation infrastructure** and **Green Energy Corridor-type** initiatives, is therefore a prerequisite for attaining the country's long-term clean energy targets.

What are the Issues and Concerns in Grid Infrastructure?

- **Inflexible and Outdated Grid Architecture:** India's conventional grid was designed largely for one-way power flows from large generating stations to consumers.
  - Distributed solar, electric vehicles and rooftop power necessitate a more dynamic, two-way system.
- **Transmission Capacity Lag:** Renewable projects can be commissioned relatively rapidly, whereas transmission lines sometimes encounter delays owing to land acquisition, clearances and construction issues.
  - It can lead to renewable generation being stranded or reduced.
- **Insufficient Storage and Flexibility:** India's storage capacity is still inadequate for its fast expanding fleet of solar and wind energy.
  - If demand for electricity surges after sunset, it may be necessary to reduce excess solar generation during the day.
- **Inadequate Market Signals:** India's power sector continues to rely significantly on long-term bilateral contracts.
  - Existing markets mostly reward power generation, whereas flexibility, reserve, stability and dispatchability of the system typically lack suitable price signals.

- **Limited Digital Visibility at Distribution Level:** Many Distribution Companies (DISCOMs) have limited granular information on consumer demand, network health, rooftop solar and electric car charging. It weakens real-time grid management.

Related Efforts & Initiatives

- India has implemented a number of measures to boost its power infrastructure:
  - **Expansion of inter-state transmission networks** to connect renewable-rich regions with demand hubs;
  - **Green Energy Corridor Projects** for evacuation of renewable energies;
  - Promoting deployment of **Battery Energy Storage Systems (BESS)** and **pumped storage;**
  - **Smart meter deployment** in programs to modernise the electricity sector.
  - Development of **electricity exchanges** and **ancillary services marketplaces;**
  - **Competitive auctions** for renewable energy and new tools **to help enhance price discovery.**
- These projects suggest a steady shift toward a more flexible, market-oriented power system.

Way Forward: Strengthening the Green Grid

- **Deploy Advanced Grid Technologies:** India ought to focus on reconductoring of existing transmission lines, dynamic grid management, grid forming inverters and co-location of battery storage with renewable projects.
  - These types of measures can add capacity without having to build more infrastructure.
- **Build Storage and Flexible Capacity:** There is a need to expand battery storage, pumped hydro and flexible thermal generation.
  - State-owned thermal facilities can provide reserves and balancing services throughout the transition.
- **Reform Power Markets:** Markets need to reward not only energy, but **capacity, flexibility and dispatchability.**
  - Short-term capacity markets and novel contracts can draw investment to resources that help integrate renewables.
- **Adopt Technology-Neutral Procurement:** Rather than buying solar, wind, thermal and storage separately, utilities should determine the services required – capacity, flexibility and reliability – and let diverse technologies compete on a least-cost basis.
- **Accelerate Digitalisation & Consumer Participation:** Smart meters, real-time data systems and time-varying pricing can allow users to shift electricity consumption away from moments of stress on the grid.
  - Digital platforms aimed at consumers can increase transparency regarding electricity prices and consumption.

Conclusion

- India has demonstrated remarkable success in expanding clean energy capacity. But, the next phase of the transition will be decided not merely by **megawatts added, but by megawatts effectively integrated**.
- A modern grid, flexible resources, efficient markets and digital infrastructure are essential to ensure that renewable energy translates into reliable and affordable electricity for every household, farmer and enterprise.
- The real measure of India's green transition will therefore be its ability to build a power system where clean capacity is not only created—but fully utilised.

Source: BS

Daily Mains Practice Question

[Q] India's clean energy transition will be determined not merely by renewable capacity addition but by the ability of its power grid to integrate it efficiently. Discuss.

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