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Green Energy Corridor Phase-III Strengthens India's Renewable Energy Grid Integration and Storage Capacity

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Recent Developments:

- The Union Cabinet approved the **Green Energy Corridor Phase-III (GEC-III)** on **30 September 2026**, with a total project outlay of **₹1,86,405 crore**, aimed at strengthening the **Intra-State Transmission System (InSTS)** and enabling evacuation of up to **135 GW of renewable energy** across States and Union Territories.
- GEC-III introduces a major new component by providing for **50 GWh of Battery Energy Storage Systems (BESS)**, enabling renewable electricity to be stored during periods of surplus generation and supplied during periods of high demand or low renewable generation.
- The scheme is targeted for completion by **FY 2032-33** and is designed to support India's broader objective of integrating **900 GW of installed non-fossil fuel capacity by 2035**.

Green Energy Corridor: Concept and Evolution:

What is the Green Energy Corridor?

- The **Green Energy Corridor (GEC)** is a government programme for developing dedicated transmission infrastructure required to integrate large-scale **solar, wind and other renewable energy** into the electricity grid.
- Renewable-energy-rich regions are often located far from major consumption centres; therefore, generation capacity alone is insufficient unless adequate transmission networks can transport electricity from generation sites to demand centres.
- The original GEC planning emerged from a **2012 Power Grid Corporation of India Limited study**, which identified inadequate transmission and evacuation infrastructure around potential renewable-energy sites, with implementation beginning in **2015** after the required approvals.

Earlier Phases:

- **GEC-I** covered eight renewable-energy-rich States — Andhra Pradesh, Gujarat, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu— and was designed to integrate around **24 GW of renewable generation capacity** through transmission lines and substations.
- **GEC-II** covers seven States — Gujarat, Himachal Pradesh, Karnataka, Kerala, Rajasthan, Tamil Nadu and Uttar Pradesh — and is designed to integrate approximately **20 GW** of renewable generation through around **10,750 ckm of transmission lines** and **27,500 MVA of substations**.
- GEC-III represents a shift from primarily expanding transmission infrastructure to combining **transmission expansion with grid-scale energy storage**.

GEC-III: Key Features and Financial Architecture:

Financial Allocation:

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Plot A P.127, AF block, 6 th street, 11th Main Rd, Shanthi Colony, Anna Nagar, Chennai, Tamil Nadu 600040

Phone: **044 4353 9988 / 98403 94477 / Whatsapp : 09710729833**

- The scheme has a total outlay of **₹1,86,405 crore**, comprising **₹1,36,378 crore for Intra-State Transmission Systems** and **₹50,000 crore for 50 GWh of BESS deployment**.
- The scheme provides **₹54,082 crore of Central Financial Support (CFS)**, which will help offset intra-state transmission charges and thereby reduce the transmission-related burden on electricity consumers.

Implementation Mechanism:

- **Greenfield InSTS projects**, involving entirely new transmission infrastructure, will be developed through **Tariff-Based Competitive Bidding (TBCB)**, allowing transmission service providers to compete for projects on the basis of competitively determined tariffs.
- **Brownfield upgrades and network-strengthening works** will follow the **Cost-Plus Basis (CPB)**, under which approved project costs and regulated returns are recovered through the applicable tariff mechanism.
- **State Transmission Utilities (STUs)** will function as the overall implementing agencies, while **Transmission Service Providers (TSPs)** will participate in TBCB projects through the **Build-Own-Operate-Maintain (BOOM)** model.
- This approach is significant because it seeks to increase **private capital participation and competition** in intra-state transmission, rather than relying predominantly on state budgets and borrowing.

The Renewable Energy Evacuation Challenge:

Why Generation Capacity Alone Is Not Enough:

- Renewable electricity generation is inherently variable; **solar generation peaks during daylight hours**, while wind generation depends on weather conditions, creating a mismatch between generation availability and electricity demand.
- Rapid renewable-capacity addition can therefore create **transmission congestion**, particularly when large volumes of solar power are generated simultaneously in renewable-rich regions.
- When the grid lacks sufficient transmission capacity or flexibility to absorb available renewable electricity, power plants may face **curtailment**, meaning generation is reduced or temporarily stopped despite the availability of renewable resources.

Transmission as a Critical Energy Transition Infrastructure:

- India's renewable-energy transition therefore requires simultaneous expansion of **generation, transmission, storage and grid-management capabilities**.
- The Central Electricity Authority's 2026 transmission planning framework envisages transmission infrastructure capable of integrating **more than 900 GW of non-fossil-fuel capacity by 2035-36**, demonstrating that grid expansion is becoming a central component of India's energy-transition strategy.

Battery Energy Storage: Why GEC-III Is Different:

Role of BESS:

- **Battery Energy Storage Systems** absorb electricity when renewable generation exceeds immediate demand and release electricity when demand increases or renewable generation falls.
- Storage can reduce **peak-hour curtailment**, manage renewable intermittency, provide flexibility during non-solar hours and improve the utilisation of existing transmission infrastructure.
- The inclusion of **50 GWh of BESS** in GEC-III is therefore important because it addresses the problem not merely by adding transmission capacity but also by increasing the grid's ability to **shift renewable electricity across time**.

Storage Gap in India:

- India's rapidly increasing renewable capacity has created a need for much faster expansion of **dispatchable flexibility resources**, including BESS and **Pumped Hydro Storage (PHS)**.
- The Central Electricity Authority's long-term planning for 2035-36 demonstrates the scale of this requirement, with energy-storage capacity becoming essential for maintaining **resource adequacy, grid stability and reliable electricity supply** alongside high renewable penetration.

Strategic Significance for India:

Supporting the 2035-36 Energy Transition:

- GEC-III directly complements India's long-term objective of integrating a very large **non-fossil electricity-generation base**, because renewable capacity cannot contribute effectively to energy security without corresponding evacuation and balancing infrastructure.
- The scheme can reduce the risk of **stranded renewable generation**, improve utilisation of clean-energy assets and facilitate greater integration of variable renewable sources into the national electricity system.

Promoting Regional Diversification:

- Large-scale renewable generation has historically been concentrated in resource-rich regions, particularly States with high solar and wind potential.
- Strengthening intra-state networks can facilitate the development of renewable capacity across a wider geographical area and improve the ability of States to connect renewable projects to larger consumption centres.

Crowding in Private Investment:

- Opening new intra-state transmission projects to **TBCB** can reduce dependence on conventional state-led project financing and bring private transmission developers into the market.
- The model can improve project competition, capital mobilisation and efficiency while allowing regulated transmission infrastructure to operate under a predictable revenue framework.

Key Challenges:

Implementation Delays:

- GEC-I and GEC-II have experienced delays, highlighting the importance of timely **land acquisition, procurement, construction, inter-agency coordination and commissioning**.
- Delays in transmission infrastructure can create an asymmetry in which renewable-generation projects become operational before the corresponding evacuation network is ready.

Grid Flexibility:

- Transmission expansion alone cannot resolve all renewable-integration problems because electricity generation and demand do not always occur simultaneously.
- India therefore needs coordinated investment in **BESS, pumped-storage hydropower, flexible generation, forecasting systems, demand response and modern grid-management technologies**.

Financing and Regulatory Coordination:

- Large transmission projects require long-term financing, predictable tariffs and coordination among **Central and State governments, transmission utilities, regulators and private developers**.
- Effective implementation of TBCB at the intra-state level will require transparent bidding, bankable project structures and timely regulatory approvals.

Way Forward:

- India should adopt an integrated **generation-transmission-storage planning framework**, ensuring that renewable-energy capacity additions are synchronised with evacuation infrastructure and flexibility resources.
- Greater emphasis should be placed on **energy storage deployment, transmission modernisation, forecasting and real-time grid management** to minimise renewable curtailment.
- States should strengthen institutional coordination between renewable-energy developers, STUs, DISCOMs, regulators and system operators so that transmission constraints are identified before generation projects are commissioned.
- Faster implementation of GEC projects is essential because delayed transmission can undermine both the economic viability of renewable projects and India's clean-energy targets.

Value Addition for UPSC:

Key Concepts:

- **Power Evacuation:** Transfer of electricity from the generation site through transmission infrastructure to the electricity network serving consumers.
- **Curtailment:** Reduction or temporary restriction of electricity generation, often imposed when the grid cannot safely absorb the available power.
- **BESS:** A technology that stores electrical energy in batteries and releases it later to provide grid flexibility, peak management and renewable-energy integration.
- **Intra-State Transmission System:** Transmission infrastructure operating within a State, connecting generation sources with substations and demand centres.
- **TBCB:** A competitive procurement mechanism in which transmission developers bid for projects based on competitively determined tariffs.
- **BOOM Model:** A project structure under which a private transmission provider builds, owns, operates and maintains the transmission asset.

UPSC Linkages:

- **GS-III:** Infrastructure, renewable energy, energy security, environmental sustainability, climate-change mitigation and technological development.
- **Energy Security:** Effective integration of renewable generation with transmission and storage can reduce dependence on fossil-fuel-based electricity while improving system reliability.
- **Federalism:** GEC-III requires coordination between the Union government, State governments, State Transmission Utilities, regulators and private transmission developers, making it relevant to **cooperative federalism**.
- **Climate Goals:** Efficient evacuation and storage of renewable electricity can increase the utilisation of clean-energy capacity and support India's long-term **decarbonisation pathway**.
- **Core UPSC Insight:** India's energy transition is no longer only a question of **how much renewable electricity can be generated**; it increasingly depends on **whether that electricity can be transmitted, stored and dispatched when required**.