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NATIONAL CONFERENCE ON POWER TRANSMISSION

Powering Viksit Bharat 2047: The Transmission Imperative

29th May 2026
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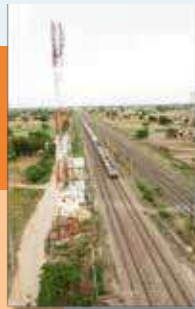
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Message



I am immensely pleased to welcome you all to the first National Conference on Power Transmission, organized by the India Energy Forum. This landmark event comes at a pivotal moment in our nation's developmental journey.

Our chosen theme, **"Powering Viksit Bharat 2047: The Transmission Imperative,"** directly addresses the core engine of India's economic future. To achieve a fully developed nation status by 2047, our power sector must undergo unprecedented expansion and modernization. A robust, resilient, and technologically advanced transmission grid is the absolute prerequisite to integrating massive renewable energy capacities and ensuring uninterrupted power for all. This conference serves as a critical platform for industry leaders to map out that very blueprint.

I would like to express my sincere gratitude to **Shri I S Jha**, Chairman, Transmission & Distribution Group, India Energy Forum and Chairman of the Organizing Committee of the National Conference on Power Transmission. His exceptional leadership and vision have been instrumental in conceptualizing and organizing this vital programme. I also extend my thanks to **Idam Infra** for authoring the comprehensive Theme Paper under the supervision of the Organizing Committee, which sets an excellent, analytical tone for our deliberations today.

I am confident that the insights generated during these sessions will provide actionable recommendations for policymakers and industry stakeholders alike.

I wish the Conference every success!

A handwritten signature in blue ink, reading "R V Shahi".

R V Shahi

President, India Energy Forum
Former Secretary, Ministry of Power, GoI

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Message



It gives me great pleasure to welcome all distinguished speakers, delegates and participants to the National Conference on Power Transmission organized by the India Energy Forum on the theme “Powering Viksit Bharat 2047: The Transmission Imperative.”

India’s power sector is going through a period of major transformation. Rapid growth of renewable energy, increasing electrification of transport and industry, development of green hydrogen hubs and rising power demand are changing the way we plan and operate our power systems. In all these developments, transmission has emerged as one of the most critical enablers of India’s energy transition.

The transmission sector today faces several important challenges, coordinated planning of generation and transmission systems, timely project execution, supply-chain readiness, optimal utilization of transmission assets and mobilization of long-term financing for the huge investments envisaged in the coming years.

This Conference has been designed to provide a platform for open and meaningful discussions on these important issues. I am happy that senior policymakers, regulators, utilities, developers, financial institutions, technology providers and sector experts have joined this Conference to share their perspectives and experiences.

I sincerely thank all the distinguished chairpersons, speakers and delegates for their participation and support. I also place on record my appreciation for the efforts of the Organizing Committee, members of the T&D Group of IEF and Idam Infra for preparing the Theme Paper for the Conference.

I am confident that the deliberations during the Conference will generate useful ideas and recommendations for strengthening India’s transmission sector and supporting the country’s journey towards Viksit Bharat 2047.

I convey my best wishes for the success of the Conference and this Souvenir.

A handwritten signature in black ink, appearing to read 'ISJ', with a horizontal line underneath.

Indu Shekhar Jha
Chairman, Transmission & Distribution Group, IEF
Former CMD, PGCIL | Former Member, CERC



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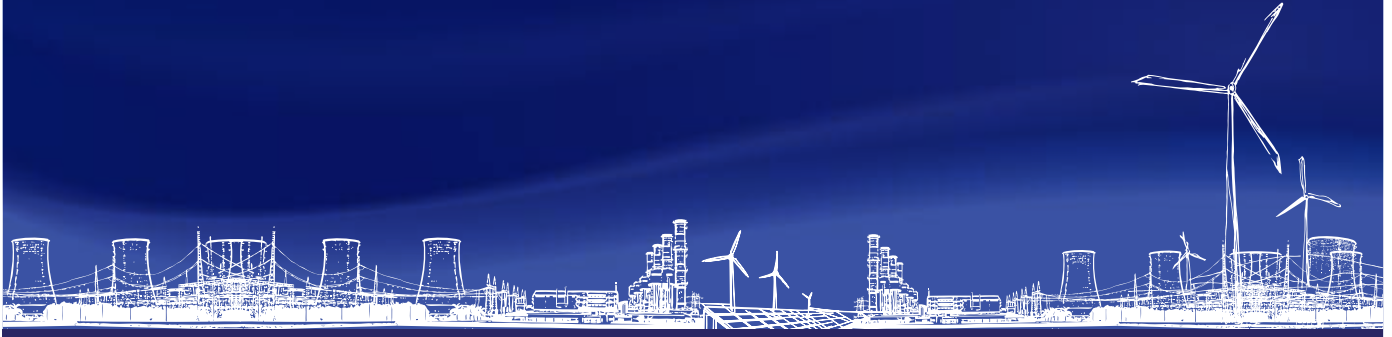
PROGRAMME

9.30 a.m. - 10:00 a.m.	Registration and Networking
10:00 a.m. - 11:12 a.m.	INAUGURAL SESSION
	<ul style="list-style-type: none"> • Welcome Address by Sh. I S Jha – Chairman, T&D Group, IEF and Former Member, CERC • Special Address by <ul style="list-style-type: none"> o Sh. Vimal Kejriwal, Managing Director & CEO, KEC International o Sh. Pratik Agarwal, Chairman, Serentica Renewables & Resonia Ltd and Managing Director - Sterlite Electric Ltd o Sh. Anil Sardana, Managing Director, Adani Energy Solutions Ltd o Sh. Vamsi Ram Mohan Burra - CMD, POWERGRID • Presidential Address by Sh. R V Shahi – President, IEF & Former Secretary (Power) • Key-note Address: Sh. Ghanshyam Prasad – Chairperson, CEA • Inaugural Address by the Chief Guest: Sh. Pankaj Agarwal IAS – Secretary (Power), GoI • Vote of Thanks by Dr Subir Sen – Convenor, T&D Group, IEF
11.12 a.m. - 11.30 a.m.	Tea Break
11.30 a.m - 1.00 p.m.	SESSION I: Planning the Transmission System for Viksit Bharat 2047
	<p>Topics to be covered in the session:</p> <p>Integrated Transmission Planning for High Renewable and Emerging Demand Centers (Focus: Coordinated planning of generation, ISTS and InSTS; RE Zones, hydrogen hubs, industrial corridors and new demand hubs; Transmission Planning under uncertainty)</p> <p>Evolution of the GNA Framework and its Implementation for Transmission Expansion (Focus: Experience with GNA implementation; Access Certainty Vs planning flexibility; Refinements required in the framework)</p> <p>Balancing Transmission Expansion and Asset Utilisation (Focus: Overbuild vs Congestion risk; Planning assets for low utilisation hours; New Technologies; Cost and tariff implications)</p> <p>Distinguished Panellists:</p> <ul style="list-style-type: none"> • Sh. V K Singh – Member (PS), CEA – Chair • Sh. Vamsi Ram Mohan Burra - CMD, POWERGRID • Sh. Samir Saxena, CMD, Grid India • Sh. Pratik Agarwal, Chairman, Serentica Renewables & Resonia Ltd and Managing Director - Sterlite Electric Ltd • Sh. Kailash Kumar Gupta – COO, Central Transmission Utility of India • Sh. Awdhesh Kumar Yadav – Chief (Engg), CERC • Sh. Ashwin Gambhir – PRAYAS: Also Theme Presenter

1.00 p.m. - 2.00 p.m.	Lunch Break
2.00 p.m. - 3.30 p.m.	<p>SESSION II: Delivering the Grid at Scale – Execution, Supply Chain and Technology</p> <p>Topics to be covered in the session:</p> <p>Project Execution Challenges in Transmission Development – TCB and regulated models (Focus: Project delays and risk allocation; Contracting issues; Need for execution reforms)</p> <p>Supply chain and Manufacturing Readiness for India’s Transmission Expansion (Focus: Transformers, GIS, HVDC equipment constraints; Import dependence vs domestic capability; Vendor ecosystem preparedness)</p> <p>Technology Innovation for Faster, Reliable and Flexible Transmission System (Focus: Technology in construction; HVDC and 1100kV/765kV corridors, FACTS, digital substations; Automation and monitoring technologies)</p> <p>Distinguished Panellists</p> <ul style="list-style-type: none"> • Dr D. Sai Baba, Addl. Secretary (Trans), MoP, Gol – Chair • Sh. Naveen Srivastava, Director (Operations), POWERGRID – Also Theme Presenter • Sh. Randeep Narang – Managing Director & CEO, Transrail Lighting Ltd. • Sh. Manish Agrawal, CEO (Conductor & Telecom Businesses), APAR Industries Ltd. and Mg Director, APAR T&D Projects • Sh. Ganesh Srinivasan, President T&D, KEC International Ltd. • Sh. Akilur Rahman, Chief Technology Officer (CTO) - India, Market Innovation Lead - South Asia, Hitachi Energy
3.30 p.m. - 5.00 p.m.	<p>SESSION III: Financing the Transmission Imperative</p> <p>Topics to be covered in the session:</p> <p>Investment Requirements and Financing Challenges for Transmission in Viksit Bharat 2047 (Focus: Capital requirements estimate to build transmission to support-500GW non-fossil based capacity by 2030; Electrification of Transport and industry; Green Hydrogen hubs; Data Centers and new load growth; Risk perception – long pay back periods, utilisation uncertainty, tariff impact on consumers; Financing constraints)</p> <p>Monetisation of Transmission Assets and Role of InVITs (Focus: Asset recycling models; InVIT experience and Opportunities; Investor participation)</p> <p>Debt and Innovative Financing Instruments for transmission expansion (Focus: Debt financing and challenges – Banks lend short-term than asset life, interest rate volatility, perceived regulatory risk; Innovative financing – Green bonds, blended finance, MDB financing; Pension and Sovereign wealth funds; Structuring long-term capital sources)</p>

	<p>Distinguished Panellists:</p> <ul style="list-style-type: none"> • Sh. Jitendra Srivastava IAS, CMD, REC – Chair • Sh. Balawant Joshi, Managing Director, Idam Infrastructure Advisory – Also Theme Presenter • Smt. Mani Khurana – Senior Energy Specialist, World Bank • Sh. Akshay Hiranandani – CEO, Serentica Renewables • Sh. Sushant Kansal, Vice President – Lending and Financing Proojects, NABFID • Sh. Satyan Kumar, Sr. Vice President, Sekura
5.00 p.m. - 5.15 p.m.	<ul style="list-style-type: none"> • Summing Up & Recommendations • Vote of Thanks

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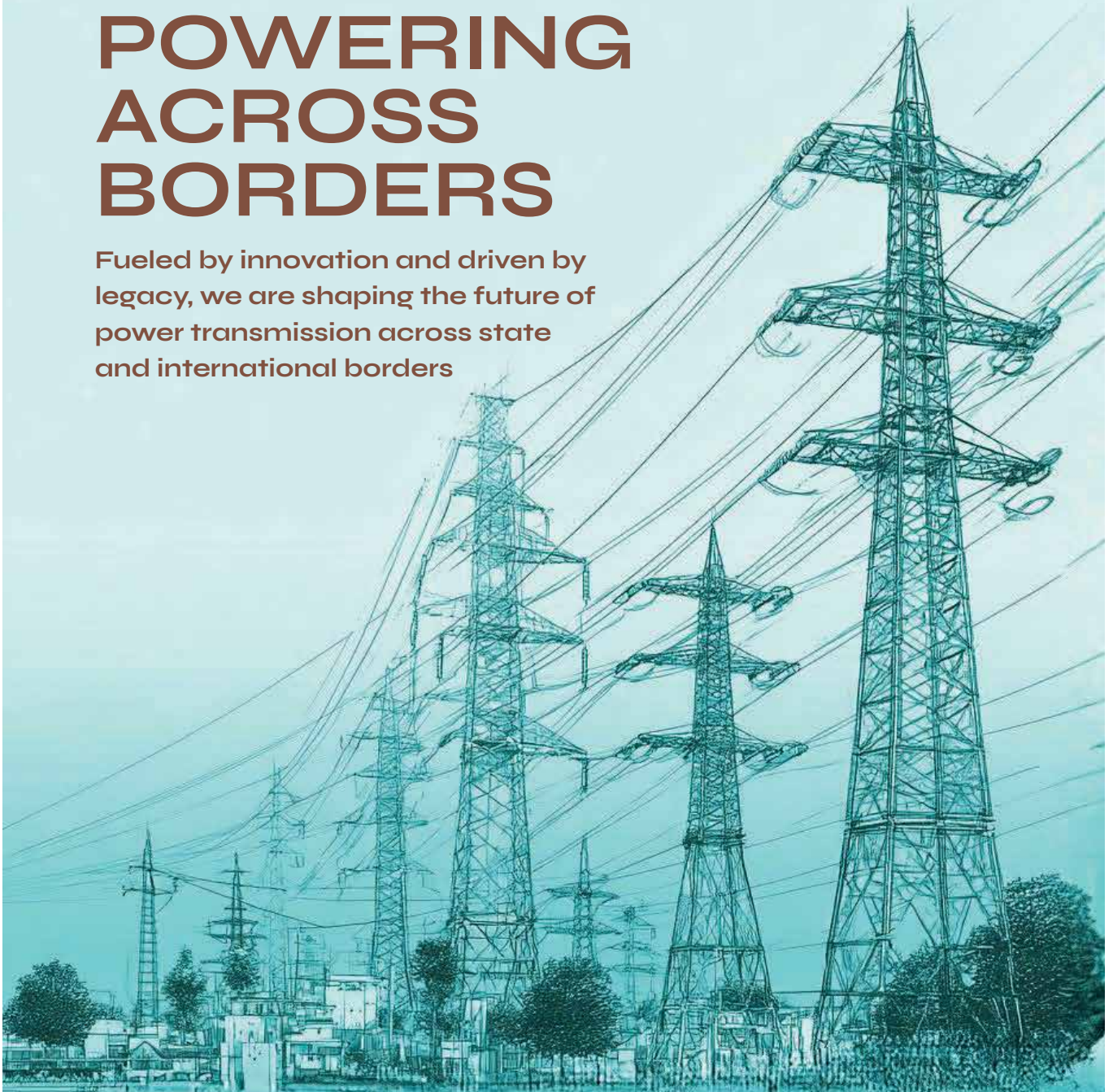
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- Under Development - 104 Km



Theme PAPER

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Executive Summary

India has set a goal of becoming a ‘Viksit Bharat’ by 2047, the centenary year of independence. This transformation will depend heavily on economic growth and continued infrastructure development across the country. Electricity will play an important role in this process, as almost every major sector of the economy depends on a reliable power system. Industries, urban infrastructure, transport systems, digital services, and new-age industries will all require increasing amounts of electricity in the coming decades.

To achieve this vision, India will require a reliable, resilient, and future-ready power system. As per the report published by NITI Aayog, the share of electricity in the overall energy mix is expected to rise from about 22% of final energy consumption at present to nearly 40% by 2047, and further to around 60% by 2070.¹ Electricity consumption is also expected to rise across emerging sectors such as electric mobility, green hydrogen production, data centers, and advanced manufacturing. In line with the growing demand for electricity, the importance of grid infrastructure is also increasing to support this transition.²

Further, India has also set an ambitious target of achieving over 500 GW of non-fossil fuel capacity by 2030. The share of RE capacity (utility + captive) is expected to increase from about 43% in 2025 to around 81-83% by 2050 and around 94-95% by 2070.³ This transition strengthens sustainability and energy security, but it also introduces new challenges arising from the variability, intermittency, and geographical concentration of renewable resources. It is fundamentally altering the way transmission systems are planned, operated, and expanded across the country.

A SNAPSHOT OF POWER SECTOR BY 2050 AND 2070









INDICATORS	2023-24	CURRENT POLICY SCENARIO		NET ZERO SCENARIO	
		2050	2070	2050	2070
 Total Electricity Consumption (TWh)	1541	6,544	9,718	8,070	12,997
 Per-capita Electricity Consumption (kWh)	1,400	~4,800	~7,400	~6,400	~10,000
 Total Capacity (GW) (including captive)	523	2,500-2,800	4,650-4,750	3,800-3,830	6,800-7,350
 VRE (Solar + Wind) Capacity (GW) (including captive)	136	1,890-2,200	4,150-4,200	3,150-3,200	6,150-6,700
 Share of Non-fossil Fuel-Based Generation Capacity (including captive)	40%	81-83%	94-95%	89%	98%
 Grid Emission Factor (kgCO ₂ /kWh)	0.727	0.328	0.067	0.257	0.0
 BESS Capacity (GW)	<0.5	420-520	1,300-1,400	900-1,150	2,500-3,000
 Pumped Hydro Capacity (GW)	3.3	117	131-163	117	150-165
 Total Investment Required (Trillion USD)	—	3.5 (2025-2050)	5.2 (2050-2070)	5.15 (2025-2050)	9 (2050-2070)

Figure 1: Snapshot of Power Sector by 2050 and 2070³

Today, India operates one of the largest synchronous grids in the world. As of January 2026, it has achieved a significant milestone of over 5 lakh ckm of transmission lines and more than

1,400 GVA of transformation capacity.⁴ As per the National Electricity Plan, an additional ~1.91 lakh ckm of transmission lines and ~1,270 GVA of transformation capacity are proposed to be added during 2022–2032, along with about 33 GW of HVDC links.²¹ This would increase inter-regional transfer capacity from 120 GW to nearly 168 GW.⁵ The transmission system is therefore expected to play a much larger role in balancing renewable-rich regions with emerging demand centers across the country.

The Central Electricity Authority has published a report on the transmission planning framework for a high-renewable scenario of around 900 GW installed capacity by 2035–36. The report suggests a total installed capacity of around 1,121 GW by 2035-36, out of which around 786 GW will come from non-fossil fuels.⁴ The report suggests planning the transmission system to evacuate power from over 900 GW of non-fossil capacity by the year 2035-36. The framework recognizes the need to proactively plan transmission systems ahead of renewable generation growth to reduce future evacuation constraints and implementation mismatches.

Further, the power system is witnessing the emergence of new demand centers, such as green hydrogen hubs, data centers, industrial corridors, and electric mobility ecosystems, which are likely to further increase demand variability and system complexity. These developments will significantly alter load patterns and are likely to increase the geographical separation between major generation locations and future demand centers. This will increase the reliance on long-distance bulk power transfer systems and the need for more inter-regional connectivity.

These developments indicate that the future transmission challenge is no longer limited to expanding network capacity alone. The transmission system will increasingly be required to support large-scale renewable evacuation, balance transfers across regions, integrate new demand centers, maintain operational flexibility, and accommodate dynamic power-flow behavior within a significantly more complex electricity system. This report examines these evolving challenges through three broad dimensions: transmission planning for a high-renewable future, execution and delivery of transmission infrastructure at scale, and mobilization of financing required to support long-term grid expansion.

The emerging power system is also exposing an increasing mismatch between the growth of renewable generation and transmission readiness across several regions. Renewable-rich corridors are beginning to experience congestion, curtailment, uneven utilization, and execution pressure as additions to generation, pooling infrastructure, interstate transmission systems, and downstream evacuation networks do not always progress at the same pace. As renewable penetration rises further, transmission systems may increasingly be required to function not only as evacuation infrastructure but also as balancing and system-flexibility platforms that support dynamic and multidirectional power flows across regions.

The future electricity network will be far larger, more interconnected, and more dynamic than the systems planned in the past. This will require planners to move beyond conventional generator-linked planning approaches and adopt more integrated transmission planning methods. Future transmission planning will therefore require a shift from traditional

deterministic approaches to more coordinated, scenario-based planning methodologies that address uncertainty in renewable deployment, demand growth, storage integration, market behavior, and system operation. The implementation of the General Network Access (GNA) framework is also changing how transmission access, utilization, and future corridor planning are viewed. Planning transmission systems independently of generation development may become increasingly difficult under high-renewable operating conditions.

Execution of transmission projects at the required scale remains a major challenge. Issues related to Right-of-Way, land acquisition, forest clearances, coordination among multiple agencies, and delays during project execution continue to affect timelines across many regions. At the same time, the rapid expansion of renewable-linked transmission systems is also increasing pressure on equipment supply chains, contractor availability, manufacturing timelines, and commissioning capability. In several cases, transmission infrastructure and renewable generation systems are also not progressing uniformly, resulting in temporary underutilization of assets in some regions and evacuation constraints in others. Maintaining synchronization between generation addition and transmission readiness is therefore becoming increasingly important.

Technology will also play a key role in shaping the future transmission system. Technologies such as 765 kV AC systems, HVDC corridors, FACTS devices, digital substations, and advanced monitoring systems are expected to play an important role in improving transfer capability, operational flexibility, and grid reliability. In addition, increasing digitalization, particularly in areas such as real-time monitoring, forecasting, and automation, will be essential to manage the operational complexity of a high-renewable power system. The role of technology is also expanding beyond simple capacity augmentation towards improving controllability, operational visibility, congestion management, and corridor utilization under increasingly dynamic system conditions.

Financing the scale of planned transmission expansion will also remain a critical challenge. CEA estimates an investment of around ₹9.15 lakh crore in the transmission sector until 2032.²¹ Transmission assets are generally well-suited for long-term investment due to their stable, regulated returns; however, the sector continues to face risks related to limited availability of long-term financing, evolving regulatory frameworks, and uncertainties around asset utilization. Private sector participation in the sector has increased steadily through the Tariff-Based Competitive Bidding (TBCB) route. However, further expansion will require stronger support from capital markets and greater use of financing instruments such as Infrastructure Investment Trusts (InvITs), green bonds, and blended finance models. Greater participation by long-term institutional investors will also be important for mobilizing large-scale investment in the sector.

This report focuses on three key thematic areas: planning the transmission system for Viksit Bharat 2047, delivering the grid at scale through execution, supply chain, and technology, and financing the transmission imperative. Together, these themes reflect the key areas that are likely to shape the next phase of India's transmission development as the country moves towards building a larger, more flexible, and future-ready grid.

1 Evolution of India's Power System and Transmission Sector

This chapter examines the evolution of India's power system and transmission sector. It discusses network expansion, technology development, changing planning approaches, and emerging system requirements.

1.1 Introduction

India's power sector has changed substantially over the past few decades. In the early years, the country operated through fragmented and largely isolated regional power systems. Over time, these systems became increasingly interconnected, leading to the development of one of the world's largest synchronous electricity grids. This transformation has gone beyond capacity addition alone. It has also changed the way the grid is planned, operated, and managed, with major improvements in transmission infrastructure, system operations, technology adoption, and electricity market development.

The transmission sector has played a central role in this transition. Initially, transmission networks mainly connected nearby generating stations with local demand centers. However, rising electricity demand and growing interconnection between regional grids have gradually expanded the role of the transmission system. Today, the transmission network supports large-scale power transfer across regions, facilitates electricity market operations, and enables the integration of renewable energy at the national level.

Today, India operates a transmission network exceeding 5 lakh circuit kilometers, with more than 1,400 GVA of transformation capacity and inter-regional transfer capability exceeding 120 GW.⁴ The system has evolved into a highly interconnected national grid capable of supporting large-scale movement of electricity across regions.

At the same time, India's power system is undergoing a major transition. Renewable energy is expected to account for most of the future capacity addition, while new sources of electricity demand are emerging across the country. Data centers, green hydrogen projects, industrial corridors, and electric mobility infrastructure are creating new demand clusters and reshaping the grid's overall demand profile. As a result, the transmission system is becoming more important than ever for moving electricity across regions and maintaining grid reliability.

Renewable energy also presents a different set of operational challenges than conventional thermal generation. Solar and wind resources are concentrated in specific regions, and their generation varies with weather conditions, seasons, and time of day. States such as Rajasthan, Gujarat, Karnataka, and Tamil Nadu are emerging as major renewable energy hubs, whereas a large share of future electricity demand is expected to come from industrial and urban centers located across other parts of the country.

The increasing distance between generation centers and demand centers is making the grid more dependent on interstate transmission corridors and coordinated system operation. As a result, the transmission network is no longer functioning only as an evacuation system. It now

supports power balancing across regions, renewable energy integration, and reliable grid operation under changing demand and generation conditions.

1.2 Growth of India's Electricity Sector

India's electricity sector evolved from isolated state-level systems to a nationally integrated grid. Following the Electricity (Supply) Act, 1948, State Electricity Boards (SEBs) were established to manage power systems within states, while growing demand later drove the expansion of interstate transmission and regional grid integration. Over time, institutions such as POWERGRID and RLDCs, along with technologies like HVDC and mechanisms such as ABT, strengthened grid operations. A major milestone was achieved in 2013 with the synchronization of all regional grids into a single national grid. The **Figure 2** below illustrates the evolution of India's electricity sector from isolated state-level systems to a nationally integrated grid over the years.



Figure 2: Key Milestones in the Evolution of India's Power Sector

India’s power sector has expanded rapidly over the last two decades, driven by economic growth, urbanization, industrialization, and electrification. Installed generation capacity increased from about 105 GW in 2000 to over 524 GW by 2025–26, while peak demand rose from below 100 GW to nearly 270 GW. Despite this growth, India’s per capita electricity consumption remains well below global averages, indicating significant potential for future demand growth.⁶



Figure 3: Growth of India’s Power Sector^{6,7}

Notwithstanding the above sectoral growth, India’s per capita electricity consumption still remains significantly below global averages and substantially lower than that of developed economies. This indicates considerable headroom for future growth in electricity demand as India moves towards becoming a developed economy.

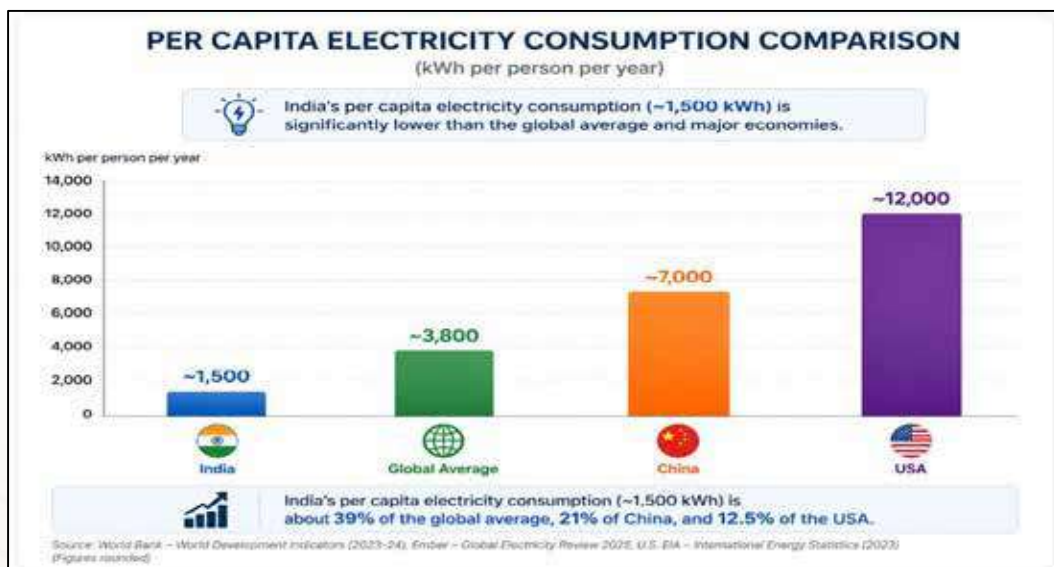


Figure 4: Per Capita Electricity Consumption Comparison⁹

1.3 India's Generation Mix and Transmission Infrastructure

India's generation mix has shifted significantly over the past decade, with renewable energy becoming the dominant source of new capacity addition. Coal's share in installed capacity declined from nearly 61% in 2015–16 to about 41.3% by April 2026, while solar capacity increased from around 7 GW to more than 143 GW. The concentration of renewable projects in resource-rich states such as Rajasthan and Gujarat, far from major demand centers, has increased the need for interstate balancing capability and long-distance transmission infrastructure.

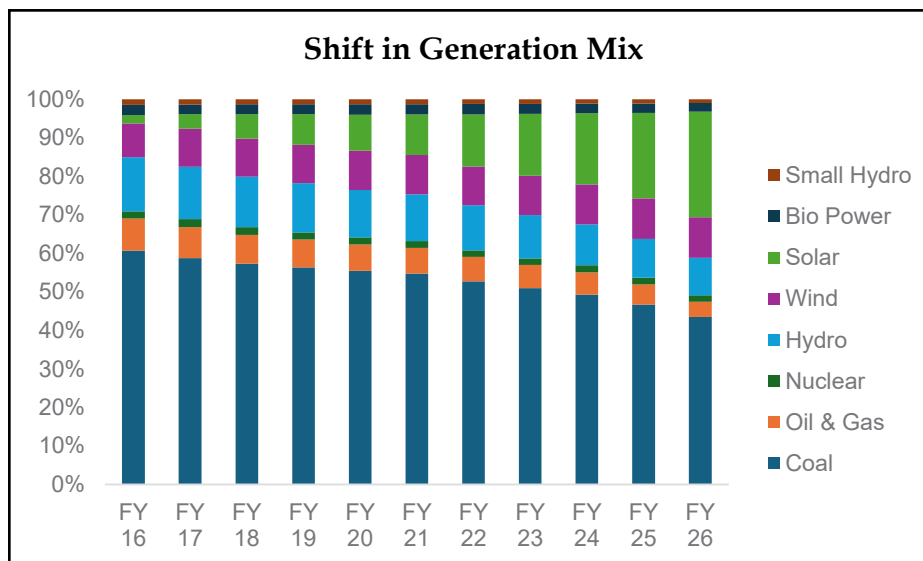


Figure 5: Shift in Installed Capacity Mix (2015–26)

RENEWABLE STRENGTHS AND SYSTEM IMPLICATIONS		
STATE	RENEWABLE CHARACTERISTICS	SYSTEM IMPLICATION
Rajasthan	Large-scale solar and hybrid projects	High interstate export dependency
Gujarat	Solar, hybrid and green hydrogen ecosystem	Bulk transfer requirement
Tamil Nadu	Wind-dominated renewable generation	Seasonal transfer variability
Karnataka	Diversified solar-wind mix	Increasing balancing requirement

Figure 6: Geographic Concentration of Renewable Energy Development

The renewable energy transition is therefore not only changing the generation mix but also increasing the power system's dependence on interstate balancing capability and high-capacity transmission corridors.

The renewable energy transition has substantially increased the transmission intensity of India's power system, as renewable-heavy systems require more transmission infrastructure than conventional thermal-based systems. Growing integration of renewables, dynamic power flows, and market-based operations are making transmission planning more complex and increasingly dependent on flexible, scenario-based approaches.

Transformation capacity increased from around 270 GVA in 2002 to more than 1,400 GVA by 2026.¹⁰ According to CEA projections, India will require an additional transmission network expansion of nearly 1.91 lakh ckm in line length and about 1270 GVA of transformation capacity by 2032. Inter-regional transfer capability increased from around 9 GW in 2002 to more than 120 GW by 2025–26 and is planned to increase further to around 168 GW by 2031–32.^{11,21}



Figure 7: Growth of Transmission Infrastructure¹¹

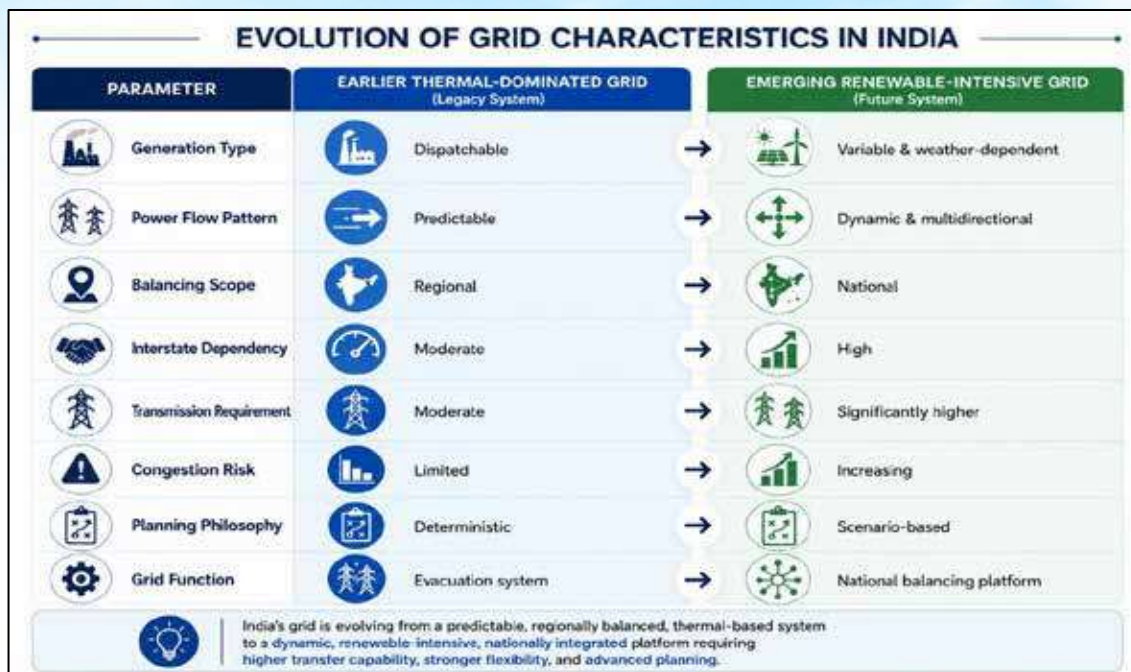


Figure 8: Evolution of Grid Characteristics in India

As discussed earlier, India’s transmission infrastructure has evolved significantly from low-voltage state-level systems to a high-capacity national transmission network. Over the years, the sector adopted higher-voltage systems such as 220 kV, 400 kV, 765 kV, and HVDC technologies to support long-distance bulk power transfer and interstate connectivity. As a result, the total transmission line length increased from around 52,000 ckm in 1985 to nearly 4.86 lakh ckm by 2024, strengthening the national grid and enabling large-scale integration of renewable energy.

Over the next decade, the sector focused more on high-capacity long-distance transmission systems. India commissioned the 1200 kV UHVAC national test station in 2012 and introduced the first ±800 kV UHVDC system in 2017. These developments supported larger power transfers across regions and helped strengthen the national grid.¹²

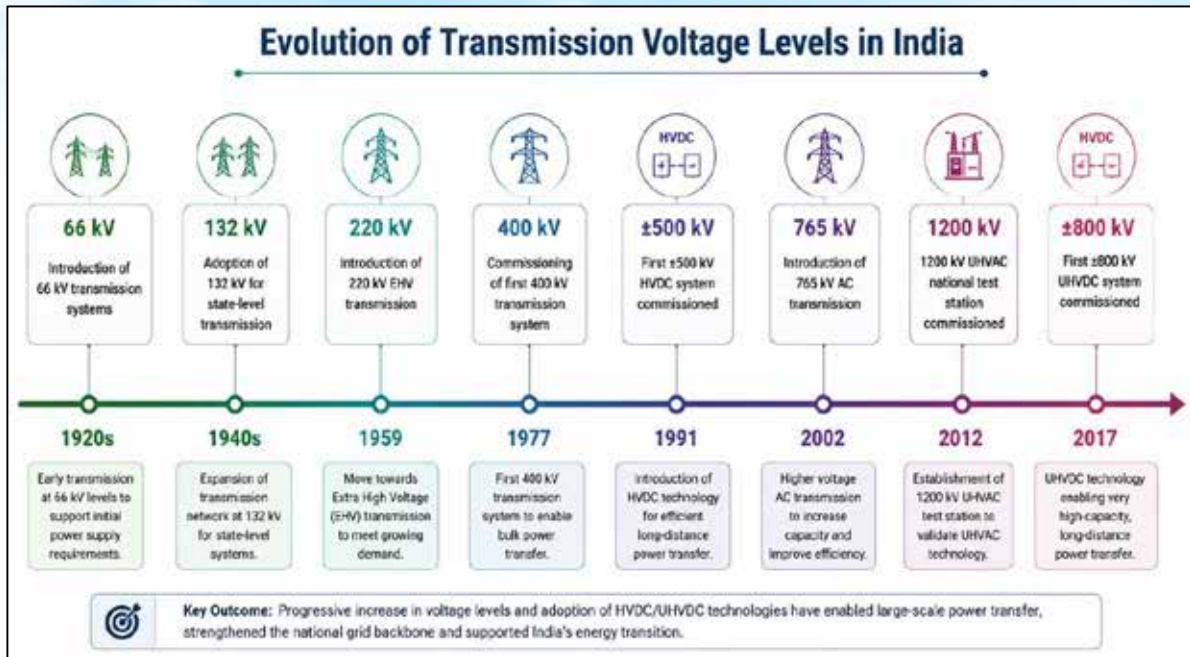


Figure 9: Evolution of Transmission Voltage Levels in India

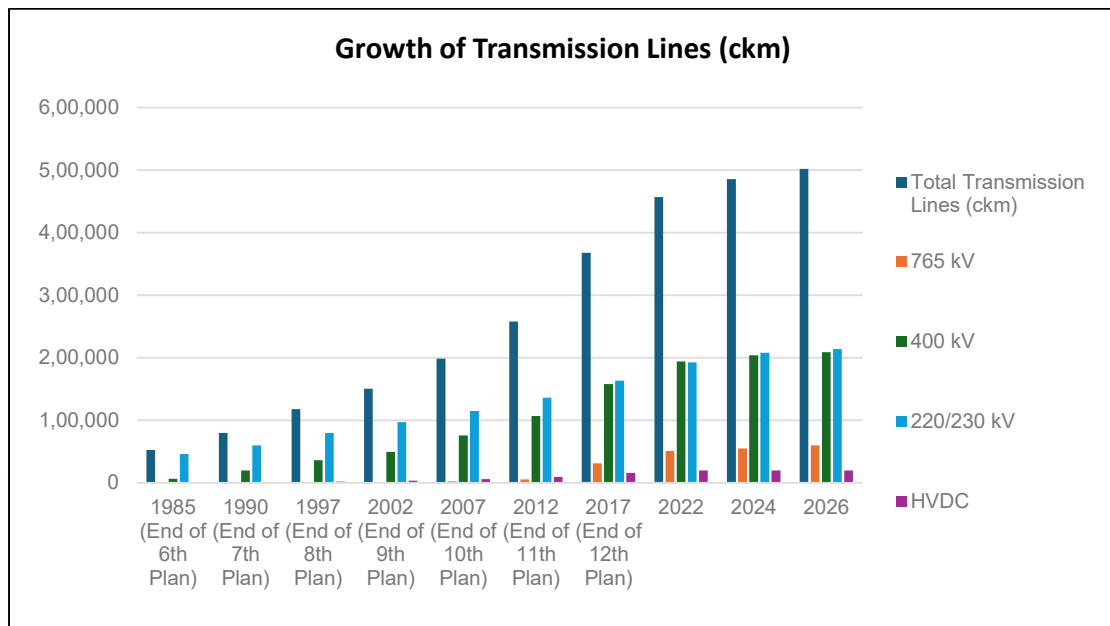


Figure 10: Growth of Transmission Lines (ckm) in India¹³

1.4 National Grid and Transmission Planning

India's power system has evolved from independently operated regional grids into a fully interconnected national grid, significantly improving interstate power transfer, grid reliability, and national-level balancing. The gradual strengthening of interstate transmission corridors enabled the synchronization of all regional grids, with the final milestone achieved in 2013 when the Southern Grid was integrated with the national grid.

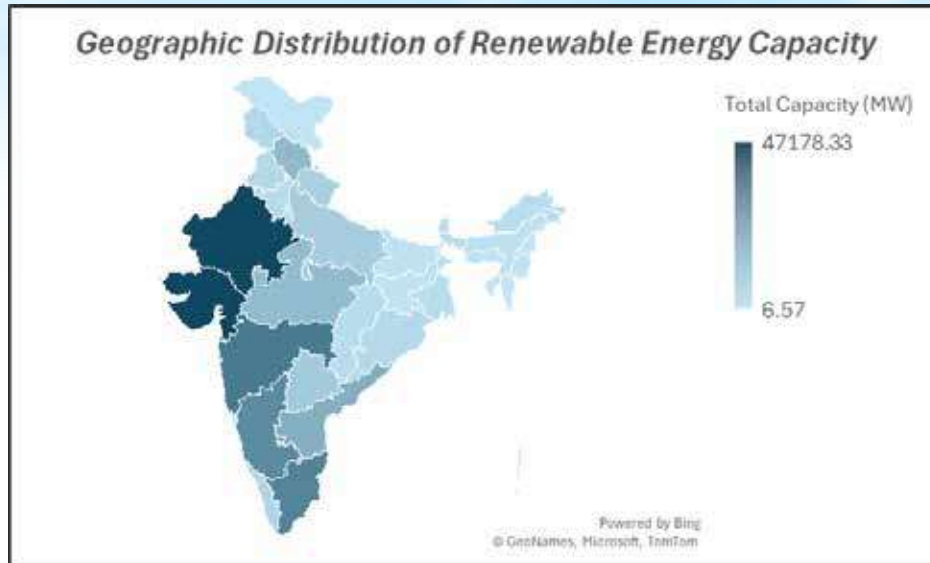


Figure 11: Geographic Distribution of Renewable Energy Capacity¹⁵

At the same time, transmission planning has shifted from a generation-linked approach to a more integrated and network-centric framework, driven by the rapid growth of renewable energy, market-based power flows, and the implementation of the General Network Access (GNA) regime. The increasing dependence on Renewable Energy Zones (REZs), Green Energy Corridors (GECs), high-capacity interstate corridors, and HVDC systems is making future transmission planning more dynamic, flexible, and scenario-based to support large-scale renewable integration and evolving grid requirements.

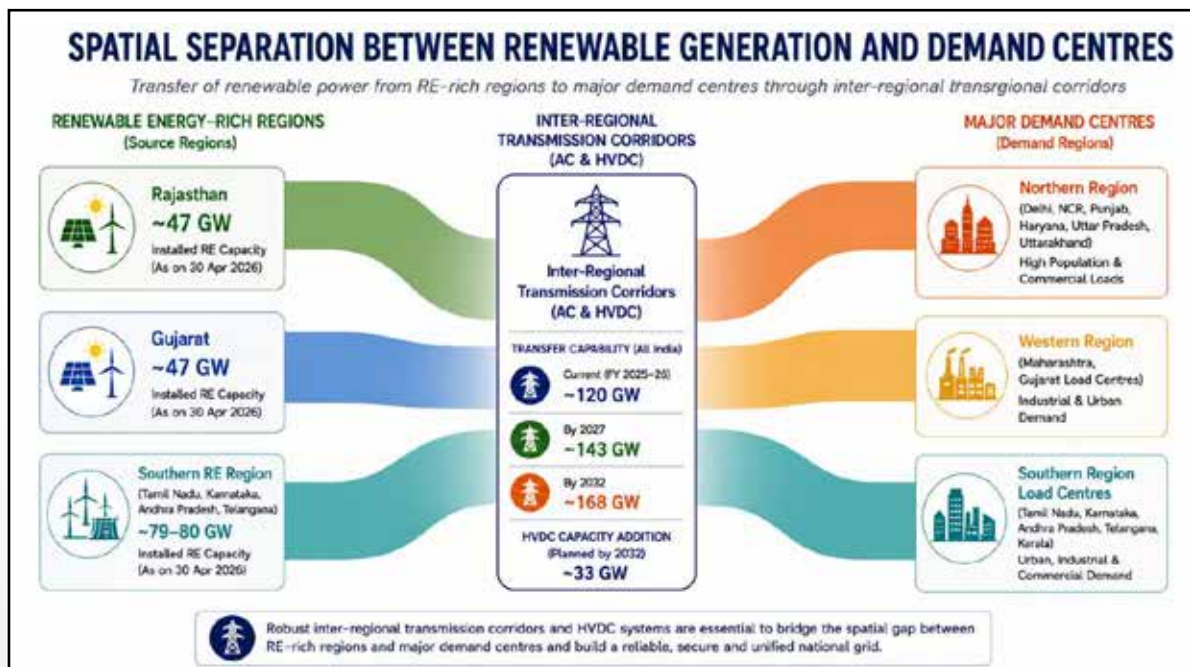


Figure 12: Spatial Separation Between Renewable Generation and Demand Centers

India's power sector is therefore entering a phase where transmission infrastructure will play a central role in enabling reliable, flexible, and renewable-intensive grid operations.

Strengthening the national grid and adopting adaptive transmission planning approaches will be critical to supporting India’s long-term energy transition and economic growth objectives.

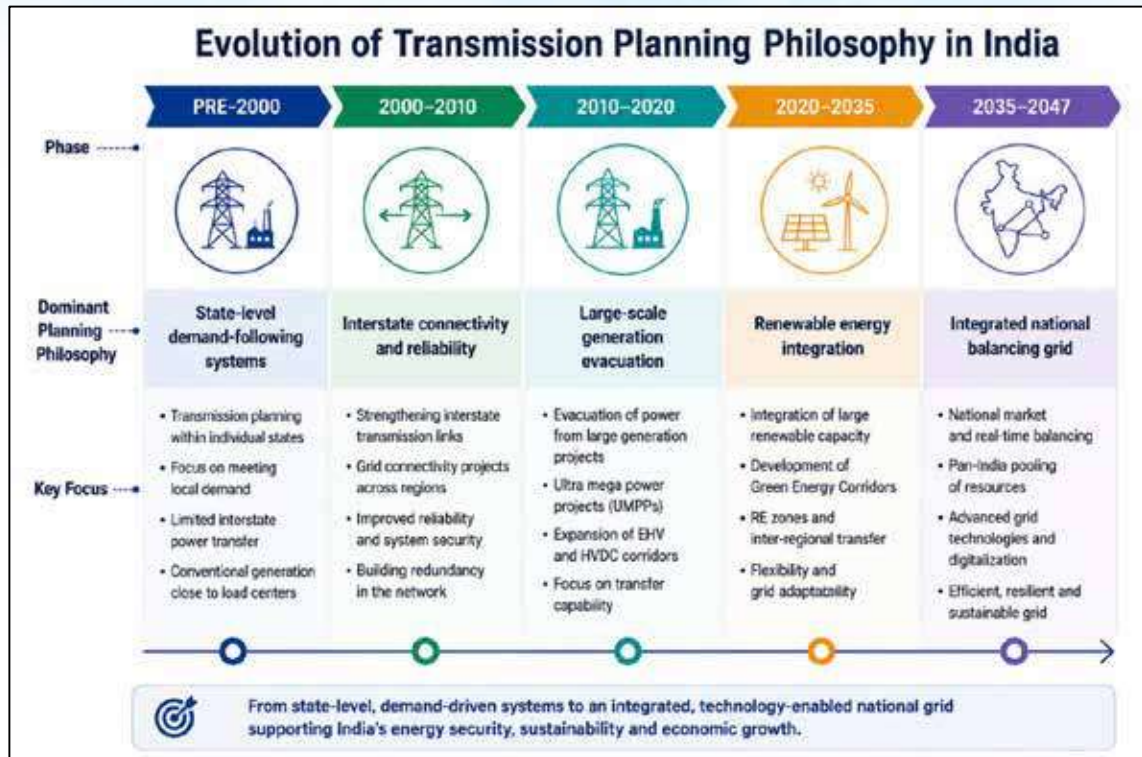


Figure 13: Evolution of Transmission Planning Philosophy in India

1.5 Emerging Structural Changes in the Grid

The Indian power system is now entering a new phase characterized by increasing operational complexity and structural transformation.

Several simultaneous transitions are taking place across the sector:

- Rapid renewable energy expansion
- Electrification of transport and industry
- Emergence of green hydrogen production
- Expansion of electricity markets
- Growth of digital infrastructure and data centers
- Increasing interregional dependency
- Greater digitalization of grid operations

These changing grid conditions are also increasing the importance of technologies such as HVDC systems, FACTS devices, PMUs, WAMS, dynamic line rating, digital substations, and advanced forecasting tools.

1.6 Key Takeaways

India’s power system has undergone a major structural transformation over the past several decades. The country has evolved from fragmented regional systems into one of the world’s

largest synchronous national grids supported by more than 5 lakh ckm of transmission network and over 120 GW of interregional transfer capability.

At the same time, the rapid expansion of renewable energy is fundamentally changing the nature of power flows, grid operation, and transmission planning requirements. Renewable-heavy systems require significantly greater transmission intensity, operational flexibility, and balancing capability compared to conventional thermal-dominated systems.

The future transmission system will therefore need support:

- Large-scale renewable integration
- Long-distance bulk power transfer
- National balancing capability
- Dynamic market-driven power flows
- Emerging industrial and digital demand centers
- Increasing operational uncertainty

As a result, the role of transmission infrastructure is expanding beyond conventional power evacuation. It is increasingly becoming the backbone of the national grid, supporting power balancing, renewable energy integration, and India's long-term energy transition.

This transition forms the foundation for understanding the future power system requirements and transmission planning challenges associated with Viksit Bharat 2047.

2 Power System for Viksit Bharat 2047

India's goal of becoming a developed economy by 2047 will bring major changes to the country's power system. Electricity demand is expected to rise sharply as industries expand, cities grow, transport systems electrify, and new sectors such as green hydrogen and data centers develop at scale.

Meeting this demand will require far more than adding generation capacity alone. The future power system will be larger, more interconnected, and increasingly dependent on renewable energy. This will also increase the importance of a strong and flexible transmission network capable of supporting long-distance power transfer, grid balancing, and reliable system operation across regions.

The scale of this transition will be unprecedented in the Indian context and will require corresponding transformation in planning frameworks, execution capability, financing structures, and technology deployment.

As India progresses towards the vision of Viksit Bharat 2047, the future power system is expected to become significantly larger, more renewable-intensive, and increasingly dependent on high-capacity transmission infrastructure. Consequently, future transmission planning will play a critical role in enabling large-scale integration of renewables, interstate balancing, and a reliable power supply for emerging industrial and urban demand centers.

2.1 Demand Growth and Electrification Trends

India's electricity demand is projected to grow significantly over the coming decades. According to the 20th Electric Power Survey (EPS), peak demand may reach around 366 GW by 2031–32, with energy requirement rising to nearly 2,473 BU, and potentially 700–800 GW by 2047 as India advances toward a developed economy.

Future demand growth is expected to differ from historical trends, becoming increasingly concentrated around industrial corridors, urban clusters, data centers, semiconductor facilities, EV charging networks, and green hydrogen hubs. Emerging clusters in Chennai, Mumbai, Noida, Gujarat, and Odisha are already shaping transmission planning requirements due to their high-density and power-intensive nature.

India's per capita electricity consumption, at around 1,500 kWh, also remains well below the global average and levels seen in developed economies.




INDIA POWER SECTOR – KEY PARAMETERS			
Rising demand, capacity and clean energy deployment towards 2047			
PARAMETER	2026 (Latest Estimates)	2032 (Projected)	2047 (Long-term)
 Peak Demand (GW)	~270 GW Peak electricity demand	~366 GW Peak electricity demand	~700–800 GW Peak electricity demand
 Energy Requirement (BU)	~1,800 BU Total electricity requirement	~2,473 BU Total electricity requirement	~4,500–5,500 BU Total electricity requirement
 Installed Capacity (GW)	~524 GW Total installed generation capacity	~900 GW Total installed generation capacity	~1,800–2,200 GW Total installed generation capacity
 RE Capacity (GW)	~280 GW Renewable Energy capacity	~600 GW Renewable Energy capacity	~1,200–1,500 GW Renewable Energy capacity
 India is on a strong growth trajectory towards 2047, with significant rise in electricity demand, capacity addition and renewable energy integration driving a sustainable energy future.			

Figure 14: Indicative Power Sector Outlook till 2047¹⁶

2.2 Renewable Energy Transition and Grid Transformation

The energy transition in India is likely to transform the power sector, given that the country aims to achieve more than 500 GW of non-fossil fuel capacity by 2030, with renewable energy as the main source of future capacity additions. The transformation in the sector is likely to increase the geographical distance between generation and consumption centers, thus increasing dependence on inter-state power corridors, inter-regional balancing, and large-scale power transfer facilities.

According to CEA high-renewable scenarios, the transmission network will be required to manage renewable-rich systems with over 900 GW capacity by 2035-36,⁴ calling for more interstate connectivity, large-scale HVDC corridors, renewable evacuation facilities, and flexible balancing solutions.

Renewable-rich power systems are also likely to pose operational challenges, including curtailment of renewables, seasonal variations in power transfer, corridor congestion, and increased balancing needs. In such circumstances, the transmission networks of the future will have to facilitate both renewable evacuation and flexible power flow.

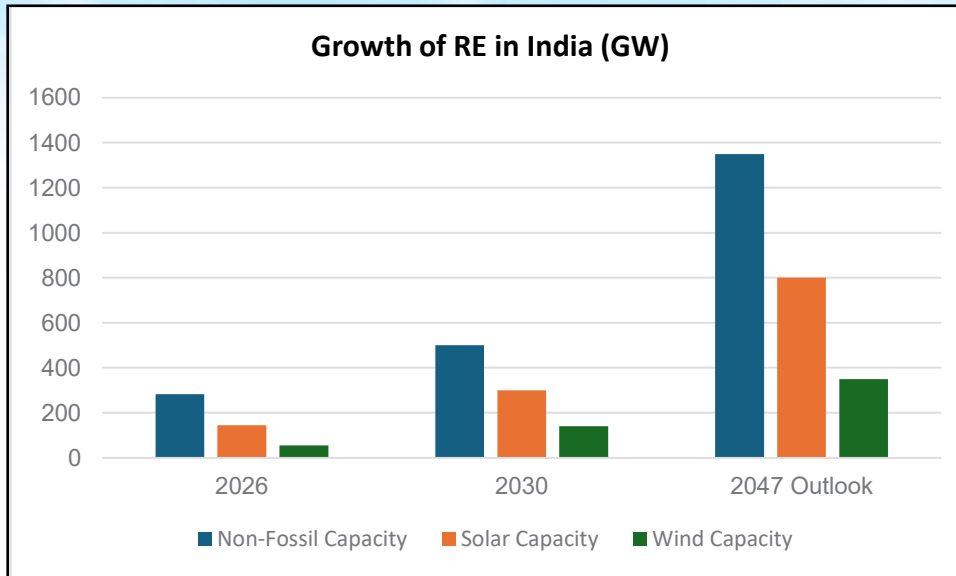


Figure 15: Growth of Renewable Energy Capacity in India (2047 Outlook)¹⁶

2.3 Expansion of Transmission Infrastructure

The transmission expansion required to support India's future power system is expected to be unprecedented. The National Electricity Plan (Transmission) proposes adding nearly 1.91 lakh ckm of transmission lines, 1,270 GVA of transformation capacity, and around 33 GW of HVDC systems between 2022 and 2032, with requirements expected to rise further beyond 2032 due to growing electricity demand and renewable penetration.

Unlike the historical incremental approach, renewable-heavy systems require significantly higher transmission intensity because renewable resources are often located far from demand centers. This is expected to increase interstate dependency, long-distance bulk power transfer, and the need for greater grid flexibility and controllability. HVDC systems are increasingly emerging as strategic balancing infrastructure for controlling long-distance transfer of renewable power across regions.

Future transmission architecture is expected to include large-scale HVDC overlay networks, renewable energy corridors, green hydrogen and offshore wind integration systems, digitally enabled substations, and high-capacity national balancing corridors

The future transmission system is expected to include:

- Large-scale HVDC overlay systems
- Renewable energy superhighways
- Green hydrogen evacuation corridors
- Offshore wind integration systems
- Digitally enabled substations
- High-capacity national balancing corridors

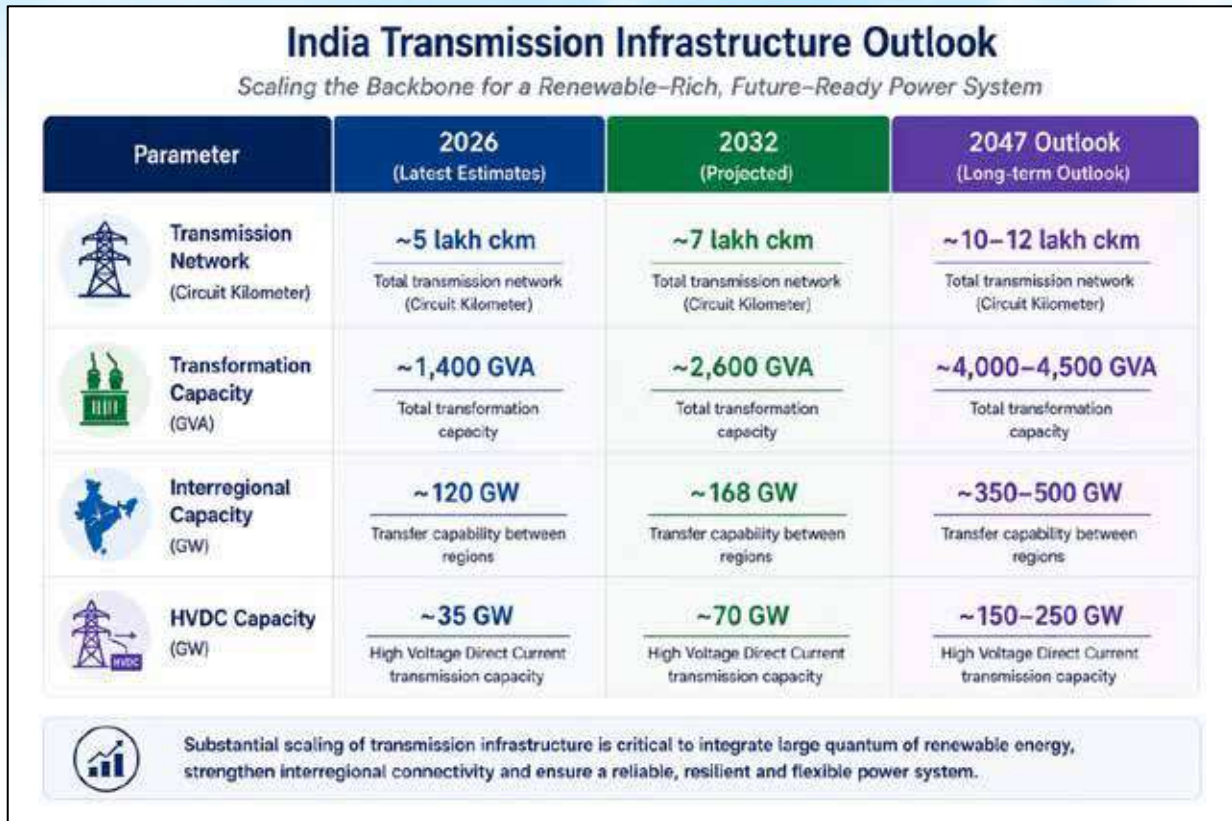


Figure 16: Future Expansion of Transmission Infrastructure^{11,14,16}

2.4 Emerging Demand Centers and Transmission Implications

Future electricity demand growth is expected to become increasingly concentrated around emerging industrial and digital ecosystems.

Several emerging demand centers are likely to influence transmission planning in the coming decades. These include green hydrogen projects in states such as Gujarat and Odisha; large data center clusters around Mumbai, Hyderabad, Chennai, and Noida; semiconductor and electronics manufacturing facilities; industrial corridors; electric vehicle charging infrastructure; and metro and rail electrification systems. Many of these loads are expected to be large, concentrated, and highly power-intensive, creating new requirements for transmission connectivity, reliability, and system flexibility.

Unlike conventional demand growth, these emerging sectors are expected to create highly concentrated, energy-intensive load clusters that require a reliable, high-capacity power supply.

Green hydrogen production alone could create substantial electricity demand. Indicatively, large-scale green hydrogen production is expected to create substantial electricity demand concentrated around renewable-rich industrial regions. Similarly, the rapid expansion of data center infrastructure is creating new clusters of high-quality and reliable power demand around major urban and industrial centers

The growth of electric mobility is also expected to significantly influence future load patterns, particularly in urban areas. Increasing electrification of transport systems may create new

peak demand centers and require strengthening of both interstate and intrastate transmission systems.

These emerging demand centers are likely to change the way transmission systems are planned in the future. Large industrial facilities, data centers, and electrified transport systems will require reliable access to a high-capacity power supply. In many regions, the grid will also need to handle both renewable energy integration and rising electricity demand simultaneously. This will increase the need for flexible interstate power transfer, stronger system reliability, and transmission planning that can respond to changing regional demand patterns.

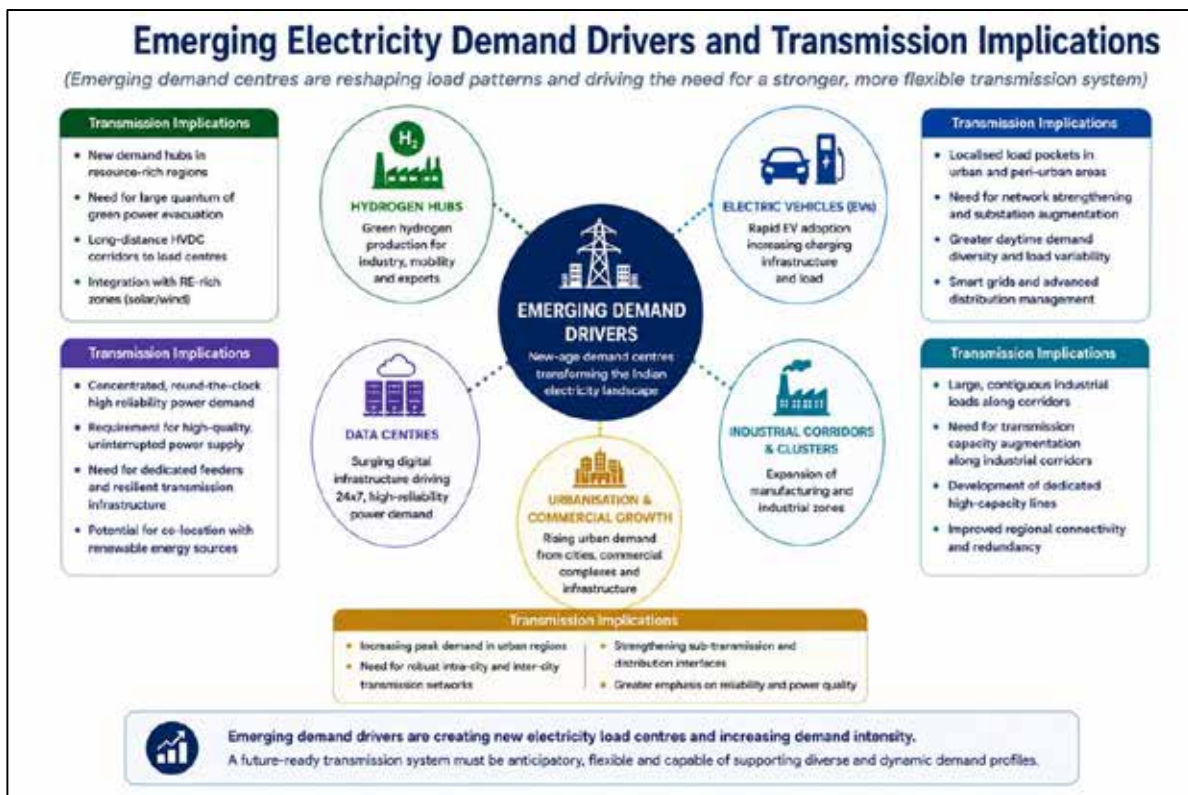


Figure 17: Emerging Electricity Demand Drivers and Transmission Implications

2.5 Technology and Digitalization

The future transmission system will require significantly greater operational flexibility, controllability, and digital visibility.

Today, with the rising integration of renewable energy, grid operators also require better real-time monitoring, faster control systems, and greater operational flexibility.

As power flows become increasingly dynamic, technologies such as HVDC systems, FACTS devices, digital substations, PMUs, Wide Area Measurement Systems (WAMS), dynamic line rating systems, and AI-assisted forecasting tools are expected to play a much larger role in future grid operations.

The growing complexity of grid operation is also expected to increase reliance on digital forecasting and advanced analytics tools. Renewable-heavy systems require faster operational

decision-making, real-time balancing capability, and improved forecasting accuracy for both generation and demand.

Technology, therefore, becomes an integral part of future transmission planning rather than merely an operational enhancement. Technology adoption is increasingly being driven not merely by capacity augmentation requirements, but also by the need to improve controllability, congestion management, operational visibility, and corridor utilization under renewable-heavy operating conditions.

2.6 Investment Requirement for Viksit Bharat 2047

The scale of infrastructure expansion required over the next two decades will require unprecedented levels of investment across the transmission sector.

As per the National Electricity Plan (Transmission), transmission investment requirement till 2032 is estimated at approximately ₹9.15 lakh crore.²¹ However, infrastructure required for supporting Viksit Bharat 2047 is expected to require significantly larger cumulative investment.

Future investment requirements will not be limited to conventional transmission line expansion alone. Substantial investment will also be required in:

- HVDC systems
- Renewable evacuation corridors
- Digital substations
- Grid automation
- Smart monitoring systems
- Dynamic grid management technologies
- Offshore wind integration infrastructure

The increasing scale of renewable integration is also expected to increase transmission intensity within the power system. Renewable-heavy systems generally require significantly larger transmission infrastructure relative to installed capacity because generation is geographically concentrated while demand remains distributed across the country.

Financing such large-scale infrastructure expansion will require substantial participation from both public and private sectors. Private sector participation through Tariff-Based Competitive Bidding (TBCB) has already increased significantly over the past decade. However, future transmission expansion is expected to require substantially larger pools of long-tenure capital capable of supporting infrastructure with long asset lives and evolving utilization patterns.

Future financing frameworks are expected to increasingly depend on:

- Tariff-Based Competitive Bidding (TBCB)
- Infrastructure Investment Trusts (InvITs)
- Green bonds
- Sovereign and pension funds
- Multilateral financing
- Blended finance structures

Transmission infrastructure is therefore emerging not only as a technical requirement, but also as one of the largest long-term infrastructure investment themes associated with India's energy transition.

2.7 Key Takeaways

India's future power system will be defined not only by scale, but also by increasing variability, flexibility requirements, and geographical complexity of generation and demand.

Over the coming decades, the transmission network is expected to play a much larger role in the power system. Rising electricity demand, growth in renewable energy, new industrial and digital load centers, and increasing power transfer across regions will drive the need for stronger, more flexible transmission infrastructure.

The future transmission system will therefore need to be:

- Larger in scale
- More interconnected
- More flexible
- More digitally enabled
- More resilient
- More transfer-intensive

Transmission infrastructure will increasingly emerge as the central enabling platform for renewable integration, national balancing capability, industrial electrification, market integration, and long-term economic growth. At the same time, meeting India's long-term transmission expansion requirements will require unprecedented levels of capital investment, innovative financing structures, and sustained public-private participation to support the scale and pace of network development envisioned over the coming decades.

The next chapter examines how transmission planning philosophy and planning frameworks must evolve to support this transition towards Viksit Bharat 2047.

3 Planning the Transmission System for Viksit Bharat 2047

India's transmission sector is entering a much more complex phase of development. Large-scale renewable energy development across a few Renewable Energy Zones (REZs), rising interstate power transfers, growth in market-based scheduling, and changing power flow patterns are reshaping the way transmission systems are planned and operated.

Despite the large-scale transmission expansion, several operational indicators of stress are already becoming visible across the grid:

- Congestion during simultaneous renewable injection periods
- Renewable curtailment during high generation windows
- Evacuation bottlenecks in renewable-rich regions and
- Growing uncertainty regarding long-term utilization behavior of transmission infrastructure.

These developments indicate that future transmission planning challenges are increasingly linked to coordination between generation growth, evacuation readiness, balancing capability, storage deployment, and operational planning across regions.

3.1 Integrated Transmission Planning

3.1.1 Coordinated Planning of Generation, ISTS, and InSTS

One of the most significant structural challenges emerging in India's renewable transition is the growing mismatch between the expansion of renewable generation and the readiness of transmission infrastructure.

Under conventional thermal-based systems, transmission development generally followed generation expansion. This approach remained manageable because thermal projects took longer to develop, plant locations were known well in advance, and grid power flows did not change sharply under normal operating conditions.

The situation today is quite different. Renewable energy projects are being developed and commissioned much faster than conventional power plants. At the same time, transmission projects continue to require longer implementation periods because of right-of-way issues, forest clearances, land acquisition challenges, pooling infrastructure requirements, and coordination across multiple agencies.

The challenge is already becoming visible across several renewable evacuation systems where generation development, intrastate evacuation infrastructure, and interstate transmission systems are not progressing uniformly. In certain cases, downstream InSTS readiness and pooling substations remain under development even after upstream ISTS corridors are available, limiting effective utilization of transmission infrastructure. Conversely, delays in commissioning renewable projects have also left evacuation systems underutilized for extended periods.

These conditions are increasingly creating situations in which transmission systems and renewable generation projects are not always progressing in tandem. In some cases, transmission infrastructure becomes available ahead of generation commissioning, while in others, renewable projects face delays due to evacuation constraints. Such sequencing mismatches pose an important planning and investment challenge in renewable-intensive systems.

As a result, generation projects, pooling infrastructure, interstate transmission systems, balancing resources, and intrastate evacuation networks may increasingly need to be planned in parallel rather than through sequential development approaches.



Figure 18: Generation-Transmission Coordination Challenges

3.1.2 Planning for Renewable Energy Zones (REZs)

The emergence of large Renewable Energy Zones is fundamentally changing the spatial characteristics of India’s power system.

Historically, conventional generation capacity was relatively dispersed across regions and often located closer to fuel sources or demand centers. Renewable generation development, however, is increasingly concentrated within high-resource regions such as western Rajasthan, Gujarat, and parts of southern India.

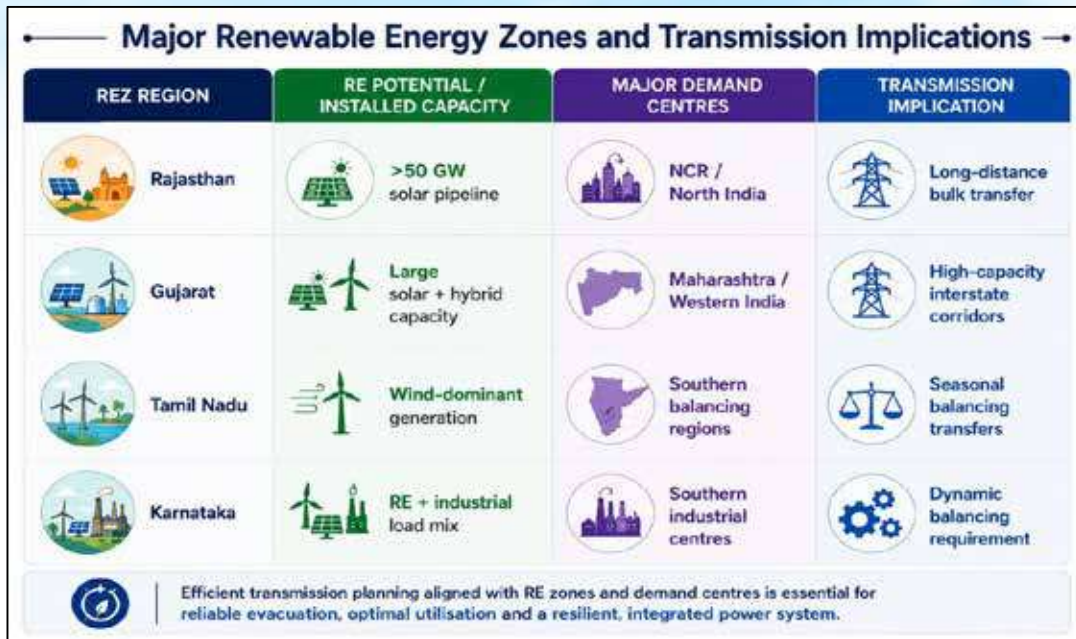


Figure 19: Major Renewable Energy Zones and Transmission Implications

With renewable energy capacity increasingly concentrated in a few regions, several interstate corridors are experiencing much higher variability in power flows during periods of high renewable generation.

Similarly, wind-rich regions continue to exhibit strong seasonal variability in transfer behavior depending on wind conditions.

As renewable energy capacity increases, some interstate corridors and HVDC links are expected to play a much larger role in balancing the national grid. Their importance will go beyond the evacuation of power from renewable energy zones. Any congestion, delay in augmentation, or outage on these corridors could affect power flows and renewable integration across multiple regions.













As a result, certain interstate transmission corridors are gradually evolving beyond conventional evacuation infrastructure and increasingly functioning as strategic national balancing corridors within the power system. Their operational importance is expected to increase further as renewable penetration and interstate balancing requirements continue to grow.

Certain corridors may experience heavy loading during daytime solar generation hours, but much lower utilization during evening demand periods. Wind generation can also change transfer patterns across regions during different seasons.

REZ planning, therefore, increasingly requires assessment not only of evacuation infrastructure near generation sites, but also of wider network behavior under varying renewable generation and balancing conditions across regions.

3.1.3 Emerging Transmission Bottlenecks in Renewable-Rich Corridors

Renewable energy capacity is growing rapidly in a few major REZs. As a result, some interstate transmission corridors are under increasing stress during periods of high solar and wind generation.

REGION / CORRIDOR	ISSUE OBSERVED	OPERATIONAL IMPLICATION
 Rajasthan RE corridors	 High simultaneous solar injection	 Congestion during solar hours
 Tamil Nadu wind corridors	 Seasonal transfer stress	 Curtailment risk
 Gujarat RE evacuation	 High interstate dependency	 Corridor criticality
 Southern balancing corridors	 Variable transfer patterns	 Dynamic loading

Addressing transmission bottlenecks is critical to ensure reliable renewable energy evacuation, minimise curtailment, and strengthen grid resilience.

Figure 20: Transmission Bottlenecks in Renewable-Rich Corridors

These issues become more visible during specific periods when renewable generation is very high across multiple regions simultaneously. The shift towards market-based despatch and the GNA framework is also making interstate power flows more dynamic than before.

In many regions, renewable generation capacity is growing faster than transmission infrastructure. This has already begun to create evacuation constraints, delay project commissioning, and curtail renewable output in some areas.

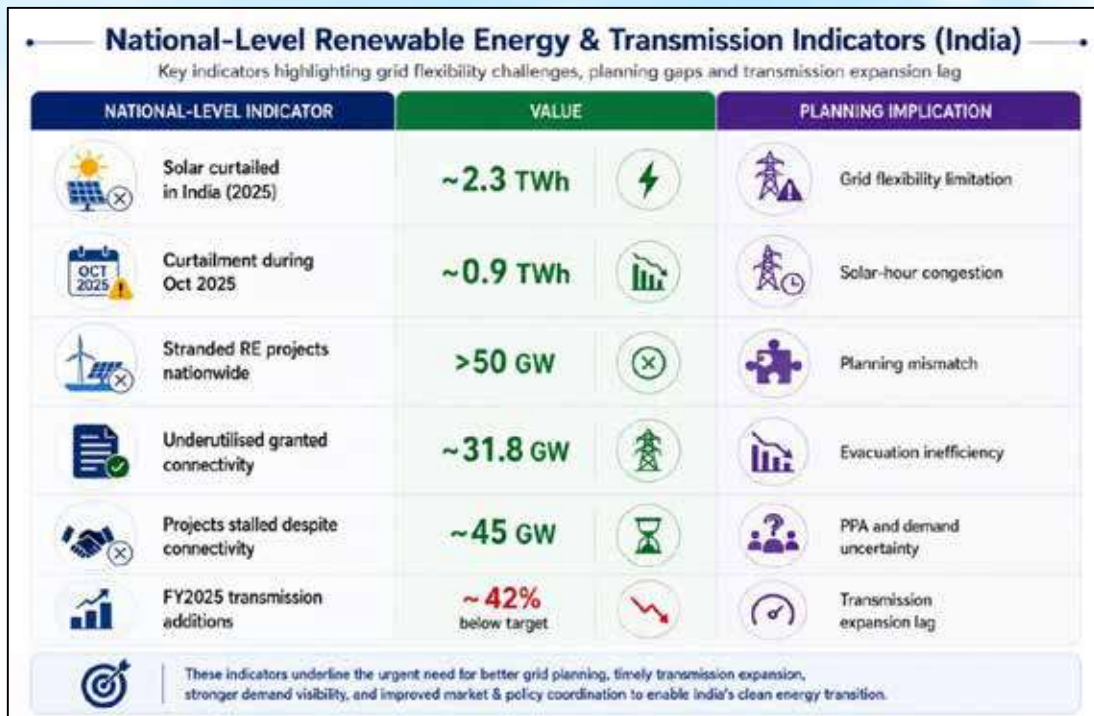


Figure 21: Indicators for bottleneck in Indian Grid^{18,19}

States such as Rajasthan, Tamil Nadu, and Karnataka are already witnessing such conditions during periods of high renewable generation. Rajasthan, for example, has nearly 23 GW of commissioned renewable capacity, while evacuation capability under certain operating conditions remains at around 18.9 GW. As a result, more than 4,000 MW of renewable capacity may face evacuation constraints during peak solar generation hours.²⁰

Congestion management practices have also created operational challenges. Instead of sharing around 15% peak-hour losses across all projects, projects operating under Temporary General Network Access (T-GNA) often face complete shutdowns during congestion periods, while projects with Permanent GNA continue operating normally.²⁰

At the same time, several 765 kV double-circuit transmission corridors designed to transfer nearly 6,000 MW are reportedly operating at only around 600–1,000 MW, reflecting utilisation levels below 20%. Consequently, multiple newly commissioned renewable energy projects remain grid-connected but are unable to inject power.²⁰

This highlights a growing disconnect between transmission planning and real-time system operations, where GNA approvals and corridor planning are undertaken based on full projected capacities, while actual operational transfer capability permitted by system operators remains substantially lower.

3.1.4 Integration of Emerging Demand Centers

Alongside changes in generation, demand is also evolving. New demand is emerging in concentrated forms. Green hydrogen projects, data centers, and industrial corridors are creating large, location-specific load centers. Instead of spreading gradually across regions,

they tend to emerge in specific locations and often on a much larger scale. Their timelines are also unclear at the planning stage. In many cases, they depend on how policies evolve, how markets develop, and how quickly technologies become viable.

Transmission decisions cannot wait for full clarity. By the time demand is fully visible, it is often too late to build the required network. This puts planners in a difficult position; they have to move ahead based on early signals, knowing that these may change. If they move too slowly, the system can face constraints later. If they move too early or too aggressively, the risk of creating underutilized assets increases.

Table 1 Emerging Demand Centers and Transmission Implications

Emerging Demand Segment	Transmission Planning Implication
Green Hydrogen Hubs	Large concentrated industrial demand
Data Centers	High-quality, reliable supply requirement
Electric Mobility Ecosystems	Urban load concentration
Manufacturing Corridors	Bulk industrial transfer requirement
Pumped Storage Systems	Bidirectional power flow behavior

The challenge becomes more complex because future transmission systems may increasingly need to support bidirectional transfer behavior between renewable-rich regions and emerging industrial demand centers. Green hydrogen production clusters, for instance, may emerge either near renewable generation zones or near industrial consumption centers, depending on infrastructure availability, export logistics, and policy support mechanisms.

3.1.5 Transmission Planning Under Uncertainty

Uncertainty is now a defining feature of transmission planning. Renewable-heavy systems are fundamentally increasing uncertainty in transmission planning and corridor utilization behavior.

Earlier transmission planning approaches worked reasonably well because generation patterns, demand growth, and power flows were relatively stable and predictable over long periods. However, higher renewable energy integration is making system behavior more dynamic. Weather-dependent generation, changing power-flow patterns, market-based despatch, and increasing use of storage are creating greater variability in grid operations and balancing requirements.

Table 2 Emerging Sources of Planning Uncertainty

Source of Uncertainty	Transmission Planning Impact
Simultaneous RE injection	Corridor congestion risk

Source of Uncertainty	Transmission Planning Impact
Market despatch	Dynamic transfer patterns
GNA scheduling	Variable utilization
Storage deployment	Changing charging/discharging flows
Hydrogen growth	Uncertain future load centers
Wind seasonality	Flow reversals

Future corridor utilization behavior may vary substantially depending on operating conditions. For example, simultaneous high solar generation across multiple Renewable Energy Zones may sharply increase transfer loading during daytime periods, while evening demand ramps may alter balancing transfer requirements within a few hours.

These developments indicate that conventional deterministic planning methodologies may face increasing limitations in renewable-heavy systems.

Traditional deterministic planning approaches were developed around relatively stable generation and demand behavior. Renewable-intensive systems, however, are increasingly characterized by variable generation profiles, changing transfer behavior, storage interaction, and market-responsive despatch patterns. As a result, transmission planning may increasingly require probabilistic assessment techniques capable of evaluating a wider range of operating scenarios and congestion conditions.

As a result, transmission planning is gradually shifting away from deterministic approaches towards more adaptive and scenario-based methodologies capable of evaluating multiple demands, renewable generation, storage, and market-operating conditions.

3.2 Evolution of the GNA Framework and its Implementation

The transition to the General Network Access (GNA) framework represents a major structural shift in the philosophy of transmission access within the Indian power sector.

Under conventional long-term access frameworks, transmission systems were largely planned around relatively predictable bilateral transfer arrangements and contracted generation capacities. GNA frameworks, however, are expected to increase flexibility in network utilization by enabling more dynamic scheduling and transfer behavior across the grid.

3.2.1 Background and Need for GNA

Earlier, transmission access was closely linked to individual generation projects. When a generator applied for connectivity or long-term access, the transmission system was planned around that specific requirement. In most cases, planners could make a reasonable assumption about where the power would flow.

This worked because the system was simpler. Most generations were conventional. Despatch did not change much from one period to the next. Power was usually tied to long-term contracts, so flows were easier to anticipate.

Over time, this started to change. Renewable generation does not behave the same way. Output depends on resource availability and can vary significantly. At the same time, power markets have made it easier to buy and sell electricity across regions. A generator is no longer tied to a single buyer, and a buyer is not tied to a fixed source.

As a result, power flows have become less predictable. The earlier access framework was not designed for this kind of system. It assumed a level of certainty that no longer exists.

The move to GNA came from this gap. Instead of linking access to specific assets, it allows users to access the network more generally, offering more flexibility in how the grid is used, which is necessary given how the system is now operating.

3.2.2 Experience with Implementation

In practice, GNA has made the system more flexible. Generators now have greater flexibility in scheduling and Despatch. Buyers can respond to market conditions rather than relying solely on fixed arrangements.

However, this also makes transmission planning more complex. Earlier, planners worked with relatively well-defined generation and demand locations, which made overall system behavior easier to assess even when forecasts were not fully accurate.

Now, that structure is no longer as fixed or predictable as before. Power flows can change depending on market outcomes, renewable output, and system conditions at a given time. This means planners cannot rely on a single set of assumptions.

This is also increasing uncertainty regarding future corridor utilization behavior and long-term augmentation requirements. Under increasingly market-driven operating conditions, transmission systems may need to maintain higher flexibility margins to accommodate changing Despatch behavior and transfer patterns across regions.

Transmission planning under the GNA framework increasingly requires assessment of a wider range of operating conditions, including market-based Despatch, renewable variability, and changing transfer behavior across regions.

3.2.3 Access Certainty versus Planning Flexibility

One issue that keeps coming up with GNA is the balance between certainty and flexibility. On one side is the need for certainty of access. Generators, particularly those investing in large renewable projects, require confidence that they can evacuate power. Without this assurance, investment decisions become difficult.

At the same time, the system cannot be locked into rigid structures. Flexibility is needed to allow power to move where it is required.

The difficulty is that both cannot be maximized simultaneously. If the system provides too much certainty in fixed terms, it can reduce flexibility. If it moves too far towards flexibility, it can create uncertainty for investors and planners.

The balance between access certainty and planning flexibility is therefore emerging as an important consideration in renewable-intensive, market-driven transmission systems, with implications for both transmission planning and operational decision-making.

Table 3 Shift from Conventional Access Framework to GNA

Conventional Framework	GNA-Based Framework
Bilateral scheduling	Dynamic scheduling
Predictable flows	Variable flows
Stable utilization	Dynamic utilization
Fixed transfer assumptions	Market-responsive behavior

3.2.4 Need for Refinements in the GNA Framework

The GNA framework is still evolving, as expected. Some issues are already becoming visible. One is the alignment between access and planning. If planning assumptions do not align with how the system is actually used, it can lead to either congestion or underutilization of assets.

In a system with dynamic flows, congestion will happen. The question is not how to eliminate it completely, but how to manage it without distorting system behaviour. There is also the interaction with markets. As markets become more active, their impact on power flows will increase. Planning will need to account for that more explicitly.

As market participation, renewable penetration, and interstate transfer variability continue to increase, the GNA framework may require ongoing refinement to better align transmission planning assumptions with operational realities and evolving market behaviour.

3.3 Balancing Transmission Expansion and Asset Utilization

One of the most important planning challenges emerging in renewable-heavy systems relates to balancing transmission expansion requirements with long-term asset utilization efficiency.

Earlier transmission systems were planned around relatively stable utilization patterns because conventional generation and power flows remained fairly predictable over long periods. Higher levels of renewable energy integration are significantly changing these operating conditions.

Table 4 Drivers of Transmission Utilization Variability

System Condition	Possible Grid Impact
High solar generation during the daytime	Sharp increase in corridor loading for certain hours
Seasonal increase in wind	Changing transfer patterns across regions

System Condition	Possible Grid Impact
generation	
Delay in renewable project commissioning	Lower utilization of transmission assets
Market-based Despatch	More variable interstate power flows
Storage charging and discharging	Changing direction of power flows

In renewable-rich systems, transmission congestion does not always occur during normal operating conditions. In many cases, stress on the grid occurs when renewable generation rises sharply across multiple regions simultaneously, particularly during high solar or wind output hours.

At the same time, designing transmission systems solely around peak renewable injection conditions may result in infrastructure being moderately utilized across several operating periods. This creates a difficult planning trade-off between minimizing congestion risk, ensuring balancing capability, maintaining evacuation readiness, and avoiding excessive underutilization of transmission assets.

This is no longer an occasional operational issue. Similar patterns are already evident in several renewable-rich regions, where high solar generation at certain times creates congestion on key transmission corridors, even though the network may appear adequate under average loading conditions.

As the system moves towards much higher renewable penetration over the next two decades in line with the Viksit Bharat 2047 vision, these variations are expected to become more pronounced. Because of this, the discussion is no longer limited to technical design. It has begun to raise questions about cost, utilization, and how the system should be evaluated.

3.3.1 Overbuilding versus Congestion Risk

India's growing renewable energy capacity is creating new challenges for transmission planning and corridor utilization. In several cases, transmission corridors experience sharp increases in loading during periods of high renewable generation, even though utilization may remain moderate for the rest of the day. This is changing the way planners assess congestion risk, corridor sizing, and overall transmission requirements.

This trend is becoming particularly evident in renewable-rich regions, where simultaneous injection from multiple projects can rapidly increase corridor loading during solar generation hours or high-wind periods. Rajasthan and Gujarat, which are emerging as major renewable generation hubs, are expected to support very large volumes of utility-scale solar and hybrid capacity over the coming years. As a result, interstate corridors connecting these regions with northern and western demand centers are increasingly becoming critical balancing and evacuation pathways.

Despite significant expansion of the transmission network, congestion is increasingly being observed during specific operating windows characterised by simultaneous renewable energy injections and high balancing transfer requirements. This reflects the growing operational complexity of managing renewable-rich corridors under dynamic grid conditions.

Several operational studies and regulatory proceedings have pointed to a reduction in renewable generation during periods of transmission congestion, particularly during high-wind seasons and peak solar generation hours. These instances show that transmission stress is no longer linked only to a shortage of transmission capacity. In many cases, the challenge also comes from gaps between renewable generation growth, transmission readiness, balancing support, and operational flexibility across the grid.

Renewable curtailment is increasingly becoming an important indicator of such system stress. India reportedly curtailed nearly 2.3 TWh of solar generation between May and December 2025 as the grid struggled to absorb high daytime output from renewables amid constrained transmission and balancing conditions. Similar trends have been observed in Rajasthan, where solar curtailment during certain peak generation periods reportedly reached very high levels due to congestion and delays in the development of evacuation infrastructure.

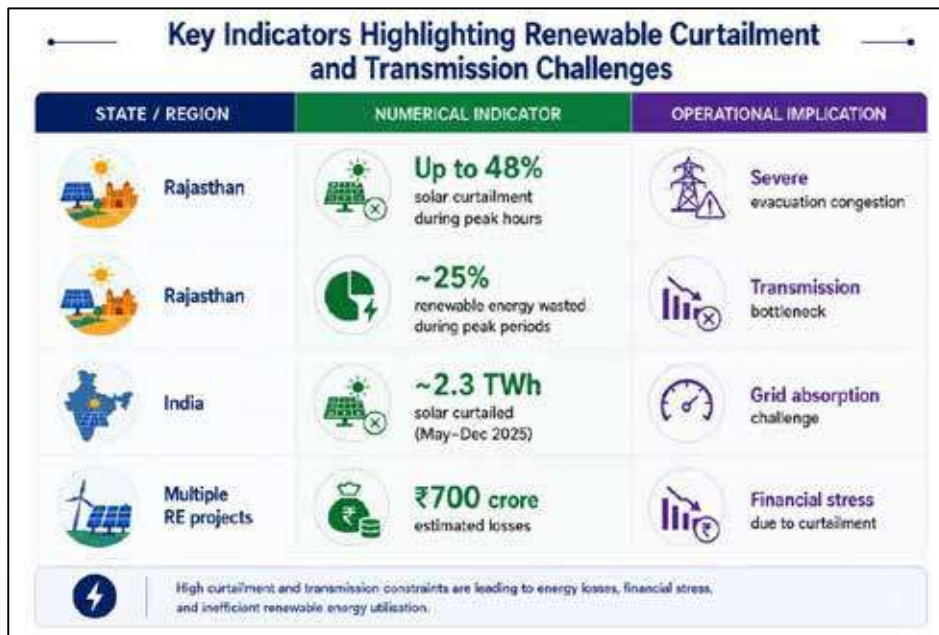


Figure 22: Key Indicators for RE Curtailment^{18,19,20}

Another operational challenge emerging in renewable-rich systems is the sharp variation in corridor loading within the same day. Some transmission corridors may carry very high power flows during daytime solar generation hours but operate under very different conditions during evening peak-demand periods. Seasonal increases in wind generation can also change power transfer patterns across key corridors within short durations.

Consequently, transmission congestion in renewable-heavy systems may no longer emerge under average operating conditions. Increasingly, operational stress is occurring during

specific high-renewable-injection windows characterized by simultaneous generation across multiple Renewable Energy Zones.

Curtailment in renewable-rich systems should not be seen only as a short-term operational issue. In many cases, it reflects deeper challenges in the grid, such as transmission congestion, limited balancing capability, corridor saturation, and delays in evacuation infrastructure compared to the pace of renewable capacity addition.

3.3.2 Planning for Low Utilization Periods

Conventional transmission planning philosophies evolved around comparatively stable generation behavior and predictable transfer patterns associated with thermal-dominated power systems. Under such conditions, transmission infrastructure was generally expected to operate with relatively consistent utilization over extended periods, and lower utilization was often viewed as indicative of inefficient network planning.

Renewable-heavy systems are fundamentally altering these assumptions.

Transmission stress in renewable-rich systems increasingly occurs during specific operating windows characterized by simultaneous renewable injection, seasonal wind surges, or sharp balancing transfer requirements, rather than under average operating conditions. Consequently, certain corridors may experience extremely high loading during limited periods while remaining only moderately utilized during the rest of the year.

Table 5 Drivers of Uneven Corridor Utilization in Renewable-Heavy Systems

Driver	Impact on Utilization Behavior
Simultaneous REZ injection	Short-duration peak loading
Seasonal wind generation	Seasonal utilization variation
Evening balancing transfers	Intraday loading swings
Renewable intermittency	Uneven corridor utilization
Market-driven Despatch	Dynamic transfer behavior

This represents a significant shift in transmission planning philosophy. Future transmission systems may increasingly need to be designed around stressed operating conditions rather than average utilization behavior alone.

The rapid pace of renewable energy development is also creating uncertainty around future transmission utilization patterns. As of mid-2025, more than 50 GW of renewable energy projects across the country were reportedly awaiting commissioning due to delays in transmission connectivity, pending PPAs, and other regulatory issues. Rajasthan reportedly had nearly 60 GW of renewable projects awaiting transmission access, highlighting the growing gap between renewable project development and the readiness of evacuation infrastructure.

At the same time, several high-capacity renewable evacuation corridors are reportedly operating significantly below design utilization levels. Certain 765 kV double-circuit corridors designed for nearly 6000 MW of transfer capability have reportedly been operating at only 600–1000 MW under some conditions, indicating a substantial divergence between planned corridor capability and actual operational utilization.

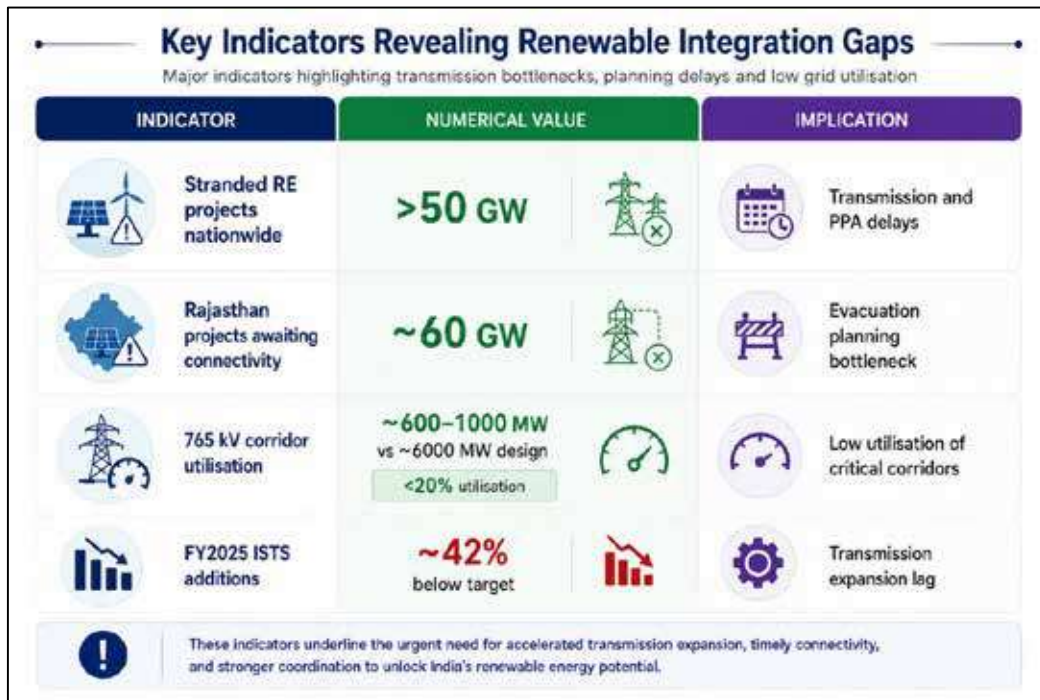


Figure 23: Stranded RE Capacity in India^{19,20}

In renewable-heavy systems, transmission corridors may increasingly exhibit highly uneven loading across operating periods. Certain corridors may remain moderately utilized under normal operating conditions but experience sharp increases in loading during simultaneous periods of renewable injection, seasonal wind surges, or high balancing transfer requirements. Such conditions are becoming increasingly evident along renewable evacuation corridors connecting major Renewable Energy Zones to distant demand centers.

Lower utilization levels in some transmission corridors may not always indicate overbuilding or inefficient planning. In renewable-rich systems, certain corridors may remain lightly loaded for much of the time but become critically important during periods of high renewable generation. During such periods, these corridors help maintain reliable evacuation, provide operational flexibility, and support regional balance.

This becomes particularly important for transmission systems linked to Renewable Energy Zones (REZs), where power injections can rise sharply during limited operating windows.

As renewable penetration increases, transmission planning will need to balance evacuation readiness, congestion management, operational reliability, and efficient long-term infrastructure utilization in a much more dynamic grid environment.

3.3.3 Role of Technology in Enhancing Utilization and Flexibility

Technology has begun to play a larger role in managing these challenges. In the past, increasing capacity largely meant building new lines. That remains important, but it is no longer the only option.

Certain technologies enable more efficient use of the existing network. HVDC systems, for example, provide much greater control over power flows. They are particularly useful when large amounts of power need to be transferred across long distances, especially from renewable-rich regions to demand centers.

FACTS devices help in managing voltage and power flow in real time. They can ease congestion in specific sections of the network without requiring immediate expansion.

Dynamic line ratings take a different approach. Instead of assuming a fixed capacity for transmission lines, it adjusts capacity based on actual weather conditions. This can unlock additional capacity during favorable conditions.

These technologies do not remove the need for new transmission infrastructure. However, they help in getting more out of what already exists. At the same time, they are not universal solutions. Their effectiveness is often location-specific, and they require strong system visibility and operational capability to deliver results. In most cases, they complement core transmission expansion rather than replace it.

3.3.4 Cost and Tariff Implications

The scale of transmission expansion that lies ahead brings cost recovery into focus. Transmission investments are large and long-term. These costs have to be recovered through tariffs. In a system with steady utilization, this process is relatively straightforward.

In a system with variable utilization, it becomes less clear. Some assets may appear underutilized when looked at in isolation. But they may still play an important role in enabling the integration of renewables or in maintaining reliability.

This creates a difficult issue for tariff design. Renewable-intensive systems may increasingly require transmission infrastructure that provides system-wide balancing and reliability benefits even if utilization remains uneven across operating periods. This could gradually shift transmission tariff discussions away from narrow utilization-based assessment towards broader system-level evaluation of reliability, flexibility, and congestion management benefits.

Tariffs based solely on network usage may not fully reflect the broader role of transmission infrastructure. On the other hand, allocating costs across a wider set of users can also raise concerns about equity and cost sharing.

This leads to a set of practical questions. How should costs be shared between generators and consumers? How should assets that are critical during peak conditions be treated? How should system-wide benefits be recognized in tariff structures?

These are not easy questions, and there are no one-size-fits-all answers. Regulatory frameworks are already evolving to deal with some of these issues. But as the system becomes more complex, tariff design will also need to be adapted.

There is growing recognition that transmission behaves more like shared infrastructure. Its value cannot always be traced to a single user or transaction.

3.3.5 A System-Level Perspective on Planning

Taking it together, these issues point to a broader change in how transmission planning is approached. It is no longer sufficient to evaluate decisions based on a single parameter such as utilization.

Planners need to look at the system. This means considering how investment decisions affect not just asset usage, but also system reliability, operational flexibility, and overall cost. It also means accepting that some level of underutilization is unavoidable in a system that depends heavily on variable generation.

The objective, therefore, is not to maximize utilization at every point in time. The objective is to ensure that the system continues to function reliably, even under conditions that are difficult to predict in advance.

Key Takeaway

The emerging transmission challenges observed across India's renewable transition indicate that future planning complexity may no longer be limited to network expansion alone. Increasingly, the challenge is to ensure that generation development, evacuation readiness, balancing capability, market evolution, storage deployment, and operational flexibility evolve together within an integrated, system-oriented planning framework. In renewable-heavy systems, transmission planning can no longer function as a downstream activity following generation expansion but may increasingly need to evolve simultaneously with generation planning.

4 Delivering the Grid at Scale – Execution, Supply Chain and Technology

India's transmission sector is entering a phase in which the challenge is no longer limited to planning future networks but increasingly concerns the ability to execute large-scale transmission infrastructure within compressed timelines and under significantly more complex operating conditions. The scale of renewable integration, expansion of interstate transfer requirements, growth of REZs, and increasing dependence on high-capacity bulk power transfer systems are fundamentally altering the execution and delivery requirements of the transmission sector.

Historically, transmission expansion in India progressed in relatively sequential cycles, with generation growth, transmission augmentation, and demand expansion evolving over longer time horizons. The emerging power system transition is significantly different. Renewable generation is now being added simultaneously across multiple regions, requiring parallel execution of high-capacity transmission corridors, substations, pooling infrastructure, balancing systems, and associated evacuation networks.

The scale of transmission expansion now planned over a relatively compressed time horizon is significantly larger than earlier development cycles. Unlike previous phases where projects were staggered over longer durations, current transmission expansion increasingly involves the simultaneous execution of multiple high-capacity interstate corridors, renewable evacuation systems, substations, and HVDC links across different regions.

At the same time, the execution environment itself is becoming increasingly challenging. Transmission projects now routinely encounter Right-of-Way constraints, forest-clearance delays, terrain-related construction difficulties, supply-chain limitations, equipment lead-time pressures, and increasing coordination complexity among generation developers, transmission utilities, equipment suppliers, contractors, and system operators.

Consequently, future transmission readiness may increasingly depend not only on planning capability but also on execution resilience, manufacturing readiness, technology adoption, and the ability to coordinate multiple project components under compressed timelines.

Because of this, planning alone is not enough. Execution speed, equipment availability, and technology choice now play an equal role. Delays in either of these areas affect the system as a whole. They slow down the generation evacuation. They increase costs. They also create uncertainty for developers and investors.

This chapter examines three areas that shape on-the-ground outcomes: execution, supply chain readiness, and technology adoption.

4.1 Project Execution Challenges in Transmission Development

Once construction begins, things rarely follow the same logic as the planning stage. What looked straightforward on drawings starts to depend on the actual ground level issues / conditions, including but not limited to access to sites, coordination with local authorities, and

how different activities are sequenced. Even projects that appear well structured at the outset can start slipping once work moves to the ground.

The development model does not remove these issues. It only changes how much flexibility is available when they arise.

4.1.1 Key Execution Bottlenecks in Transmission Development

Transmission project execution in India has always involved coordination across multiple agencies, land jurisdictions, contractors, and approval mechanisms. However, the scale and geographic concentration of renewable-linked transmission systems are increasing the intensity and simultaneity of these challenges.

Right-of-Way is the most common cause of delays in transmission projects in India. Compensation rules exist, but outcomes differ from place to place. In some locations, access is granted without much delay. In others, work stops for small but critical stretches. These stretches often decide the project timeline. A line may be complete for most of its length, but a few unresolved locations can delay commissioning.

Clearances follow a similar pattern. Transmission corridors increasingly pass through densely populated areas, forest regions, environmentally sensitive zones, and renewable-rich geographies where land access and local clearances can substantially affect project timelines. Forest clearances and local permissions do not always move at the same pace. In some cases, approvals come through, but conditions on the ground change once work starts.



Figure 24: Execution Challenges in Transmission Projects

This is seen more often in corridors linked to renewable projects. Many of these routes pass through areas where supporting infrastructure is still developing. Because of this, the issue is not only the approval itself, but also how those approvals hold up when construction begins.

In many renewable-linked systems, transmission infrastructure and generation projects do not always progress at the same pace. In some cases, evacuation systems become ready before renewable projects are commissioned, while in others, generation capacity comes online before downstream transmission systems are fully available.



Figure 25: Difference between planned timelines and actual execution timelines

4.1.2 Risk and Behavior under Different Project Structures

The same execution environment affects projects differently depending on their structure. Execution risk now depends as much on corridor readiness and supply chain visibility as on the financing structure or tariff competitiveness.

In regulated projects, there is some room to deal with delays. Adjustments can be considered, subject to regulatory review. In competitively bid projects, the situation is tighter. Developers commit to fixed tariffs and timelines. Bids are usually built around assumptions on timelines and site conditions. These assumptions do not always hold once work begins.

When delays come in, the impact is immediate. Costs increase, and schedules move out. Developers have limited room to adjust. Developers are increasingly evaluating projects based not only on tariffs, but also on execution visibility, equipment availability, approval certainty, and corridor accessibility.

This has started to reflect in how bids are placed. Projects with clearer execution conditions tend to see stronger interest. Where land access or clearances are uncertain, bidders tend to be more cautious.

This is less about choosing one model over another. It is more about whether the project structure recognizes the level of uncertainty involved.

4.1.3 Coordination Challenges and Contractual Complexities

Execution also depends on how different parts of the project move together. Renewable-linked transmission systems often involve simultaneous execution of substations, pooling systems, generation infrastructure, and interstate corridors, making coordination across project components significantly more important. Line construction, substations, equipment

supply, and civil works run in parallel, but not at the same pace. When one part slows down, the rest of the project does not automatically adjust to it.

Delays in one part of the execution chain can directly affect commissioning timelines across associated transmission and evacuation systems. If one part slows down, the rest of the project does not automatically adjust. For example, a line may be ready, but substation equipment may still be under procurement. In other cases, equipment may arrive on time, but civil works may lag.

These mismatches usually show up at the time of commissioning. Contracts add another layer to this. Once work starts, site conditions often require changes, such as alignment adjustments, foundation redesigns, or access-related modifications. These are routine in transmission projects, but they are not always easy to handle within fixed contract structures. If contracts are too rigid, even small changes can delay progress. If they are too flexible, coordination becomes difficult.

So, the issue is not only contractual. It is about how well contracts reflect ground realities.

4.1.4 Importance of Early-Stage Project Preparation and Route Planning

Many execution outcomes are shaped before construction begins. Route selection is one example. Two routes may appear similar on paper, but their execution profile can be very different. Land conditions, forest involvement, and local factors all matter.

Timelines also behave differently on the ground. Work does not progress uniformly across the route. Progress is rarely uniform across the route. Some stretches move ahead without much issue, while others take much longer than expected. In most projects, it is these slower sections that end up deciding the final completion date.

Projects that identify such stretches early tend to manage timelines better. The issues do not go away, but they are addressed before they start affecting the entire schedule. Corridor selection, accessibility, terrain conditions, and crossing requirements often determine how smoothly later construction activities progress. Local engagement also matters. Where discussions with authorities and communities begin early, disruptions are easier to handle later.

In that sense, execution does not begin at the construction stage. It is shaped much earlier, by how routes are selected, how risks are understood, and how the work is planned.

4.2 Supply Chain and Manufacturing Readiness

The supply side of transmission development is starting to show signs of strain. Not everywhere, and not in the same way, but it is visible.

Earlier, projects were spaced out. Orders came in phases. Manufacturers and contractors had some breathing room. That pattern has shifted. A number of projects are now moving together, and they tend to require similar equipment within a short window. That overlap is where things begin to tighten.

4.2.1 Equipment Availability, Manufacturing Capacity, and Lead Times

The rapid pace of renewable-linked transmission development is putting pressure on equipment supply chains across multiple projects simultaneously. For some items, supply is still manageable. Conductors and towers, for instance, do not usually create major issues. Timelines may stretch during peak demand, but the system absorbs it.

The difficulty begins with specialized equipment. Large transformers, reactors, and GIS depend on specific facilities. Testing capacity is not unlimited. In a few cases, production slots are already committed well in advance. Large transformer procurement timelines have lengthened across several projects due to concurrent demand from renewable evacuation systems, interstate corridors, and substation augmentation programs. HVDC equipment manufacturing remains concentrated in a relatively limited supplier ecosystem, limiting procurement flexibility during large-scale simultaneous transmission expansion. The supplier base is small, and their schedules tend to fill up early.



Figure 26: Supply Chain Stress Areas

Because of this, procurement behavior has shifted, quietly but noticeably. Developers are moving earlier, sometimes even before everything is finalized. It helps secure supply, but it also means committing with partial visibility. So, the risk has not been reduced but has moved upstream.



Figure 27: Transmission Supply Chain Pressure Points

The challenge is not limited to manufacturing timelines alone. Delays in testing availability, transportation logistics, import clearances, or specialized commissioning resources can also affect project readiness.

As multiple renewable-linked transmission projects progress simultaneously, supply chain resilience is increasingly important to transmission planning itself.

4.2.2 Domestic Manufacturing Capability and Technology Depth

India has developed substantial domestic manufacturing capability across several segments of transmission equipment over the past two decades.



Figure 28: Domestic Manufacturing Readiness Across Technologies

While India possesses strong manufacturing capabilities in towers, conductors, and several transformer categories, this picture is not uniform across all technologies. For example, HVDC equipment still depends on a limited pool of global suppliers. A similar situation exists for certain GIS components and advanced control systems, in which parts of the value chain are located outside the country. These are not segments where capacity can be scaled quickly, even if demand increases.

This creates a split system. Some parts move faster, while others follow a different cycle. A delay in one area can hold up everything else, even if the rest of the project is ready. There is also the question of pace. Adding manufacturing capacity is one step. Building skilled teams and testing capability is another. These take longer and tend to lag demand.

The sector, therefore, often relates not only to manufacturing capability but also to manufacturing depth, supplier diversity, access to technology, and the ability to scale up production during simultaneous large-scale transmission expansion.

4.2.3 Contractor, Vendor, and Skilled Manpower Ecosystem

The transmission supply chain ecosystem extends beyond manufacturing plants alone. It also includes contractors, installation teams, and specialized service providers. This part of the ecosystem usually gets less attention, but it often directly affects how quickly projects move.

With several projects running at once, contractors are stretched, and the same teams often move between sites. Mobilization takes longer than expected. In some cases, equipment reaches the site before the teams do. There is also a question of skills. The availability of specialized commissioning teams, protection engineers, testing personnel, HVDC-skilled manpower, and experienced construction contractors is increasingly emerging as a parallel-execution constraint.

The challenge is further amplified because renewable-linked transmission systems often require execution on compressed timelines, with multiple project components required to become operational simultaneously. So even when procurement looks aligned, execution may not keep pace. This is usually visible only after work begins.

4.2.4 Emerging Supply Chain Risks in Transmission Development

Supply chain risk is no longer just about delays. Timing has started to matter as much as availability. If equipment arrives late, the project gets pushed out. If it comes in too early, that creates a different set of issues, storage, handling, and exposure, especially for high-value equipment.

External factors add to this. Shipping delays, disruptions in global supply, or even currency movements can affect delivery schedules. Because of this, procurement decisions are now taken earlier than before, often without full clarity on site readiness.

The sector, therefore, is no longer limited to whether equipment can be manufactured, but often whether manufacturing, logistics, testing, commissioning, and execution schedules can remain synchronized across multiple parallel projects.

4.3 Technology Innovation for Faster, Reliable, and Flexible Transmission

Technology in transmission rarely starts as an upgrade. It usually starts as a workaround. It comes into play when conventional methods begin to fall short, space is limited, loading increases, or flows become harder to manage. So, the question is less about what exists and more about what fits.

4.3.1 Technology Solutions for Corridor-Constrained Transmission Systems

The increasing scarcity of transmission corridors and growing right-of-way constraints are changing technology choices across several parts of the network. In many locations, especially near urban or densely developed areas, laying a new transmission line is not easy. In such situations, the approach tends to change. Not always by choice, but because the usual options are limited.

Technologies such as HTLS conductors, compact towers, and monopoles are often used where capacity needs to increase without major structural changes, with a justified cost-benefit analysis. Insulated Cross Arms help where clearances are tight. These solutions help avoid larger structural changes, such as increasing tower height.

Their use is limited to specific cases, but where applied, they address very practical constraints. Monopoles work along similar lines. They take up less space and can be installed more quickly. This becomes relevant in areas where footprint is a constraint.

Such technologies are becoming particularly relevant in renewable-linked corridors where transfer requirements are increasing rapidly while corridor availability remains constrained.



Figure 29: Technology Options for Corridor-Constrained Transmission Systems

The objective of these technologies is not merely to increase transfer capability but often to improve corridor flexibility, execution feasibility, and network scalability under constrained conditions.

4.3.2 Improving Utilization of Existing Transmission Infrastructure

In some corridors, adding new lines is not feasible in the near term. So, attention shifts to improving the utilization of existing infrastructure. Dynamic line ratings, advanced monitoring systems, digital substations, and real-time operational analytics are often being explored to improve corridor visibility and operational flexibility.

Dynamic line ratings work by adjusting line capacity based on actual conditions, rather than fixed assumptions. The outcome, however, is not consistent everywhere. Some corridors see noticeable improvement. In others, the change is limited; its effectiveness depends significantly on corridor-specific weather conditions, forecasting quality, operational integration, and real-time monitoring capability.

The growing importance of such technologies reflects a broader transition in which future transmission efficiency may often depend not only on building new infrastructure but also on improving operational awareness and controllability of existing systems.

4.3.3 Role of Underground Cables and Gas Insulated Lines (GIL)

Underground cables and GIL often come up in discussions, especially for constrained areas. Their use is more limited than it appears. EHV cables are typically used over shorter distances, particularly in urban areas. As the length increases, issues related to joints and maintenance become more difficult to manage.

GIL offers higher capacity, but at a significantly higher cost. They may become often relevant in densely populated urban regions, critical infrastructure zones, environmentally sensitive areas, and strategic high-reliability applications. Its use is limited to specific applications, such as substations, industrial zones, or corridors where overhead lines are not feasible. These options are not used as default solutions. They come into play when conventional alternatives are not practical.

The adoption of such technologies is therefore likely to remain selective but strategically important under often-constrained transmission development conditions.

4.3.4 High-Capacity Bulk Power Transfer Technologies

The need to move power across longer distances is increasing. Renewable generation does not always sit close to demand centers. This creates the need for bulk power transfer systems across the national grid.

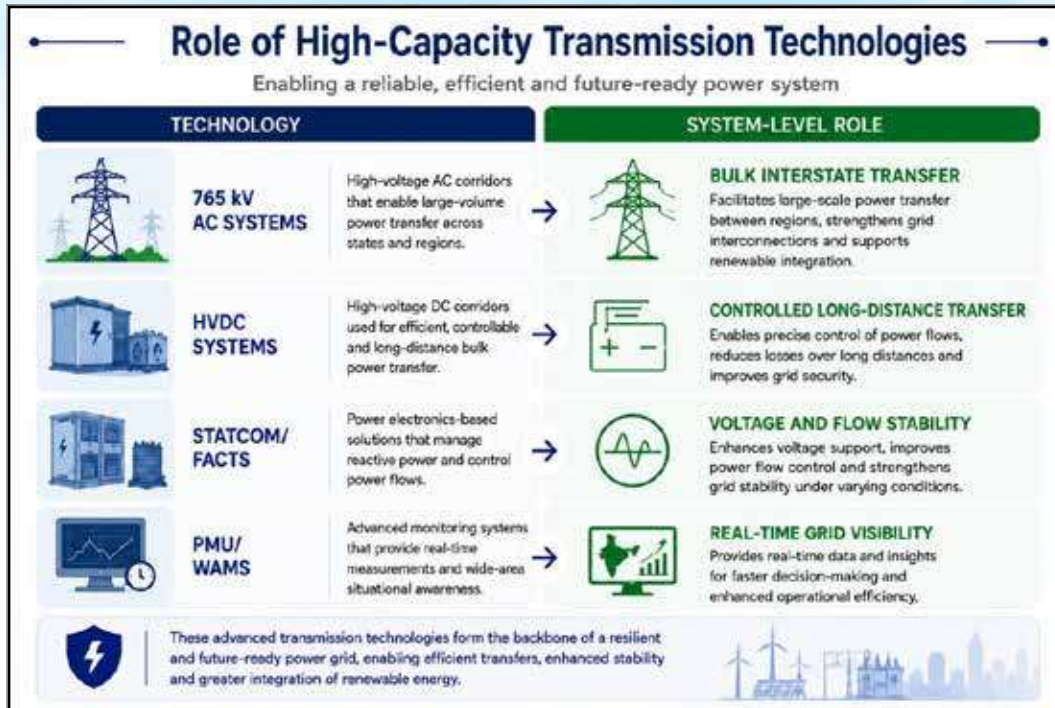


Figure 30: Role of High-Capacity Transmission Technologies

India has already expanded its 765 kV network. HVDC systems are deployed where precise control of power flows is essential. These are not niche technologies anymore. They form part of the backbone.

As renewable generation often concentrates within geographically distant Renewable Energy Zones, bulk transfer systems are becoming critical not only for evacuation, but also for balancing support, transfer controllability, and operational flexibility across regions.

HVDC systems are often deployed where long-distance controlled transfer capability becomes important for integrating renewable-rich regions with major demand centers.

Similarly, FACTS devices, STATCOM systems, and advanced control technologies are often becoming important for voltage stability, dynamic balancing, and congestion management under variable renewable operating conditions.

The future transmission system is therefore expected to often rely on a combination of high-capacity transfer systems, digital monitoring capabilities, and controllable network technologies.

4.3.5 Digital Monitoring and Grid Visibility Technologies

As the network expands and operating conditions become less predictable, the need for better visibility increases. PMUs and Wide Area Measurement Systems, advanced digital substations, forecasting tools, and real-time grid analytics provide visibility across transmission operations. They do not alter the physical network, but they improve how system conditions are observed and understood.

This layer depends on communication systems. OPGW has become standard for new lines. Other technologies are being introduced gradually. These systems do not increase physical transfer capacity. Their value lies in improving system visibility and enabling faster operational response.

Such technologies are becoming particularly important in renewable-heavy systems where transfer conditions may change rapidly due to renewable intermittency, market-based Dispatch, balancing transfers, and multidirectional power flows.

As renewable penetration rises further, the importance of real-time visibility, dynamic system awareness, and faster operational response is expected to increase significantly across transmission operations

4.3.6 Technology Adoption Trends in Transmission Systems

Technology adoption within the transmission sector is often moving beyond isolated pilot applications towards system-level operational integration.

The relevance of technology often depends not only on technical capability but also on corridor conditions, execution feasibility, operational requirements, scalability, maintainability, and integration with broader network behavior.

As transmission systems become larger, more dynamic, and often renewable-driven, technology adoption is expected to shift from isolated equipment upgrades to improving corridor flexibility, operational visibility, transfer controllability, and execution feasibility under often-constrained system conditions.

The future transmission network is therefore likely to evolve not only through physical expansion but also through the increasing integration of advanced technologies, digital operational capabilities, and flexible network solutions that support a significantly more dynamic power system environment.

5 Financing the Transmission Infrastructure

This chapter discusses how India's Viksit Bharat 2047 journey will require an unprecedented expansion of transmission infrastructure, including interstate and intrastate networks, HVDC systems, renewable corridors, and digital grid technologies, to enable renewable integration, industrial electrification, and long-term economic growth. It also highlights the growing challenges in financing and executing this transition, emphasizing the need for innovative funding models such as InvITs, asset monetization, private participation, green finance, and diversified long-term capital to build the future grid.

5.1 Transmission Investment and Financing Challenges

India's power system is entering a phase where transmission infrastructure will increasingly determine the pace and effectiveness of the country's energy transition. Over the next two decades, the transmission sector will need to support not only rapid integration of renewable energy but also large-scale industrial electrification, electric mobility, green hydrogen development, data center expansion, and increasing interregional power transfers.

Unlike earlier phases of transmission development, future expansion will involve significantly larger investments in:

- Interstate renewable energy corridors,
- Intra-state evacuation systems,
- HVDC transmission systems,
- Digital substations,
- Flexible grid technologies,
- High-capacity national balancing infrastructure.

Transmission infrastructure is no longer merely a supporting network for the evacuation of generations. It is increasingly emerging as a strategic national infrastructure essential for enabling India's long-term economic growth and clean energy transition.

5.1.1 Scale of Future Transmission Investment Requirement

India's transmission network has expanded significantly over the past two decades alongside rapid growth in electricity demand and installed generation capacity. The transmission network today is substantially larger and more interconnected than the grid that existed a decade ago. However, the future scale of infrastructure required for Viksit Bharat 2047 is expected to be significantly greater.

CEA has estimated the length of the transmission lines and sub-station capacity planned under ISTS and Intra-state for integration of additional wind and solar capacity during 2026-27 to 2035-36 as 1,37,500 ckm and 8,27,600 MVA, respectively, at an estimated cost of Rs. 7,93,300 crores.⁴

This investment requirement is expected to rise further beyond 2035 due to:

- Increasing electrification of transport and industry,

- Large-scale green hydrogen development,
- Offshore wind integration,
- Rising cooling demand,
- Urbanization, and
- Expansion of digital infrastructure

5.1.2 ISTS and InSTS Expansion Requirements

Future transmission expansion will require simultaneous strengthening of both Interstate Transmission Systems (ISTS) and Intra-State Transmission Systems (InSTS).

The ISTS network is expected to function as the backbone of India's future renewable-heavy power system. The increasing geographical concentration of renewable energy in states such as Rajasthan, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh, and Ladakh is expected to substantially increase reliance on long-distance bulk power transfer.

Green hydrogen production is expected to become a particularly important driver of future transmission expansion. Producing 1 MTPA of green hydrogen may require nearly 5–6 GW of renewable energy capacity, along with associated transmission infrastructure. Similarly, hyperscale data centers are expected to create concentrated pockets of demand with stringent reliability requirements around major urban regions.

As per current transmission planning studies⁴:

- Rajasthan alone is expected to require transmission integration for nearly 119 GW of renewable energy,
- Gujarat for around 65 GW, and
- Maharashtra for nearly 10 GW.

Several of these renewable-rich regions are expected to be connected to distant load centres through high-capacity 765 kV AC and HVDC transmission corridors.

The scale of interstate infrastructure required is already visible in the rapid growth of India's ISTS network. As of 2025–26:

- ISTS lines account for nearly 2.16 lakh ckm of the national transmission network,
- With a transformation capacity of approximately 599 GVA.

At the same time, InSTS systems are expected to become equally critical for renewable integration.

While ISTS systems enable bulk interregional transfer, challenges in renewable integration increasingly originate at the state level, where renewable pooling stations, renewable energy zones, hybrid parks, and distributed renewable systems require substantial evacuation infrastructure.

India's Green Energy Corridor (GEC) programs are central to this transition.

Under GEC-II⁴:

- Around 19.4 GW of renewable integration is planned,
- Requiring approximately 7,919 ckm transmission lines, and
- Nearly 24,488 MVA transformation capacity addition.

Under GEC-III⁴:

- More than 134 GW of renewable integration is envisaged,
- Involving over 51,000 ckm transmission lines, and
- Approximately 2.29 lakh MVA transformation capacity.

States such as Maharashtra, Karnataka, Rajasthan, Gujarat, Telangana, and Andhra Pradesh are expected to witness particularly large-scale intra-state transmission expansion under these programs.

Despite the growing importance of InSTS infrastructure, several State Transmission Utilities (STUs) continue to face:

- Balance sheet limitations,
- Slower capital mobilization capability, and
- Execution constraints.

This is emerging as a critical issue because delays in intra-state evacuation systems can lead to:

- Renewable curtailment,
- Congestion within renewable-rich regions,
- Underutilization of ISTS assets, and
- Stranded generation capacity.

The future transmission planning framework will therefore increasingly require integrated ISTS-InSTS planning rather than isolated network development.

5.1.3 Financing Challenges in Transmission Development

Financing transmission infrastructure is becoming more complex as the grid's scale, technology profile, and planning philosophy continue to evolve.

Unlike generation projects, transmission systems require a large upfront investment with relatively long development timelines. Major interstate corridors often take several years to commission because of Right-of-Way (RoW) constraints, forest clearances, land acquisition issues, and multi-agency coordination requirements. Renewable generation projects, on the other hand, are frequently commissioned within much shorter timelines. This mismatch creates a recurring challenge across the sector.

In several cases, transmission infrastructure needs to be developed ahead of the commissioning of generation to avoid future congestion and curtailment of renewables. Such anticipatory investment has become increasingly necessary in renewable-rich regions where generation capacity is expected to grow rapidly.

However, financing infrastructure that may initially operate at relatively low loading levels creates a different set of concerns for utilities, developers, and lenders.

From a system planning perspective, early investment improves long-term grid readiness and reduces the risk of transmission bottlenecks. From a financing perspective, however, lower utilization during the initial years can affect perceptions around asset efficiency and cost recovery.

This issue becomes more relevant as India moves towards larger renewable energy zones, offshore wind integration, green hydrogen hubs, and long-distance bulk power transfer systems. Many of these investments must be planned several years in advance, often before demand patterns fully stabilize.

The financing profile of future transmission systems is also changing because the grid's technology profile is evolving.

Large-scale deployment of HVDC systems, FACTS devices, digital substations, PMU/WAMS infrastructure, dynamic monitoring systems, and advanced communication networks is increasing the capital intensity of transmission projects. These technologies improve controllability, flexibility, and system visibility, but they also increase project costs and financing requirements.

At the same time, utilities and transmission developers are operating in an environment of:

- Rising interest rates,
- Evolving GNA and PoC frameworks,
- Increasing tariff sensitivity, and
- Growing scrutiny of transmission charges and consumer impact.

For lenders and investors, long-term visibility on utilization, tariff recovery, and regulatory stability therefore become increasingly important.

The challenge is no longer limited to financing individual transmission lines. The sector is gradually moving towards financing a much larger, more dynamic national balancing infrastructure designed to support the integration of renewables on scale.

5.2 Monetization of Transmission Assets

5.2.1 Need for Transmission Asset Monetization

The scale of future transmission investment required for Viksit Bharat 2047 is expected to significantly exceed the capacity of many public-sector entities and utilities to fund new infrastructure projects on the strength of their balance sheets. Asset monetization is therefore emerging as an important mechanism for unlocking capital from operational transmission assets and redeploying it into new infrastructure development.

Transmission assets are particularly suitable for monetization because they generally provide:

- Stable, regulated cash flows,
- Long operational life,
- Predictable returns, and
- Relatively lower demand volatility compared to several other infrastructure sectors.

India's transmission sector is already seeing rising investor interest due to the stable, annuity-like nature of transmission revenues and the growing long-term infrastructure pipeline.

5.2.2 Role of Private Participation in Transmission Expansion

Private participation in India's transmission sector has expanded significantly over the past decade, particularly through Tariff-Based Competitive Bidding (TBCB) projects.

Private developers are now actively participating in:

- Renewable evacuation corridors,
- Interstate transmission systems,
- HVDC-linked projects, and
- Large-scale grid expansion programs.

TBCB has emerged as a major route for developing interstate transmission infrastructure, particularly after the introduction of competitive bidding guidelines under Section 63 of the Electricity Act, 2003. TBCB has grown significantly over the years, leading to faster project execution and greater private sector participation. As per the CEA, as of December 2025, a total of 84 transmission projects had been awarded through the TBCB mechanism. Of the total awarded projects, 43 projects, with a transmission line length of 21,634 ckt km and a transformation capacity of 180,600 MVA, were secured by Power Grid Corporation of India Limited, and 41 projects were secured by private transmission service providers.

The growth of TBCB projects has increased competition, introduced execution discipline, and expanded private-sector participation in transmission infrastructure development. Several large interstate corridors developed through competitive bidding have demonstrated strong execution capability and tariff competitiveness. The sector has also seen growing participation by developers such as Adani Energy Solutions, Tata Power, Sterlite Power, IndiGrid, and Apraava Energy, particularly in renewable evacuation systems and interstate transmission corridors associated with large renewable energy zones.

However, the nature of transmission projects is also changing. Earlier phases of TBCB largely involved relatively conventional interstate transmission systems with clearer load flows and more stable planning assumptions. Future projects are expected to involve:

- Renewable-heavy corridors,
- Anticipatory transmission systems,
- Evacuation infrastructure for Renewable Energy Zones (REZs), and
- Systems linked to emerging demand centers such as green hydrogen and industrial clusters.

These projects involve a different risk profile.

Generation timelines may shift over time. Renewable build-out may occur in phases. Transmission infrastructure may therefore operate initially at lower utilization levels before future generation capacity materializes.

At the same time, project execution risks have increased in several regions due to:

- RoW constraints,
- Environmental clearances,
- Land access challenges, and
- Growing complexity of multi-state coordination.

This has important implications for project financing and bidder behavior.

Aggressive tariff discovery was possible in earlier phases, partly because project risks were relatively more predictable. As execution complexity increases, developers and lenders are becoming more cautious regarding:

- Construction timelines,
- Financing assumptions,
- Equipment lead times, and
- Regulatory certainty.

The sector is therefore entering a phase where financial structuring and risk allocation may become as important as tariff competitiveness itself.

The future growth of private participation will depend not only on the scale of opportunities available but also on how effectively regulatory and contractual frameworks address evolving execution and financing risks.

5.2.3 InvITs and Emerging Monetization Platforms

Infrastructure Investment Trusts (InvITs) have emerged as one of the most important financing and monetization platforms for transmission infrastructure in India.

InvITs allow operational transmission assets to be pooled into a trust structure, thereby enabling them to raise long-term capital from institutional and retail investors. Investors receive returns through stable cash flows generated by operational infrastructure assets.

PowerGrid Infrastructure Investment Trust (PGInvIT) and IndiGrid are among the major transmission-focused InvIT platforms currently operating in India.

IndiGrid, which began with two transmission assets, has since expanded into a diversified transmission platform comprising multiple interstate assets across several states.

Transmission InvITs are attracting growing participation from:

- Pension funds,
- Sovereign wealth funds,
- Insurance funds,
- Infrastructure investment funds, and
- Global institutional investors seeking long-duration stable returns.

These structures offer several advantages:

- Capital recycling,

- Lower financing cost,
- Operational efficiency,
- Balance sheet optimization, and
- Access to long-duration institutional capital.

The growing maturity of India's transmission asset class is therefore gradually transforming transmission infrastructure into an attractive long-term investment platform.

5.2.4 Emerging Monetization Models and Regulatory Challenges

Alongside InvITs, several additional monetization structures are also being explored for transmission infrastructure, including:

- AOMT (Acquire-Operate-Maintain-Transfer),
- OMT (Operate-Maintain-Transfer),
- Long-term lease structures, and
- Transmission platform models.

Among these, AOMT-based structures are increasingly being discussed for the monetization of intra-state transmission assets because they allow:

- Public ownership retention,
- Private operational participation, and
- Long-term capital mobilization while maintaining regulatory oversight.

However, the successful implementation of transmission monetization programs will require significant regulatory clarity in areas such as:

- Tariff treatment,
- Asset valuation,
- Depreciation methodology,
- Transmission charge recovery,
- License transfer, and
- Operational coordination frameworks.

Several investors continue to view regulatory uncertainty as a major risk to transmission monetization.

5.3 Debt and Innovative Financing Instruments for Transmission Expansion

5.3.1 Limitations of Conventional Debt Financing

Traditional debt financing structures are becoming increasingly difficult to align with the future requirements of transmission development.

Transmission assets are designed for long operational life, often extending beyond 35–40 years. However, conventional financing available from commercial banks is usually structured for much shorter durations. This creates refinancing exposure over the asset's life and increases long-term financing uncertainty.

The challenge becomes more pronounced in renewable-heavy systems where transmission infrastructure is increasingly developed ahead of actual utilization requirements.

In several renewable-rich regions, transmission systems must be commissioned before full generation capacity materializes. This is necessary to avoid future congestion and curtailment, but it also means that asset loading in the initial years may remain below long-term design capacity.

From a system planning perspective, such anticipatory investment improves long-term reliability and the capability to integrate renewables. However, from a financing perspective, lower early utilization can create concerns regarding:

- Revenue visibility,
- Tariff sensitivity, and
- Long-term asset recovery assumptions.

This creates a financing mismatch.

Transmission planners must build for future system requirements, while lenders often evaluate projects based on near-term visibility of utilization and cash flows.

The financing environment is also becoming more complex because future transmission systems are significantly more capital-intensive than conventional networks. Large HVDC corridors, digital substations, offshore wind evacuation systems, and advanced grid control infrastructure require higher upfront investment and longer capital commitment.

At the same time, utilities are facing balance sheet pressure due to the overall scale of transmission expansion planned over the next two decades.

Conventional debt financing alone is therefore unlikely to support the full scale of investment required for Viksit Bharat 2047. Future expansion will be increasingly required:

- Long-duration institutional capital,
- Diversified financing instruments,
- Blended public-private financing structures, and
- Mechanisms capable of supporting anticipatory transmission investment.

5.3.2 Emerging Financing Instruments and Long-Term Capital Sources

Future transmission expansion will increasingly require access to diversified and long-duration financing instruments.

Green financing instruments are expected to play a major role because transmission infrastructure is increasingly recognized as a critical enabler of renewable integration and decarbonization.

Potential financing instruments include:

- Green bonds,
- Sovereign green bonds,

- Blended finance structures,
- Multilateral development financing,
- Infrastructure debt funds,
- Pension fund capital, and
- Sovereign wealth fund investments.

Multilateral Development Banks (MDBs) are expected to play a particularly important role in financing:

- Green Energy Corridors,
- HVDC systems,
- Offshore wind integration,
- Digital grid infrastructure, and
- National balancing systems.

Similarly, sovereign wealth funds and pension funds are increasingly viewing transmission infrastructure as a stable long-duration infrastructure asset class due to:

- Predictable cash flows,
- Regulated returns, and
- Lower operational volatility.

India is therefore emerging as one of the largest long-term transmission investment opportunities globally.

5.3.3 Financing the Future Transmission Grid

The future transmission grid will require a significantly more diversified financing ecosystem compared to earlier phases of grid development.

Future transmission financing is expected to increasingly depend on:

- Blended public-private capital,
- Institutional investment platforms,
- Green finance mechanisms,
- Asset monetization, and
- Long-duration patient capital.

At the same time, financing frameworks will need to evolve alongside:

- Anticipatory transmission planning,
- HVDC-based national balancing systems,
- Renewable-heavy grid architectures, and
- Digitally enabled transmission infrastructure.

Transmission infrastructure is therefore no longer merely an engineering investment. It is increasingly emerging as a strategic national infrastructure central to India's long-term economic transformation and clean energy transition.

5.4 Conclusion

India's transmission sector is entering a phase of structural transformation driven by the integration of renewables, industrial electrification, the growth of digital infrastructure, and rising interregional power transfers.

The future grid will require significantly larger investments in interstate corridors, intra-state evacuation systems, HVDC networks, digital infrastructure, and national balancing capability. Financing this transition will require a much broader and more diversified capital ecosystem than earlier phases of transmission development.

Asset monetization platforms, InvITs, institutional investors, green finance mechanisms, and long-duration infrastructure capital are expected to play an increasingly important role in supporting future transmission expansion.

At the same time, transmission planning and financing frameworks will need to evolve alongside:

- Anticipatory network development,
- Renewable-heavy grid operation,
- Emerging demand centers, and
- Increasingly technology-intensive transmission systems.

Transmission infrastructure is therefore no longer only an enabling layer for generation growth. It is gradually emerging as a strategic national infrastructure central to India's long-term economic transformation and clean energy transition.

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LIST OF ABBREVIATIONS

ABT	Availability-Based Tariff
AC	Alternating Current
AI	Artificial Intelligence
BU	Billion Units
CEA	Central Electricity Authority
ckm	Circuit Kilometre
DC	Direct Current
EHV	Extra High Voltage
EPS	Electric Power Survey
EV	Electric Vehicle
FACTS	Flexible AC Transmission Systems
FOR	Forum of Regulators
GEC	Green Energy Corridor
GIS	Gas Insulated Substation
GNA	General Network Access
GVA	Giga Volt Ampere
GW	Gigawatt
HV	High Voltage
HVDC	High Voltage Direct Current
InSTS	Intra-State Transmission System
ISTS	Inter-State Transmission System
kV	Kilovolt
kWh	Kilowatt-hour
MW	Megawatt
PMU	Phasor Measurement Unit
PPA	Power Purchase Agreement
RE	Renewable Energy
REZ	Renewable Energy Zone
RLDC	Regional Load Despatch Centre
ROW	Right-of-Way
SEB	State Electricity Board
STU	State Transmission Utility
TBCB	Tariff-Based Competitive Bidding
TWh	Terawatt-hour
UHVAC	Ultra-High Voltage Alternating Current
UHVDC	Ultra-High Voltage Direct Current
WAMS	Wide Area Measurement System
WEC	Wind Energy Conversion



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Shri Pankaj Agarwal, IAS
Ministry of Power, GoI

Shri Pankaj Agarwal is Secretary, Ministry of Power, Government of India from 1st July, 2023.

Prior to this, Shri Agarwal was Additional Secretary & Director General (Acquisition), Ministry of Defense, Government of India since January, 2022. He was Additional Secretary and Joint Secretary in Cabinet Sectt from 2019 to 2022. Before this, he has held various important portfolios in the Government of Madhya Pradesh. Amongst them, he was Principal Secretary, Public Health Engg., Water Resources, Narmada Valley Development and Micro, Small and Medium Enterprises (MSME) in the State Government of Madhya Pradesh.

Shri Agarwal belongs to the Indian Administrative Service of 1992 batch and has wide experience in the area of Health, Industry, Infrastructure and Finance in a career spanning 29 years. He studied Civil Engineering at IIT, Roorkee followed by Master of Technology in Construction Management at IIT, Delhi and Masters in Public Management at National University of Singapore.



Shri Ghanshyam Prasad
Chairperson, CEA

Shri Ghanshyam Prasad is presently holding the post of Chairperson and Ex-Officio Secretary to the Government of India, Central Electricity Authority, Ministry of Power from 15th July 2022. He is also the Member, ex-officio, of the Central Electricity Regulatory Commission. He belongs to the Central Power Engineering Services batch of 1989.

Prior to this he was holding the post of Joint Secretary in the Ministry of Power from 1st June 2020. He has served in the Ministry of Power for around 9 years in various capacities, i.e. Director (OM, Transmission) and Chief Engineer (OM, Transmission, Reforms & Restructuring and Regulatory Compliance Monitoring).

He did his graduation in B.Tech (Electrical Engineering) for IIT/BHU, Benares Hindu University. He holds a M.Tech in Energy and Environment Management from IIT, Delhi and also a MBA(Finance) from IGNOU, Delhi.

He has served 30 years in power sector and three years in the Bokaro Steel Plant, SAIL. During 30 years in power sector, he has worked and contributed in the areas of generation including the renewable energy, transmission, distribution, power market development/trading of power, Reforms & restructuring in power sector, energy efficiency, regulatory commission experience, disaster management in power sector, data analytics and information management system. A number of measures were taken to reduce the cost of power, ease of doing business, simplification of the procedures for approvals, bringing competition in power sector etc.

He has also served in Haryana Electricity Regulatory Commission for around six years and brought out new regulations.

He also has corporate experience and was Government Nominee Director of Power Grid Corporation of India Limited (PGCIL), a Maharatna Company; Power System Operation Corporation Limited (POSOCO); and Jammu and Kashmir State Power development Corporation Limited (J&KPDCL). Presently he is the Director on the Board of Nuclear Power Corporation of India Limited in an ex-officio capacity.



Shri R V Shahi

President, IEF and Former Secretary, Ministry of Power, GoI

Mr. R V Shahi was Secretary, Ministry of Power, Government of India, from 2002-07 which is the longest term served by any incumbent. In this position, he was responsible for policy initiatives and implementation for India's entire Power Sector (2,00,000 MW capacity) and over significant restructuring with the institution of the Electricity Act 2003, National Electricity Policy 2005 and National Tariff Policy 2006. Other major initiatives include 50,000 MW Hydro Power Initiative 2003, Accelerated Power Development and Reform Programme 2003, Setting up Bureau of Energy Efficiency 2003, Rural Electrification Policy 2005, Ultra Mega Power Policy 2006 and Merchant Power Policy 2006. Mr. Shahi is currently the Chairman of Energy Infratech Pvt. Ltd. and was formerly the Chairman and Managing Director (1994-2002) of professionally managed BSES Ltd (later taken over by Reliance Energy in 2004). He transformed BSES from a small distribution utility to a multi-unit fully integrated power utility having generation, transmission and distribution. At National Thermal Power Corporation (NTPC) from 1978-94, he was the General Manager in charge of Dadri Power Project; Executive Director in charge of Southern Region of NTPC, and Member on the Board of Directors of NTPC in-charge of Operations, R&D and Commercial functions. He has authored several books on the power sector, is a Fellow of the World Academy of Productivity Sciences, Institution of Engineers (India), International Institute of Electrical Engineers, and Indian National Academy of Engineering. He has been on the Boards of Xavier Management Institute Bhubaneswar, IIM Lucknow, and Management Development Institute in Gurugram. Mr. Shahi is a graduate in mechanical engineering from the National Institute of Technology, Jamshedpur, post-graduate in Industrial Engineering, post graduate in Business Management (MBA), and a diploma in Advanced Industrial Management (Delft, Holland). Mr. Shahi is currently, as Consultant, Senior Energy Advisor with the World Bank for South Asia Regional Integration.



Shri Vamsi Ram Mohan Burra

Chairman & Managing Director, Power Grid of India Ltd.

Shri Burra Vamsi Rama Mohan (DIN: 09806168) has taken over the charge of Chairman and Managing Director of Power Grid Corporation of India Limited (POWERGRID), a Maharatna Central Public Sector Undertaking under the Ministry of Power, Government of India. Prior to his elevation, he served as Director (Projects) at POWERGRID.

An accomplished engineering professional, Shri Vamsi is a graduate in Engineering and holds a Post Graduate Diploma in Planning & Project Management along with a Post Graduate Diploma in Management from the Management Development Institute (MDI, Gurugram). He has further reinforced his leadership credentials

through the Harvard Manage Mentor (HMM) Program and advanced management programmes at the Indian School of Business (ISB), Hyderabad.

With over 33 years of rich and diverse experience in the power transmission and telecom sectors, Shri Vamsi has held several key leadership, policy-making, and strategic roles at both regional and corporate level in POWERGRID. His professional expertise spans a wide range of critical business domains, including Projects, Procurement, Commercial, Regulatory Affairs, Asset Management, and Telecom.

Shri Vamsi was a founding member of POWERGRID's Regulatory Cell, where his deep understanding of the power sector's regulatory framework played a critical role in shaping the organization's regulatory strategy. As a key architect of POWERGRID's entry into competitive bidding, he was instrumental in successfully positioning the company in the evolving competitive power transmission market.

During his tenure as CEO of POWERGRID Teleservices Limited, Shri Vamsi led the expansion of the company's telecom business and was instrumental in initiating POWERGRID's first Data Centre project, marking a significant milestone in the organization's digital journey. In his tenure as Director (Projects), POWERGRID achieved several milestones including highest ever Capitalisation and CAPEX.

A strong proponent of digitalization and mechanization, Shri Vamsi has introduced transformational reforms in project monitoring and execution, significantly enhancing efficiency, transparency, and delivery outcomes across large-scale infrastructure projects.



Shri Anil Sardana
Managing Director, Adani Energy Solutions Ltd.

Anil Sardana is presently the Managing Director of Adani Energy Solutions Limited (since 1st May 2018) & also heads Adani Power (w.e.f. July 2020) as its Managing Director. In addition, he holds the responsibility of PSP & Hydros for Adani Green, as designated Chief Business Officer. He is also Adani's oversight Director for Data Center Business, being developed through JV Company. Recently he has been given additional assignment as CEO of Navbharat Mega Developers Pvt Ltd. (Dharavi Redevelopment Project of Mumbai). Till 30th April 2018, he was the CEO & Managing Director of Tata Power for over seven years.

Till 31st January 2011 (beginning August 2007), he was the Managing Director & CEO of Tata Teleservices. Prior to his telecom stint, Anil was the founding CEO & Managing Director of Tata Power Delhi Distribution Limited (TPDDL/NDPL), having taken over the Discom as founding CEO in 2002, when the company was taken over from state owned Discom. Anil is credited with having spearheaded the dramatic turnaround of companies having achieved benchmark performance and won prestigious recognitions.

Anil spearheaded several major M&A's, including with NTT DOCOMO of Japan and a creative reverse equity swap & merger to create most valuable Telecom-Tower Infrastructure company VIOM, with highest tenancy in the industry. Anil led successful launch of Tata DOCOMO & Tata Photon brands. He also launched several innovative schemes including Pay per-use & per-second billing that brought transformation in the Telecom Industry. Anil has more than 46 years of experience in the infrastructure space, particularly in the Energy and Telecom sectors. His work experience includes NTPC (14 years), BSES (7 years), Tata Group (18 years) and Adani Group (8+ years). He is holding Chairman's position at CII National Committee on Power & Infra.

Anil holds Bachelors degree in Engineering from Delhi College of Engineering. He also holds Post-Graduate degree in Cost Accountancy (ICWAI) and Post-Graduate Diploma in Management. He has also attended Top Management Program at the IIM-A (Indian Institute of Management,



Shri Pratik Agarwal

Chairman - Serentica Renewables & Resonia Ltd.
Managing Director - Sterlite Electric Ltd.

Shri Pratik Agarwal is the Chairman of Serentica Renewables, a leading renewable energy developer providing round-the-clock clean energy to large-scale industries; Chairman of Resonia Ltd, a key player in India's power transmission sector; and the Managing Director of Sterlite Electric, a global leader in manufacturing and supply of high-performance power transmission products & solutions.

Serentica's projects, which include a mix of solar, wind, and energy storage technologies, are helping industrial clients reduce their carbon footprint and meet sustainability targets. With a robust portfolio of 7 GW of industrial Power Purchase Agreements (PPAs) signed and government tenders won, Serentica is on track to commission 3 GW of renewable energy capacity by December 2025.

The company's portfolio is set to supply 9 billion units of green energy annually, contributing to the displacement of 47 million tons of CO₂ emissions. Under Pratik's leadership, Resonia Ltd (erstwhile Sterlite Power) has evolved into one of India's most prominent transmission infrastructure developers, focusing on integrating renewable energy into the national grid. Resonia has developed and is executing 24 transmission projects across India (operational flipped, developed, and under construction projects), covering over ~13,700 CKM of transmission lines and attracting over INR 53,000 Crore (as of FY25) in investments.

Sterlite Electric, wire & cables arm, is a market leader in high-performance power conductors, extra-high voltage (EHV) cables and optical ground wires (OPGW). The Company also provides bespoke solutions for the upgrade, uprate, and fiberization of existing transmission infrastructure projects and it has four state-of-the-art manufacturing facilities.

Pratik is a prominent figure in the Indian power sector and has been recognised for his distinguished leadership in the industry. Pratik was also the driving force behind the formation and launch of India's first power sector Infrastructure Investment Trust (InvIT).

Pratik received the Economic Times CEO of the Year Award at the Energy Leadership Summit 2022. In 2018, he also received the Economic Times 40 under 40 award, which recognizes young business leaders under the age of forty.

Pratik holds a Bachelor of Science degree from the Wharton School at the University of Pennsylvania and an MBA from the London Business School.



Shri Vimal Kejriwal
Managing Director & CEO
KEC International Limited

Shri Vimal Kejriwal, Managing Director and Chief Executive Officer of KEC International Limited, brings over four decades of rich experience in Infrastructure, Oil & Gas, Pharmaceuticals, Fertilisers, and Investment Banking sectors. He has been instrumental in driving the company's diversified growth across Power Transmission & Distribution, Civil, Transportation, Oil & Gas Pipelines, Renewables and Cables & Conductors.

Shri Kejriwal's professional journey is defined by his commitment to strategic expansion and operational excellence. Under his leadership, KEC has achieved remarkable growth, executed strategic acquisitions, enhanced manufacturing capabilities, and expanded its presence across multiple geographies. He has navigated KEC through complex challenges, strengthening its competitive edge as a global EPC company.

In addition to his role at KEC, Shri Kejriwal serves on the Boards of KEC's subsidiaries and Raychem RPG Private Limited, an RPG Group company. He is an Executive Council member of the Indian Electrical and Electronics Manufacturers Association (IEEMA) and the Confederation of Indian Industry (CII) Infrastructure Council. In addition, he is a Patron Member of the Construction Federation of India (CFI) and plays an active role on various committees of other key trade associations.



Shri I. S. Jha
Chairman, T&D Group, IEF and Former Member, CERC

Shri I. S. Jha is a distinguished leader in the Indian power sector, with over 43 years of experience spanning power generation, transmission, distribution, system operation, and regulation. He served as Chairman & Managing Director of Powergrid Corporation of India Ltd., where he led transformative growth in India's transmission infrastructure. Later, as Member of the Central Electricity Regulatory Commission (CERC), he played a pivotal role in framing key regulations, including GNA, the Grid Code 2023, and adjudicating critical sectoral disputes. A technocrat with expertise in project management, regulatory frameworks, and stakeholder engagement, Sh. Jha has also been recognized with numerous awards, including Best CEO Awards in Power Sector for three consecutive years by Business Today, the SCOPE Excellence Award, CBIP Award, and the Lifetime Achievement Alumnus Award from NIT Jamshedpur. He holds an honorary doctorate and continues to guide the sector through advisory and institutional roles.

**Dr Subir Sen**

Convenor, T&D Group, IEF
Former ED, POWERGRID

Dr. Subir Sen is currently working as Director(Technical), Tripura State Electricity Corporation Ltd. He has over 35 years of experience in various capacities at senior level positions in premier Central Public Sector Enterprises in power sector viz. POWERGRID and NTPC. Combined an in depth technical, analytical, operational, commercial, organisational, regulatory, project management and capacity building skills in Transmission & Distribution.

Dr. Sen is one of the architect of Indian robust & reliable National Grid through regional grid interconnections, development of Cross-border interconnections, power market, and establishment of Green Energy Corridors comprising Transmission lines, Substations, RE integration, control infrastructures like REMCs, FACTS devices and Energy Storage System facilitating integration of large scale Renewable capacity in a seamless manner. Introduced new technologies like 765kV, 1200kV AC, 800kV, 320kV HVDC, GIS, Digital Substations, Hybrid GIS, WAMS, STATCOM, Series Reactor, Drone based monitoring, EV Charging system, Smart Grid in distribution, Cybersecurity etc. Introduced Smart metering and Smart Grid Technologies in Distribution. Formulated plan for One Sun One World One Grid facilitating rapid clean energy transition. His experience also includes Power System Simulation and analysis, preparation of cost estimates, project viability, design of equipment parameters, technical specifications, bid documents of RE transmission projects, project management and implementation, engaging with broad range of stakeholders, capacity building with special emphasis on RE integration, Electricity Act, Regulations, demonstration projects.



Shri V K Singh
Member (PS), CEA

Shri V.K. Singh (DOB: 12/10/1967) is holding the post of Member (Power Systems) and Ex officio Additional Secretary to the Govt. of India, Central Electricity Authority, Ministry of Power. He belongs to Central Power Engineering Service, 1991 Batch. Prior to this, he was holding the post of Member Secretary, NRPC where he was handling the works of operation, protection, outage planning, energy accounting, commercial matters and coordination among all power utilities of Northern Region States to ensure smooth operation of Grid.

Shri V.K. Singh graduated in Electrical Engineering from IIT Roorkee in 1989 (then known as University of Roorkee). He also completed his MBA (Finance) degree from IGNOU, New Delhi in the year 2002 while in Govt. Service. He joined Central Electricity Authority, Ministry of Power in June, 1992 as Assistant Director (Grade-I). Since, then he is working in Power Sector in different capacities and in different organizations having 33 years of experience in Planning, Hydro construction, O&M of thermal power plant, distribution, construction monitoring of transmission lines and Grid Operation.

During his career, he served for 5 years in Mangdechhu Hydro Project Authority (MHPA), Bhutan on deputation during the year 2014-19, wherein he was extensively involved in the monitoring of the Construction Activities of Dam, HRT, Power House and transmission lines for evacuation of power from the 720 MW Mangdechhu Hydroelectric Project. He also coordinated various activities among different agencies during testing/commissioning of the 720 MW Mangdechhu HE Project, leading to successful commissioning of project during June-August, 2019, which was inaugurated by Hon'ble Prime Minister of India on 17th August, 2019. His contribution in successful commissioning of the 720 MW Mangdechhu HE Project was duly recognized and Official Appreciation Letter was issued by the Hon'ble Minister, Tenzin Gyatso, Royal Govt. of Bhutan (RGoB) and Chairman MHPA.

Shri V. K. Singh also served in NTPC, Farakka STPS for 3 years on deputation as Officer on Special Duty (OSD) wherein he was extensively involved in Operation & maintenance jobs of various electrical equipment of Farakka Super Thermal Power Station (2100 MW). He also supervised Erection & Testing works of CT & Breakers in 08 Nos of bays in 400 KV Switchyard at FSTPP under R&M programme approved by CEA.

In CEA, as a Chief Engineer he was looking after monitoring of transmission projects on all India basis and as a Director/Deputy Director/Assistant Director, he was involved in works related to formulation of National Electricity Plan, Long-term and Short Term Generation Planning for the country, Preparation of Working Group Report on Power for 12th Plan, Policy issues, Allocation of Gas to power plants, Allocation of Power from Central Sector Stations, Power Supply Position, Fuel related issues and miscellaneous subjects.



Shri Samir Chandra Saxena
Chairman & Managing Director, Grid India

Shri Samir Chandra Saxena is the Chairman and Managing Director of Grid India. He is a Fellow of the Institution of Engineers (India), Senior Member IEEE and Distinguished Member CIGRE. He obtained his Bachelor's Degree in Electrical Engineering from Aligarh Muslim University and MBA from Indian Institute of Technology, Delhi and has also completed a Certificate Course in "Regulation of Power Sector" from the Florence School of Regulation, Italy. Prior to assuming the charge of CMD, he was the Director (Market Operation) of the Company. Shri Saxena has about 30 years of experience in diverse areas comprising of Power Market Operations, Power System Operations, Power Exchange Operations, Electricity Market Design, Regulatory Affairs, Integration of Renewables, REC markets design & operations, and SCADA-IT system and has also served as the head of National Load Despatch Centre (NLDC). Shri Saxena has been actively associated with the development of the regulatory framework for integration of Renewables, implementation & development of Ancillary Services, Fast Response Ancillary Services and Market Based Ancillary Services. He was responsible for the implementation of the Real Time Market (RTM) and Integrated Day Ahead Market (including Green Day Ahead Market). He has been associated with the implementation of Security Constrained Economic Despatch (SCED) at inter-state level in India. He also led a pilot study for intra-state SCED implementation with multiple states. He has led the team for implementation of the National Open Access Registry (NOAR), a one stop portal for administration of the Short Term Electricity Market in India. In 2023, as head of the National Load Despatch Centre, he has led the implementation of Market Based Ancillary Services and the implementation of IEGC 2023. He has also been associated with the capacity building of Power System Operators and the System Operator Certification Programs. He represents India in the CIGRE Study Committee C5 on Electricity Markets and Regulation and has many publications related to his work areas in various national and international journals & conferences. He joined our Board in July, 2024.



Shri Awdhesh Kumar Yadav
Chief (Engg), CERC

Shri Awdhesh Kumar Yadav is serving as Chief (Engineering) at Central Electricity Regulatory Commission since June 2022. An officer of the Central Power Engineering Services (1999 Batch) has extensive experience in the Indian power sector spanning transmission planning, grid operations and regulatory frameworks.

He graduated in Electrical Engineering from Madan Mohan Malaviya Engineering College (MMMEC) Gorakhpur in 1997.

He began his professional career with Bharat Heavy Electricals Limited (BHEL) in 1999. Joined Central Power Engineering Service at Central Electricity Authority (CEA) in 2000. During his tenure at CEA, he was associated with transmission planning, various off-line grid functions in the Regional Power Committees, and Tariff Based Competitive Bidding (TBCB) of transmission projects, etc.

At CERC, he has been involved in the formulation of several key regulations, including General Network Access (GNA), the Indian Electricity Grid Code (IEGC), RLDC Fees and Charges Regulations, Tariff Regulations 2024–29, etc. and in the determination of tariffs for thermal power projects, hydro power projects, and transmission projects.



Shri Kailash Kumar Gupta
COO, Central Transmission Utility of India

- Graduated from Govt. of India Engg. College SAGAR in Electrical Engineering with Gold Medal.
- He has done MBA from MDI Gurgaon with specialisation in Finance and Marketing also holds the Diploma in Management and PG Diploma in Operation Management and certification course from Harvard Business Publishing.
- Presently he is heading CTUIL as a COO, before this he was posted in various regions for a period of around 25 years such as North East Regions, Western Regions, Chhattisgarh Projects, Northern Region III and NERPSIP in various capacities. During this tenure, handled various functions such as planning and monitoring, engineering, Project execution, HRD, Commercial etc.
- He was also posted in Contracts and Material Management Dept, Corporate Centre at Gurgaon for a period of around 5 years.



Shri Ashwin Gambhir
Fellow, Prayas (Energy Group)

Shri Ashwin Gambhir has been a Fellow with the Prayas (Energy Group) since 2009. He coordinates the work on renewable energy, energy storage and transmission. He is part of the team working on issues related to electricity policy, regulation, energy data and power sector modelling. He has an MS in Mechanical Engineering from the University of Massachusetts, Amherst. He has been part of several official Committees & processes representing Prayas (Energy Group) with MNRE, Niti Aayog, CEA, SERCs and GoM.

**Dr D. Sai Baba**

Addl. Secretary (Trans), MoP, GoI

Dr. D. Sai Baba (Darbamulla Saibaba) is a senior bureaucrat serving as the Additional Secretary (Transmission, V&S) in the Ministry of Power, Government of India. A member of the 1993 batch of the Indian Railway Service of Mechanical Engineers (IRSME), he brings over three decades of core infrastructure management experience to his current role. Based out of Shram Shakti Bhawan in New Delhi, he was elevated to the post of Additional Secretary in December 2025 following a successful tenure as Joint Secretary within the same ministry, demonstrating a proven track record in national policy execution.

In his current capacity, Dr. Saibaba plays a pivotal role in shaping India's power transmission landscape and driving critical sector reforms. His responsibilities encompass overseeing transmission policies, vigilance, and security, with a strong focus on resolving complex infrastructure challenges. He has been instrumental in reforming the transmission sector by addressing Right of Way (RoW) issues through pragmatic compensation policies, optimizing the utilization of existing power grids, and accelerating project implementation timelines across the country.

Furthermore, his work extends to navigating modern energy challenges, including grid stability and the smooth integration of renewable energy sources into the national power grid. Beyond policy formulation, he has also contributed to digital administration by serving as a nodal officer for the ministry's web domain coordination.

**Shri Naveen Srivastava**

Director (Operations), POWERGRID

Shri Naveen Srivastava (DIN: 10158134), a dynamic leader, brings a wealth of expertise to the table. He is an accomplished electrical engineer, having graduated in Electrical Engineering (Hons) from the prestigious National Institute of Technology - Durgapur, and has honed his leadership skills through a General Management Programme at the Management Development Institute, Gurgaon, and the Harvard Manage Mentor program at Harvard Business-School. With over two decades of experience in operations, Mr. Srivastava has consistently driven success across multiple facets, including Operations and Maintenance (O&M), Testing and Commissioning (T&C), and cutting-edge SCADA and communication technologies. He has been honored with the prestigious "Sustainability Leader of the Year Award 2024" by the Global Energy & Environment Foundation for his outstanding achievements in the Power Transmission sector, and has also been conferred the Exemplary Service Award 2025 in special recognition of his distinguished contributions and exemplary commitment to the industry.

**Shri Randeep Narang**

Managing Director & CEO, Transrail Lighting Limited

With around four decades of rich experience across diversified sectors, Mr. Randeep Narang brings deep domain expertise in the Power Transmission & Distribution sector, including extensive exposure to international markets. Over the course of his distinguished career, he has held several leadership positions across reputed organisations like Bharti Airtel Limited, CEAT Kelani Holdings, KEC International Limited to name a few. As the Managing Director & CEO of Transrail Lighting Limited, Mr. Narang has been instrumental in driving the company's transformation into a global EPC player in the Transmission & Distribution sector spanning over 63 countries while having a prominent presence in India's T&D EPC sector. The company provides turnkey solutions across multiple business verticals including Transmission & Distribution, Civil, Railways, Poles & Lighting and Solar.

**Shri Manish Agrawal**CEO of Conductor & Telecom Businesses at APAR Industries Limited
Managing Director of APAR T&D Projects Private Limited.

APAR is a global leader in energy and telecom infrastructure solutions — the world's largest manufacturer of aluminium and alloy conductors, amongst the world's top five manufacturers of CTC and PICC products, India's largest HTLS reconductoring EPC Company, and the world's third-largest transformer oils manufacturer.

Today, APAR has a presence in over 140 countries and a market capitalisation of USD 5 billion, with annual revenues of USD 2.5 billion.

A distinguished Harvard alumnus and a veteran in the energy-infrastructure sector, Mr. Agrawal brings over 29 years of experience across the power and telecom industries, in India and overseas. He currently also serves as the Chairperson of ASSOCHAM's National Council on Power Transmission.

Widely recognised for championing industry-shaping initiatives, Mr. Agrawal has played a significant role in advancing infrastructure modernisation, Make in India, power transmission fibreisation, and technology-led transformation. His strategic leadership continues to drive.

**Shri Ganesh Srinivasan**

President – Transmission & Distribution, KEC International Limited

Mr. Ganesh Srinivasan is the President – Transmission & Distribution at KEC and is responsible for the India and International portfolio for the T&D Business. He has over 25 years of experience in Transmission, Distribution and functionally in Strategy, Operations and Growth.

KEC International Ltd., a part of the RPG Group, is a global infrastructure EPC major with a strong presence across power transmission & distribution, railways, civil, urban infrastructure, solar, and cables. With operations spanning over 110+ countries, KEC has established itself as a leader in executing large and complex power transmission projects worldwide. The company is known for its engineering excellence, robust project execution capabilities, and commitment to quality, safety, and sustainability.

**Shri Akilur Rahman**Chief Technology Officer (CTO) - India;
Market Innovation Lead - South Asia, Hitachi Energy

Akilur Rahman, Hitachi Energy - CTO (India) and Market Innovation Lead (South Asia), is leading technology, digitalization and innovation towards the market and customers in India and supporting market innovation in south Asia. Has more than three decades of experience in research, R&D, technology management, engineering, consulting business and product development in power, automation and digital technologies.

With a master's degree in electrical engineering from IIT Kharagpur, Akilur has held various international and global roles in India, Germany and Switzerland including head of global collaborative production management, engineering, and cyber security in process/industrial automation. Was responsible for building up ABB's global automation software product and system R&D in India. Led ABB corporate research center and technology in India with focus on power, automation, robotics, analytics, AI-ML, Industry 4.0, Industrial IoT and digitalization. Previously held the role of CTO - ABB India.

In the current Hitachi Energy, Akilur has been leading core, automation and digital technologies for power, energy and asset performance management in utilities, industries, infrastructure, and transport sectors. Cocreating the concepts and applications of smart electric grid, energy internet, smart cities, sustainable electric mobility, smart production, digital enterprise, carbon-neutral energy future, ESG and CSR.

With the mission of faster time to market of technologies, Akilur is connecting market, customers, industry bodies and stakeholders with Hitachi Energy and Hitachi businesses to collaborate on energy transition and digital transformation. Akilur has been a thought leader/speaker and panelist at various international and national conferences.

**Shri Jitendra Srivastava**

Chairman & Managing Director, REC Limited

Shri Srivastava is a seasoned civil servant with over two decades of distinguished service. Over the years, he has held several key administrative and leadership roles across the Government of India and the Government of Bihar.

Shri Srivastava has served as Joint Secretary in the Department of Drinking Water & Sanitation, Ministry of Jal Shakti from January 2023 onwards. Earlier, he served as Secretary to Govt. of Bihar in Home Department and Public Health Engineering Department (PHED).

His postings have included important assignments in sectors such as finance, power sector, education, public health, and infrastructure. His deep understanding of grassroots governance, combined with his experience at the central level, makes him well-equipped to steer REC's strategic objectives and support India's growing power and energy needs.

He holds a B.A. (Hons) in Economics from Delhi University's Hansraj College and MBA (Finance) from Cochin University of Science and Technology.

**Shri Balawant Joshi**

Managing Director, Idam Infrastructure Advisory Pvt Ltd

Balawant Joshi is a founder, promoter and Managing Director of Idam Infrastructure Advisory Private Limited. He is also director on the boards of Enfragy Solutions and Aurus Lending Solutions Pvt Ltd. Balawant had started Origin Renewables Pvt Ltd, an innovative platform for solar rooftop services which he exited in 2020 by selling it to private equity. Balawant is a Founder Member and Secretary of Indian Renewable Energy Federation. He is a member of Institute of Electrical and Electronic Engineers (IEEE) and Life Member of Computer Society of India. Recently, he has been appointed as Member of Advisory Board of Power Exchange India Limited.

With more than 30 years of experience in the power sector, he is a well-known expert on policy/regulatory matters concerning electricity, renewable and energy efficiency. His experience spans from operation of power systems to financial modelling and valuation, from Utility to consulting, from technology to regulatory.

He has been extensively involved in restructuring/ reforms of utilities and has dealt with various issues ranging from financial restructuring, regulatory, financial due diligence, assessment and development IT processes, etc. He has been associated with design, development and implementation of several regulatory initiatives such as MYT, FITs for several technologies, RPOs, power trading, licensing, etc.

In clear energy sector, he has several 'firsts' to his credit such as Feed-In Tariff (FIT) determination for wind, solar and biomass. He was involved in implementation of the first Renewable Purchase Obligations at the state level. He was involved in design and implementation of 'Renewable Energy Certificates' as well as 'Energy Saving Certificates' mechanisms. He has supported several states in developing RE/ solar related policies. Recently, he was involved in development of Wind Repowering Policy, Prime Minister Solar Rooftop Scheme for Government of India.

He has worked extensively with public/ private sector as well as multilateral agencies such as World Bank, GIZ, ADB, USAID and international NGOs / Associations on issues associated with power sector reforms and clean energy development across Indian states. Apart from India, he has worked on engagements in several countries such as EU, Maldives, Eswatini, Kenya, Sri Lanka, Bangladesh, Thailand, Micronesia, Nepal, etc.

Balawant has been closely associated with various industry bodies. In the past, he was member of Power Committee, Renewable Energy Committee and Climate Change Business Council of CII. Currently, he is a member of Energy Transition Task Force of CII Southern Region. He is a member of Wind Repowering Committee of MNRE. He is also member of Advisory Board of IPPAI.

Balawant is an electrical engineer with post-graduation in both finance and software technology.



Smt. Mani Khurana
Senior Energy Specialist, World Bank

Mani Khurana is a Senior Energy Specialist with the World Bank. Working for over seventeen years in the World Bank and leading investment projects and analytical activities across the energy sector value chain. She has been leading the Bank's power sector engagement in various states in India. The engagements include financing of the critical power infrastructure and providing technical assistance to improve the operational efficiency and financial sustainability of the power sector utilities. She is also leading the World Bank dialogue on Energy transitions, including solar rooftop, battery storage and offshore wind. She has co-authored many World Bank studies, including a study on the Financial performance of India's power sector: Beyond Crisis. The book assessed the situation of India's power sector 10 years after the landmark Electricity Act 2003. She has been recognised as one of Asia's Most Influential Women in Renewable Energy. She has a master's in business administration from the Indian School of Business and holds a master's degree in economics from the Delhi School of Economics.



Shri Akshay Hiranandani
Chief Executive Officer, Serentica Renewables

Akshay Hiranandani is the Chief Executive Officer of Serentica Renewables, a decarbonisation platform, focused on providing renewable energy to energy-intensive industries. He is driven by the pursuit of making renewable energy a feasible solution for these industries, and he is committed to helping Serentica achieve its mission of reversing climate change.

Akshay has over 20 years of experience in the corporate finance and development industry. He has raised over \$1.5 billion across debt and equity while working for domestic and international developers and has supervised the development and execution of more than 1 gigawatt of renewable energy projects. Prior to joining Serentica, Akshay was the Head of Structured Investments and Project Finance at Piramal Capital, where he deployed and exited over \$1 billion of exposure in infrastructure.



Shri Sushant Kansal
Vice President – Lending & Project Finance, NABFID

Mr. Sushant Kansal is a finance professional with experience in project finance, corporate finance, and structured finance in the infrastructure and energy sectors. He is currently associated with the National Bank for Financing Infrastructure and Development (NaBFID), where he focuses on infrastructure financing and development initiatives.

Prior to NaBFID, he worked with YES BANK as Sector Lead – Energy, Project Finance Business, and has also been associated with Axis Bank. He has extensive experience in financing renewable and conventional energy projects and structuring complex infrastructure financing transactions. Mr. Kansal is an alumnus of the Faculty of Management Studies (FMS).



Shri Satyan Kumar
Sr. Vice President, Sekura

Satyan Kumar brings over 26 years of leadership experience across Project Debt Syndication, Project Finance (Infrastructure & Non Infrastructure), Corporate Credit, and Structured Finance, spanning Banks, NBFCs, and Corporates. He has built a strong track record of evaluating, structuring, and closing complex infrastructure financing transactions across sectors.

He currently heads the Project Finance and Treasury functions at Sekura India Management Limited, where he is also a core member involved in project acquisition and financing. Over the past 15 years, he has worked extensively across renewable energy (wind & solar), roads, and transmission projects, contributing to several high value transactions.

Prior to joining Sekura India Management Limited, Satyan has worked with leading institutions including Dena Bank (now Bank of Baroda), IL&FS Financial Services, and L&T Financial Services (LTFS), gaining deep exposure to credit appraisal, structured financing, and infrastructure domain expertise.

For the last five years, he has been steering the Treasury and Project Finance functions for Sekura India Management Limited, the platform for the EAAA Infrastructure strategy. During this period, he has played a pivotal role in raising funds for all projects acquired by the platform, including the Energy InvIT and Transport InvIT, contributing significantly to the platform's growth and investor confidence.

ABOUT ORGANISER

India Energy Forum

India Energy Forum is a unique, independent, non-profit research organization and represents energy sector as a whole. It was set up in February 2001 and formally inaugurated in January 2002. The mission of IEF is to help evolve a National Energy Policy aimed at development of a sustainable and competitive energy sector in India. It is, probably, the only organization which championed the cause of TOTAL ENERGY – all forms of energy ranging from Coal, Power – Thermal & Hydro, Oil & Gas, Nuclear and Renewable from the beginning of its function. This feature of its functioning gave a distinctive advantage of taking an integrated look on the energy scene. In fact, IEF did frame an Energy Policy document which became an input to the Planning Commission's Integrated Energy Policy brought out in August 2006. Its membership includes all the key players of the energy sector both from private and public and over 140 highly respected energy experts.

The Forum has an MOU with International Solar Alliance to promote the development solar power projects not only in India but throughout the world.

Every year it organizes its flagship events viz, National Power Conference, Oil and Gas Conference, Renewable Energy Summit, National Conference on Coal and Nuclear Energy Conclave besides webinars which are organized almost every month.

It also organises “India Energy Debate” - a monthly discussion to debate the critical issues of India's energy sector.

It publishes a monthly e-journal TOTAL ENERGY which provides authentic information on the whole energy sector at one source. It also brings out DAILY ENERGY NEWS REPORT.



For Further enquires, please contact:
Shri S.S. Rawat, Head (Admin)

India Energy Forum

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Shri V.K. Sehgal Former CMD, SECL		Shri Ashok Mehta Former CMD, WCL

Organising Committee of National Conference on Power Transmission

- **Shri I S Jha**, Chairman, Transmission & Distribution Group, IEF; Former, CMD, PGCIL - **Chairman**
- **Dr Subir Sen**, Convenor, Transmission & Distribution Group, IEF; Former ED, PGCIL - **Member**
- **Shri Balawant Joshi**, Mg Director, Idam Infrastructure Pvt. Ltd. - **Member**
- **From the Secretariat: Shri S S Rawat**, Head (Admn), IEF

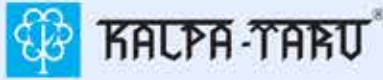
KNOWLEDGE PARTNER

Idam Infrastructure Advisory Pvt Ltd (Idam Infra or Idam) is a leading advisory firm dedicated to enabling India's clean energy transition. Established in 2007 and headquartered in Mumbai, Idam Infra is an ISO 9001:2015 certified organisation that works closely with policymakers, electricity regulatory commissions, project developers, financial institutions, and multilateral agencies to address critical challenges in the power sector.

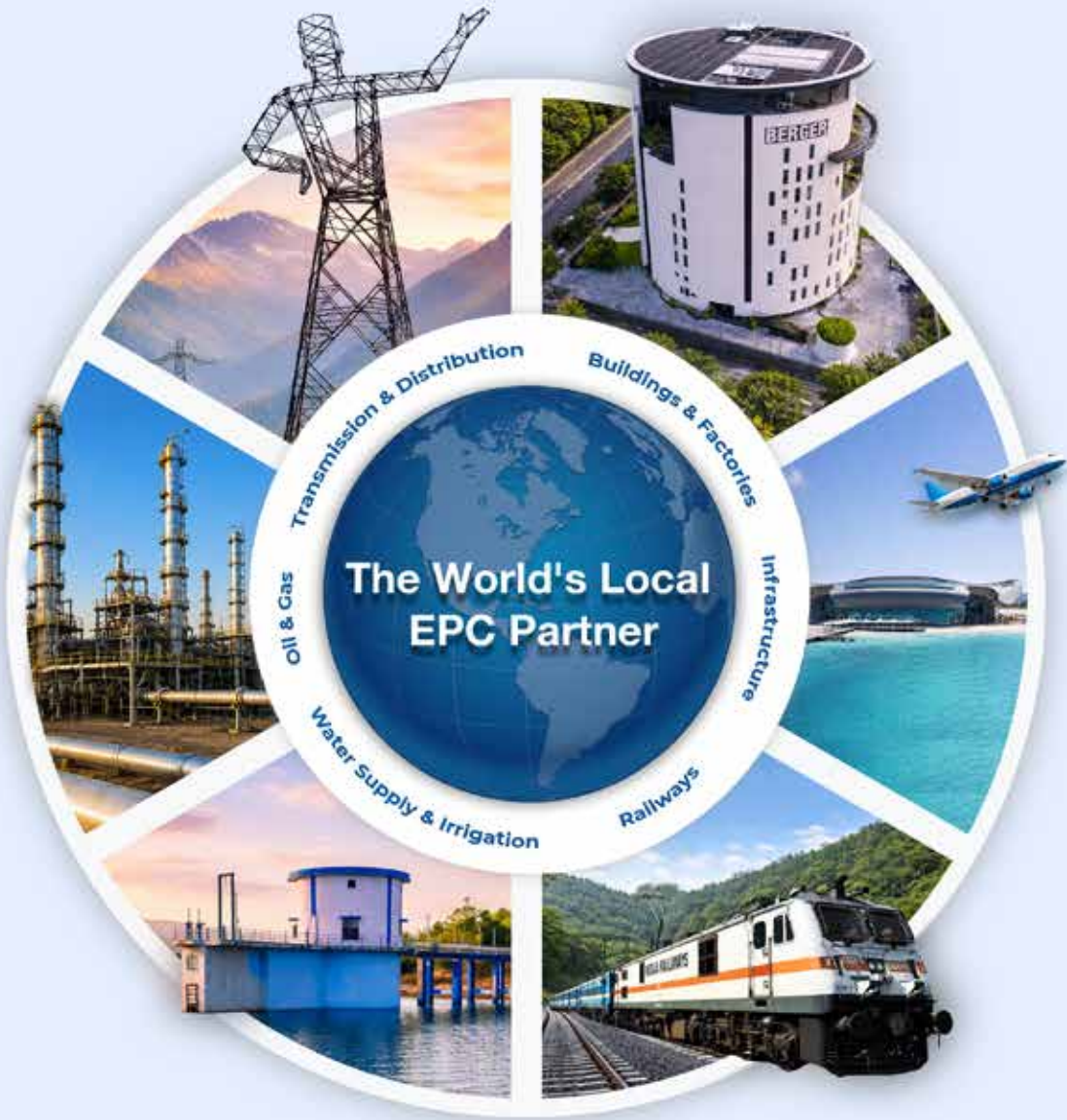
Its expertise spans renewable energy integration, energy efficiency, power market reforms, and digital solutions for utilities, combining policy insights, financial structuring, and technology solutions across the energy value chain. Idam has supported landmark initiatives with MNRE, MoP, CERC, PFC, REC, the World Bank, and ADB, contributing to policy frameworks, regulatory design, and capacity-building programs.

Through its wholly owned subsidiary, Enfragy Solutions India Pvt. Ltd., Idam Infra also delivers IT, geospatial analytics, and energy efficiency services, enhancing operational capabilities for utilities and market operators. By bridging policy, markets, and technology, Idam Infra continues to drive scalable and sustainable clean energy solutions for India's energy transition.

More details: www.idaminfra.com



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Projects

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Countries

5
Continents

55
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We deliver Power to the People.



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GRID
FREQUENCY



**पावरग्रिड
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Transmitting Power, Transforming Lives

**One of the World's Largest
Electric Power Transmission Utility**

POWERGRID's areas of operations



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- **Sub-stations** - 291
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- **Transmission related consultancy:**
Global footprints in 25 countries
- **POWERGRID Academy of Leadership:**
550+ courses catering to professionals
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