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Making an Impact

High-quality discussions, debates and technology advances at TransTech India 2025

Power Line held the second edition of its trade show, TransTech India Exhibition and Conference, on December 10-12, 2025 at the Yashobhoomi India International Convention Centre in New Delhi.

The mission of TransTech India is to provide a platform for industry leaders, innovators and visionaries to showcase the latest advancements, exchange insights, and forge collaborations that will shape the future of power transmission in India.

The three-day event this year was bigger and better than the previous edition, almost double the size in terms of area and attendance. It was supported by the Ministry of Power and the country's top transmission developers – Power Grid Corporation of India Limited, Adani Energy Solutions Limited, IndiGrid, Resonia and Tata Power. It was also supported by Global Transmission Report, the leading provider of information and analysis on the global electricity transmission industry.

The event received a tremendous response from the industry. It attracted more than 3,000 visitors from over 500 organisations, representing developers, government agencies, state transcos, system operators, regulators, technology providers, EPC contractors, financiers/investors, consultants, etc. It had representation from almost every state and every segment of the industry as well as international participation.

The inaugural address was delivered by V.K. Singh, Member, Power Systems, Central Electricity Authority, and was followed by remarks by Pratik Agarwal, Managing Director, Sterlite Electric, and Chairman, Resonia and Serentica Renewables. The high-level conference had a stellar cast of speakers, with CEOs and CXOs from leading power companies and other major stakeholders.

The conference featured views from the top, the EPC perspective, state initiatives, O&M best practices, GRID-INDIA initiatives, as well as discussions on topics such as supply chain and procurement challenges, cross-border transmission, renewable energy evacuation, and skill development for transmission. It had dedicated technical sessions on towers, transformers, substations, AI and digitalisation, drones, and cables and conductors. It also witnessed the presentation of transmission utility awards.

TransTech India 2025 received overwhelmingly positive feedback from participants. They described it a significantly larger and more impactful event than the previous edition. With increased participation from utilities and key industry players, it provided a valuable platform for interaction, collaboration and business development.

Most notably, the exhibitors highlighted the high quality of visitors, noting that every attendee was relevant and actively engaged in the transmission sector. This enabled meaningful interactions with key clients, prospective partners and vendors, and offered an opportunity for networking, business development and gaining insights into emerging technologies.

Encouraged by the success of this event, Power Line has decided to hold TransTech ASEAN 2026, the first trade show in the ASEAN region focused solely on power transmission. It will be held on April 22-24, 2026 at Indonesia Convention Exhibition (ICE) BSD City. Meanwhile, the third edition of TransTech India will be held on October 14-16, 2026 at the Yashobhoomi India International Convention Centre in New Delhi. ■

Remarks by V.K. Singh

"Transmission planning has shifted to a renewable energy potential-based approach"

V.K. Singh, Member, Power Systems, Central Electricity Authority (CEA), delivered the inaugural address at the Power Line TransTech India 2025 Exhibition and Conference. He outlined the key priorities and evolving requirements of the transmission sector, stating that transmission serves as the backbone for evacuating renewable energy from resource-rich regions to load centres. Edited excerpts from his address…

India's energy transition is being driven by rapid capacity additions in solar, wind and hydropower, underscoring the need for a strong, flexible and future-ready grid. Grid reliability and resilience, optimal utilisation of renewable energy, reduced curtailment, and the integration of technologies such as battery storage, green hydrogen and offshore wind remain central priorities.

India operates the world's largest synchronous grid. As of end-October 2025, the national transmission network spans nearly 498,000 km of 220 kV and above lines, with around 1,400 GVA of transformation capacity, including high-voltage direct current (HVDC) systems. Inter-regional transmission capacity has expanded to about 120 GW and is projected to reach 167 GW by 2031-32, enabling reliable power transfer from generation centres to load centres across regions.

Renewable energy capacity, currently at 250 GW, is expected to reach 500 GW by 2030 and around 600 GW by 2032. Long-term projections up to 2047 indicate renewables accounting for nearly 80 per cent of the power mix. To support this scale-up, the CEA has estimated a requirement of 650,000 circuit km of additional transmission lines and 2,412 GVA of transformation capacity, including HVDC, by 2032.

Planning reforms and policy initiatives

Transmission planning has shifted to a renewable energy potential-based approach, providing visibility for projects up to 2032 and aligning transmission readiness with renewable capacity addition. This is aimed at avoiding mismatches and reducing renewable energy curtailment. The tariff-based competitive bidding model continues to enable faster and more cost-effective project development, with several states adopting the framework, particularly for projects above specified thresholds.

A national single-window clearance system has been introduced to eliminate physical submissions and streamline approvals. In addition, revised right-of-way (RoW) compensation guidelines provide 100 per cent compensation for tower base footing and 30 per cent for transmission corridors. Nine states have adopted the central framework, while Rajasthan has enhanced compensation to 200 per cent for tower footing and 60 per cent for corridors.

Large renewable and storage-based hybrid projects are being developed across Rajasthan, Gujarat, Andhra Pradesh and Karnataka. Following the publication of resource adequacy plans, states are being guided to prepare intra-state transmission plans through joint studies with state transmission utilities. Plans for the north-eastern and most eastern states have been completed, with the remaining expected by January 2026, improving long-term visibility for the industry.

Execution challenges and the road ahead

Key challenges continue to include RoW and land acquisition issues; delays in permits and environmental clearances; long lead times for manufacturing transformers, reactors and equipment; and limited domestic capacity for cold-rolled grain-oriented steel. These are being addressed through high-level monitoring of clearances, with the involvement of senior officials and district administrations.

The shortage of skilled manpower, particularly for transmission line erection, has also emerged as a concern. New skill development centres are being planned in select states, alongside a call for industry-led training facilities. Integrating large volumes of variable renewable energy will require stronger forecasting, adequate reserves and balancing mechanisms, along with enhanced cybersecurity and resilience for critical infrastructure. Greater coordination among generators, transmission planners, load centres and state regulators remains essential.

Timely commissioning, quality execution, safety and long-term reliability were emphasised, amid rising incidents of transformer and tower failures. The adoption of advanced technologies such as HVDC, reconductoring with advanced conductors, integration of storage solutions and strengthening of domestic supply chains will be critical to reduce dependencies and lead times. Ongoing initiatives, supported by coordinated industry action, are expected to help build a robust transmission infrastructure by 2032, support the Viksit Bharat@2047 vision and meet long-term net-zero commitments. ■

Remarks by Pratik Agarwal

"India's transmission sector has entered a new growth phase"

Pratik Agarwal, Managing Director, Sterlite Electric, and Chairman, Resonia and Serentica Renewables, delivered the inaugural remarks at the Power Line TransTech India 2025 Exhibition and Conference. He highlighted the strong performance of India's transmission sector and the growth of the transmission infrastructure. He also deliberated on the major opportunities and challenges in the sector. Excerpts…

Sector at a glance

POWERGRID has shown leadership in the sector and has consistently invested in introducing new technologies. India has emerged as one of the world's largest countries to successfully implement the tariff-based competitive bidding (TBCB) model, which has encouraged private participation and innovation, and reduced project costs. The country has commissioned or is building more than 100 projects through the TBCB route. India has also strengthened its planning and market systems, creating a strong foundation for further growth and modernisation. India's transmission sector has entered a new growth phase, with the focus shifting from the expansion of the central transmission network to the strengthening of state transmission systems. Over the next 10 years, states will need major investments to enhance their load-handling capacity and align the state grids with the national grid.

Opportunities

India's legal framework, particularly Section 164 of the Electricity Act, 2003, enables the development of electricity transmission infrastructure projects with ease. Over the years, domestic suppliers, technology players, research and development institutions, academia, engineering, procurement, construction (EPC) companies and original equipment manufacturers have created a thriving ecosystem and have driven significant capex in transmission at both the central and state levels.

Regional and international interconnections present a strategic opportunity through initiatives such as One Sun, One

World, One Grid. Further, with round-the-clock power becoming viable at prices that are globally competitive, there is an underlying opportunity for India to become a global energy powerhouse, exporting clean electricity through HVDC and submarine cable networks. This will enable India's grid to connect not only to neighbouring regions, but also westward to the Middle East and eastward to Southeast Asia, including Thailand, Singapore and Japan.

Challenges

Project delays in the power transmission segment remain a major concern. Nearly 90-95 per cent of projects face delays of at least a year, with 30-40 per cent facing delays of over two years. Although India's power transmission projects have an average completion period of four years, which is still among the best globally, there is scope to reduce it to three years or less to meet future electricity demand. Right-of-way issues cannot be resolved through financial compensation or enforcement alone, but require systematic stakeholder engagement built on trust and communication. In this regard, Resonia's efforts to create a structured stakeholder management playbook are fostering collaboration and enabling smoother execution. In addition, the shortage of skilled labour and low levels of mechanisation in transmission construction pose a challenge in project execution. For instance, the development of 1 km of a 400 kV double-circuit line still requires about 1,300-1,500 man-days in India, versus around 700 man-days in Brazil or Thailand, and only 150 man-days in Europe.

The way forward

India is emerging as a global powerhouse, delivering 15-20 GW of round- the-clock green power annually. The country's unique capability to support upcoming high-demand sectors such as data centres positions India as a potential global hub owing to its ability to deliver reliable, affordable and renewable power faster than most economies. In a scenario of rapid renewable capacity additions, adopting digital solutions can enhance grid flexibility and protect project returns.

With respect to manpower shortages in transmission project development, EPC partners can collaborate to build a fully mechanised, technology-enabled transmission construction ecosystem in India, targeting the global efficiency standards of about 200 man-days per km.

While achieving global leadership is difficult, sustaining the position requires continuous innovation, faster project execution, adoption of advanced technology and progressive policy frameworks. In this regard, India is at the forefront of global electricity systems, with transmission as the central pillar enabling the future. ■

Remarks by Naveen Srivastava

"Digitalisation will play a central role in strengthening grid resilience"

In a special session at Power Line TransTech India 2025, Naveen Srivastava, Director (Operations), Power Grid Corporation of India Limited (POWERGRID), discussed the scale and evolution of India's transmission network, with a focus on asset management, digitalisation and renewable energy integration. He highlighted how climate resilience, grid security and advanced technologies are becoming central to transmission planning and operations. He also outlined how workforce skills and data-driven systems are shaping the future of grid management. Edited excerpts…

Network scale and asset management

POWERGRID's transmission network today comprises more than 287 substations with a total transformation capacity exceeding 550 GVA. Over the next five years, additional high-voltage direct current systems and 800 kV substations are planned, strengthening the national grid backbone. A key milestone in this journey has been the commissioning of the country's first 765 kV digital substation at Navsari, Gujarat, which demonstrated the practical deployment of digital technologies in high-voltage transmission infrastructure.

Asset management extends far beyond routine operations and maintenance. It is a collaborative and multi-disciplinary function that brings together equipment upkeep, supply chain coordination, skill development, cybersecurity and continuous innovation. As wind energy zones expand and extreme climatic events such as cyclones and floods become more frequent, strengthening transmission towers and designing resilient systems have become essential elements of asset planning.

Key challenges

The challenges facing transmission operations can be broadly grouped into four or five major categories. The first relates to India's diverse and often difficult geographical conditions, including hilly regions, dense forests, cyclonic belts and flood-prone areas. These conditions pose reliability concerns and significantly complicate construction, inspection and maintenance activities.

The second major challenge is grid security, which becomes increasingly critical as the transmission network expands in scale and complexity.

The third challenge is the need for continuous innovation. Rapid global advances in grid technologies require utilities to constantly upgrade systems and processes to ensure the delivery of reliable and quality power to end-consumers.

Skill development is an equally critical challenge. The increasing role of software and digital tools in asset management has prompted POWERGRID to incorporate artificial intelligence and machine learning into training programmes and explore the recruitment of data scientists.

Future outlook

Looking ahead, digitalisation is expected to play a central role in strengthening grid resilience and operational efficiency. The centralised monitoring and maintenance of remote substations require strong cyber resilience, continuous system upgrades and advanced analytics. Practices such as transformer health indexing are being used to determine asset criticality, while drones are deployed for transmission line inspections to enable faster identification of defects, despite certain operational limitations. Several technology pilots are under way, including dynamic line rating projects that use sensor-based systems to assess real-time transmission capacity. Smart substations are being deployed, and digital twin pilots have been initiated for few substations to simulate operational scenarios and optimise network behaviour.

Cybersecurity remains a key focus area, supported by a dedicated centre of excellence established at the Indian Institute of Science, Bengaluru. On renewable energy integration, large volumes of solar and wind power are already being injected into the grid, with offshore wind expected to emerge as the next major contributor. These challenges are most pronounced in states such as Rajasthan and Gujarat. Declining system inertia is a key technical issue, which is being addressed through the commissioning of 17 static synchronous compensators (STATCOMs) to enhance grid stability. Given the intermittent nature of renewable energy, the deployment of battery energy storage systems will be fundamental to maintaining grid reliability. Improved performance in Rajasthan and Gujarat following the commissioning of STATCOMs has already contributed to better power quality and enhanced energy security, underscoring the importance of technology-led interventions in the transmission sector. ■

Views from the Top

Call for faster project execution, deeper technology adoption

In a panel discussion among Manish Agrawal, Chief Executive Officer (CEO), Conductors and Telecom Businesses, APAR Industries Limited, and Managing Director (MD), APAR T&D Projects Private Limited; Venu Nuguri, MD and CEO, Hitachi Energy India; Arun Sharma, CEO, Resonia; and Sandeep Zanzaria, CEO and MD, GE T&D India Limited, critical issues facing the sector, such as right-of-way constraints and the need for faster project execution, were discussed. The panellists highlighted how digitalisation, advanced technologies such as monopoles and gas-insulated substations, and policy reforms could help bridge infrastructure gaps in the transmission sector. Edited excerpts...

Efficient evacuation of renewable power has become central to the viability of the clean energy sector, underscoring the need for timely strengthening of the transmission network. While generation capacity continues to scale rapidly, delays in transmission development could create stranded assets and undermine investor confidence.

One of the most effective pathways to rapidly enhance grid capacity is through augmenting existing transmission corridors. Given India's high population density and limited land availability, reconductoring and uprating of already-built lines offer a cost-effective and time-efficient alternative to developing new corridors. Several transmission assets in the country have been in operation for four to five decades, making their upgradation essential, not only for capacity enhancement but also for long-term reliability and safety.

Right-of-way constraints remain a persistent challenge across both greenfield and brownfield transmission projects. Land acquisition complexities, social resistance and procedural delays continue to impact project timelines and costs. To mitigate these constraints, utilities are increasingly being encouraged to adopt advanced design and construction solutions. Technologies such as monopoles, insulated cross-arms and compact tower configurations can significantly reduce land requirements while enabling higher power transfer capacity.

Another important dimension in transmission planning is greater consideration of technical losses during project evaluation. Loss capitalisation remains underutilised in current procurement frameworks, despite its potential to influence long-term system efficiency and emissions reduction. By explicitly accounting for losses and incorporating them into project evaluation, utilities can justify the adoption of conductors and equipment with higher current-carrying capacity and lower resistive losses within the same physical footprint.

(from left) Alok K. Brara, Power Line Magazine; Arun Sharma, Resonia; Venu Nuguri, Hitachi Energy India; Manish Agrawal, APAR Industries and Sandeep Zanzaria, GE.

Technology adoption

Digital transformation is expected to be a key driver of change in the transmission sector. As renewable energy penetration increases, grid operations are becoming more complex and less predictable. Real-time visibility of power flows, supported by advanced forecasting tools and digital monitoring platforms, is becoming essential for maintaining system stability. Asset performance management systems are being deployed to monitor the health of critical equipment such as transformers, circuit breakers and transmission lines, enabling predictive maintenance and reducing unplanned outages.

Artificial intelligence and data analytics are playing a growing role in grid management. Integrated digital platforms that combine generation, transmission and distribution data are improving forecasting accuracy and demand management. These systems allow operators to respond proactively to changing grid conditions, optimise asset utilisation and enhance overall reliability.

Project execution timelines have emerged as a central concern for the sector. Historically, the transmission industry has experienced cyclical phases of excess capacity and subdued demand. While the current environment is characterised by high demand and perceived supply shortages, many of the underlying challenges stem from legacy planning and execution processes. Lengthy approval cycles, extended bidding timelines and prolonged construction periods continue to delay project commissioning and create systemic inefficiencies.

Compressing timelines across all stages of project development is, therefore, essential to improve sectoral efficiency. This requires coordinated action across stakeholders, including technology providers, engineering, procurement and construction (EPC) players, and policymakers. Greater mechanisation, productivity improvements and workforce

"There is a need for compressing timelines at every stage of transmission line construction. The transmission ecosystem is characterised by multiple layers of project approval, and compressing timelines is essential for the sector to function in a more efficient and balanced manner. This can be achieved through improvements by technology providers and EPC players through greater mechanisation, higher productivity and stronger skill sets."

Venu Nuguri, *Hitachi Energy India*

"Even though manufacturers are rapidly scaling up capacity and aligning with long-term sectoral requirements, inefficiencies continue to arise as many developers are securing equipment before acquiring land. This results in manufacturers' capacities being blocked by projects that are not yet land-ready, preventing the diversion of transformers and other equipment to regions where demand is more urgent."

Sandeep Zanzaria, *GE T&D India Limited*

"The government's policies have enabled a significant expansion of domestic manufacturing capabilities, including the ability to supply high-voltage technologies of up to 1,200 kV. Government authorities such as the Central Electricity Authority have been instrumental in mitigating supply chain bottlenecks and assisting manufacturers and developers in fast-tracking delayed projects. The success of renewable energy projects critically depends on overcoming the slowdown in transmission line additions."

Manish Agrawal, *APAR Industries Limited*

"The biggest challenge for developers today is timeline pressures as projects must be completed within the assumptions built into time-bound financial and equity commitments. With annual bidding volumes having risen sharply and India's decarbonisation pathway driving demand for hydrogen, wind and electric mobility, transmission expansion must keep pace."

Arun Sharma, *Resonia*

upskilling can help reduce execution durations at the site level, while process reforms can help streamline approvals and bidding.

An emerging driver reshaping transmission demand is the rapid growth of data centres and digital infrastructure. Facilities that once operated at modest capacities are now moving towards gigawatt-scale deployments at single locations. Artificial intelligence workloads are contributing to sharp, momentary demand spikes that significantly increase energy requirements. Data centre-driven demand also has implications for equipment requirements. Such facilities typically require substantially higher transformer capacity and redundancy compared to conventional loads.

While interstate transmission systems have seen significant expansion, intrastate networks, particularly those below the extra-high voltage level, will require greater investment going forward, to support distributed renewable generation and emerging loads. Multi-year planning visibility is critical in this context, enabling technology providers and EPC players to prepare for upcoming requirements and align manufacturing capacities accordingly.

Challenges and outlook

Project timelines and financing constraints remain closely intertwined. Project delays can have significant financial implications, particularly in an environment where demand for transmission capacity has risen sharply over the past three years.

Conventional construction methods alone may be insufficient to meet the requirements of new transmission infrastructure. To this end, reducing manhours and execution durations through advanced technologies, mechanisation and improved planning will be essential.

The rise of electric mobility is also reshaping demand patterns, with "green electrons" increasingly flowing through state-level networks. This trend underscores the need for states to upgrade their transmission infrastructure, potentially through public-private partnership models. Experiences in certain states demonstrate that such models can accelerate asset creation while leveraging private capital and expertise.

The transmission market is expected to grow significantly over the next three to four years, driven by large-scale investments in digital infrastructure and data centres. With rising renewable penetration, grid stability will depend heavily on robust static and dynamic compensation systems, grid-forming inverters, and storage-linked solutions.

Overall, the outlook for India's transmission sector remains positive. However, translating this potential into timely infrastructure delivery will require faster execution, deeper technology adoption, improved coordination across stakeholders, and a sustained focus on quality, safety and workforce capability. ■

Remarks by S.K. Soonee

"Transmission topology optimisation is the next frontier for the Indian power sector"

S.K. Soonee, Former and Founding Chief Executive Officer of Power System Operation Corporation Limited (now Grid Controller of India Limited), delivered an address in the special session at the Power Line TransTech India 2025 Exhibition and Conference. He traced the milestones in transmission development, and highlighted the new role of optimisation techniques and future pathways for India's transmission sector. Edited excerpts from his address…

India's transmission network has evolved from largely linear, radial builds (132 kV, 220 kV to 400 kV in the 1960s–2000s) to highly meshed dynamic networks, with HVDC, 765 kV. Ambitious national objectives, such as 500 GW of renewable energy by 2030 and plans for offshore wind, electrolysers, data centres and cross-border links, are expected to exert unprecedented stress and strain on the transmission network, with a tangible risk of pushing transmission charges to double digit levels.

A well-planned electricity transmission system should be balanced in size and strength, underpinned by a robust recovery mechanism, with built-in provisions of safety and protection as well as effective maintenance. The deployment of new and innovative technology is indespensible for the integration of over 500 GW of renewable energy capacity by 2030. As inadequate transmission infrastructure poses high risks, the transmission planning needs to incorporate a short-term and long-term risk assessment, including uncertainties affecting power evacuation and, in turn, the power market.

Recent policy shifts, including initiatives such as general network access, PoC and pool-based transmission charge administration, have been transformative. Now that the transmission pool framework is in place for a multi-owner, multi-jurisdiction scenario, the next critical step is topology optimisation, ensuring that the physical network structure of the grid itself is economically and physically optimal in diurnal, seasonal scenarios, etc. The design of the market is being rapidly resolved in India; the next step is to optimise the structure of the network. Further, the integration of upcoming assets, such as green hydrogen projects, offshore wind projects and data centres, into the electricity grid will reflect unknown power demand patterns and evacuation requirements. Hence, the optimisation of existing transmission infrastructure becomes paramount.

The economic need for transmission comprises adding grid-enhancing technologies and is no longer confined to building new transmission infrastructure, but to minimising (not always eliminating) congestion and generation curtailments, upgrading ageing transmission lines (for example, with high-performance conductors, at higher voltage levels), which would need to be reconditioned now or in the future.

> "A well-planned electricity transmission system should be balanced in size and strength, flexible in topology and supported by a robust recovery mechanism."

Topology optimisation

Transmission topology optimisation (TTO) is poised to become the next frontier for the Indian power transmission sector. The mechanism complements conventional congestion management by algorithmically finding reconfigurations to enhance the power network's overall health. Typical actions include re-orienting lines of the identical voltage level at existing line crossings, construction of short small-line sections having a high-load angle difference per kilometre, substation topology re-arrangements by breaker/bus reconfiguration and evaluation of inter-utility coordination.

The objectives of TTO are multi-dimensional, including removal of overloads in transmission elements, minimisation of system losses, enhancement of renewable energy evacuation, stability improvement and better right-of-way visibility to planners and operators. The tangible benefits that TTO offers are reduced RoW requirement, savings in metal and labour costs, and improved utilisation of existing assets.

Future pathways

In transmission planning, there is now a compelling need to shift to TTO-topology optimisation. Besides, there is need for an emphasis on reliability and a more consolidated, comprehensive and proactive approach so as to get cost-effective optimal outcomes. ■

Improving Project Execution

EPC challenges and strategies to overcome them

The "EPC Perspective" session at Power Line TransTech India 2025 featured a panel discussion among Rajeev Dalela, President (Domestic and SAARC), Kalpataru Projects International; Venkat Muvvala, President and Chief Business Officer, Infra and EPX Business, Jakson Group; Akhilesh Pathak, Executive Director, PMD, Power Grid Corporation of India (POWERGRID); Manish Shrivastav, Business Head, T&D Projects, APAR Industries; and Prashant Sinha, Chief Operating Officer, Resonia. The session focused on key industry challenges, the strategies required to address these issues, and the growing need for digital interventions and stronger project execution oversight. Edited excerpts…

The simultaneous floating of multiple transmission tenders is creating significant capacity constraints across the EPC ecosystem, particularly in terms of manpower availability and manufacturing capability for critical equipment such as transformers and switchgear. EPC players are also undertaking training and skills development initiatives. However, the development of specialised skill sets is a long-term process and continues to be geographically concentrated in a few states.

Project timelines have also become increasingly compressed, with most contracts requiring completion within 21-23 months, including the monsoon season. In states such as Gujarat, where the monsoon typically extends from mid-June to October, site accessibility is severely constrained, reducing the effective execution window to about 12 months. Within this period, EPC contractors are expected to complete the transmission lines, significantly intensifying execution pressures. The rapid expansion of renewable energy capacity has amplified these challenges further.

Right-of-way (RoW) remains one of the most significant challenges facing EPC players. The federal structure of the country has resulted in widely varying RoW policies across states, making transmission line construction relatively smooth in some regions and extremely difficult in others. The simultaneous development of multiple infrastructure projects has further intensified RoW constraints, often resulting in prolonged delays. Although states are expected to actively facilitate project execution, such support remains uneven across regions. Project delivery challenges were also noted for high-voltage substations, particularly 400 kV projects, due to certain contractual and technical requirements.

(From left) Alok K. Brara, Publisher, Power Line*; Venkat Muvvala, Jakson Group; Rajeev Dalela, Kalpataru Projects International; Akhilesh Pathak, POWERGRID; Prashant Sinha, Resonia; and Manish Shrivastav, APAR Industries*

Rising material costs over the past 18 months have added to execution risks. The inclusion of price variation clauses in state-level contracts is essential to prevent undue financial exposure for EPC players. Supply chain constraints are another key challenge. To improve equipment availability and reduce lead times, there is a need to leverage production-linked incentive frameworks more actively for the transmission sector.

Solutions

The adoption of digital tools and mechanisation are widely recognised as critical to achieving the speed and scale required for future transmission build-out. Integrated programme management systems with digital visualisation capabilities are enabling better coordination, faster decision-making and improved execution monitoring. Significant progress has been made in the adoption of mechanised construction practices, with contractual mandates increasingly requiring the use of cranes and modern equipment. However, India's varied terrain and geography necessitate customised solutions, and resistance among traditional labour groups remains a challenge.

Faceless digital billing and payment systems have emerged as a major enabler, allowing contractors to upload bills online, track their status in real time and receive payments without manual intervention. This has significantly improved turnaround times and reduced disputes.

The way forward

Looking ahead, the development of greenfield transmission corridors is becoming increasingly difficult due to land constraints, environmental clearances and RoW challenges. Above all, there is a strong need to focus on safety, quality and skilled project management. Project managers are increasingly required to function not only as engineers but also as effective coordinators capable of managing local stakeholders and navigating RoW challenges. Strong collaboration between developers and EPC contractors, with shared ownership of outcomes, is essential to sustaining the pace of India's transmission expansion and supporting its broader energy transition. ■

State Initiatives

Efforts to scale up transmission infrastructure

The "State Initiatives and TBCB" session at TransTech 2025 featured insights from senior leaders of state transmission utilities, including Power Transmission Corporation of Uttarakhand Limited (PTCUL), Uttar Pradesh Power Transmission Corporation Limited (UPPTCL), Gujarat Energy Transmission Corporation Limited (GETCO), and Transmission Corporation of Telangana Limited (TGTRANSCO). The panellists discussed ongoing developments, operational challenges and the major programmes being undertaken to strengthen state transmission networks. Edited excerpts…

P.C. Dhyani, Managing Director, PTCUL

Uttarakhand's transmission sector has improved significantly in recent years, supported by strong institutional coordination, tight project monitoring and efforts to resolve long-standing bottlenecks. Earlier, transmission projects in the state faced persistent delays, weak contractor participation and unresolved staff-related issues. There has now been a broad institutional reset, with greater emphasis on HR-led grievance redressal, improved communication with field teams and renewed efforts to build a sense of ownership among employees.

Additionally, contractors have been repositioned as development partners rather than as merely executors. Regular joint reviews have helped address right-of-way (RoW), forest clearances and payment-related issues. As a result, project execution timelines have been reduced significantly. Daily project monitoring through dedicated teams for each scheme, has further improved coordination among stakeholders.

Mayur Maheshwari, Managing Director, UPPTCL

Uttar Pradesh has been undertaking major initiatives to strengthen its transmission sector amid rising energy demand. In recent years, the state has added the largest transmission capacity in the country. The roll-out of an enterprise resource planning system has helped digitalise vendor billing and payments. This has reduced delays, improved transparency and allowed vendors to mobilise equipment faster, accelerating substation and line construction.

(From left) Alok K. Brara, Publisher, Power Line*; Upendra Pande, GETCO; Mayur Maheshwari, UPPTCL; P.C. Dhyani, PTCUL; and D. Latha Vinod, TGTRANSCO*

Drone-based patrolling has improved the visibility of equipment issues. Moreover, the state transco has replaced transmission lines with high-temperature low-sag (HTLS) conductors on a large scale, enabling higher transfer capability without major RoW expansion. The state also plans to scale up its network and integrate large-scale renewables and storage. It is also installing static synchronous compensators (STATCOMs) to improve voltage stability.

Upendra Pande, Managing Director, GETCO

Gujarat has focused on improving both physical infrastructure as well as institutional capacity. Over the past 18 months, the state has commissioned more than 50 transmission lines using HTLS conductors. The state has also increased the use of monopoles and narrow-based towers to overcome land constraints and introduced integrated stack-top substations to handle high renewable penetration.

The rapid growth of solar power has altered load patterns and created daytime surpluses. Gujarat has addressed this by supplying surplus solar energy to agricultural feeders during the day, aligning demand with generation. Looking ahead, peak demand is expected to rise significantly by 2035. To support this, the state plans large-scale additions of substations and transmission lines, with investment requirements of over Rs 1,500 billion by 2035.

D. Latha Vinod, Director, Projects, TGTRANSCO

Telangana is simultaneously strengthening urban and rural networks in response to rising renewables, industrial growth and agricultural demand. Gas-insulated substations are being deployed in dense urban areas, while monopoles are planned along key ring road corridors. Large-scale reconductoring with HTLS conductors is also underway, especially where substation expansion space is limited. Project execution is being accelerated through drone-based surveys and AI-enabled tools.

However, delays in the supply of breakers, transformers and other equipment is affecting project timelines. The rapidly changing load profile is adding further pressure.

Looking ahead, Telangana plans to expand transformation capacity, scale up solar and decentralised generation, and deploy pumped storage, battery systems and solutions such as STATCOMs, reactors and enhanced capacitor banking to maintain system stability. ■

Awards and Accolades

TransTech Utility Awards for outstanding performance

The Power Line TransTech Utility Awards were presented to key power utilities to recognise excellence and outstanding performance in the transmission sector. The award categories were Highest Line Length Addition (220 kV and above), Highest Transformation Capacity Addition (220 kV and above), Outstanding Financial Performance, and Lowest Transmission Losses. The winning utilities were identified across the regions based on data from the Central Electricity Authority (CEA), Power Finance Corporation (PFC) and reports by the state utilities. The region-wise list of winners across the various categories is presented below…

Award for Highest Line Length Addition

Region	Utility	Line length addition in the past three years (220 kV and above)
Eastern Region	Bihar State Power Transmission Company Limited	2,018 ckt km
Northern Region	Uttar Pradesh Power Transmission Corporation Limited	3,847 ckt km
North-eastern Region	Meghalaya Energy Corporation Limited	258 ckt km
Southern Region	Karnataka Power Transmission Corporation Limited	1,485 ckt km
Western Region	Gujarat Energy Transmission Corporation Limited	1,651 ckt km

Award for Highest Transformation Capacity Addition

Region	Utility	Transformation capacity addition in the past three years (220 kV and above)
Eastern Region	Bihar State Power Transmission Company Limited	5,260 MVA
Northern Region	Uttar Pradesh Power Transmission Corporation Limited	20,595 MVA
Southern Region	Tamil Nadu Transmission Corporation Limited	15,075 MVA
Western Region	Gujarat Energy Transmission Corporation Limited	11,505 MVA

Award for Outstanding Financial Performance

Region	Utility	PAT margin during 2023-24
Eastern Region	West Bengal State Electricity Transmission Company Limited	26 per cent
Northern Region	Haryana Vidyut Prasaran Nigam Limited	22 per cent
North-eastern Region	Assam Electricity Grid Corporation Limited	23 per cent
Southern Region	Transmission Corporation of Andhra Pradesh Limited	19 per cent
Western Region	Gujarat Energy Transmission Corporation Limited Maharashtra State Electricity Transmission Company Limited	25 per cent

Award for Lowest Transmission Losses

Region	Utility	Transmission losses during 2023-24
Eastern Region	West Bengal State Electricity Transmission Company Limited	2.18 per cent
Northern Region	Power Transmission Corporation of Uttarakhand Limited	1.04 per cent
Southern Region	Transmission Corporation of Telangana Limited	2.30 per cent
Western Region	Madhya Pradesh Power Transmission Company Limited	2.61 per cent

Sources: CEA, PFC, and reports by state utilities

Transmission O&M

Technology-led, climate-resilient strategies gain traction

The session on "O&M Best Practices" comprised a panel discussion among Dr Nilesh Kane, Chief (Transmission & Mumbai Distribution), Tata Power; Sandip Maity, Senior Vice-President, Design and Engineering, Resonia; Sanil Namboodiripad, Chief Operating Officer, IndiGrid; and Nihar Raj, Head, O&M, Adani Energy Solutions. The panellists discussed the key trends, challenges and emerging practices in transmission operations and maintenance (O&M). Edited excerpts....

Key challenges

The close proximity of generation, transmission and distribution systems in urban areas has led to a rapid rise in faults, complicating system operations. Transient faults, encroachments around tower locations and increasing clearance requirements due to multi-storey constructions have intensified safety risks. Underground transmission infrastructure comes with its own challenges. Extensive construction activity and recurring faults further affect system reliability. In the Northeast, difficult terrain and river crossings affect tower foundations and stability. In Jammu & Kashmir, harsh winters restrict field activities for four to five months each year, requiring preventive maintenance to be completed within a limited window, using specialised equipment and region-specific techniques.

Floods in the northern and north-eastern regions and landslides in hill states pose significant risks, including conductor and tower failures. Strengthening availability, reliability and climate resilience has, therefore, become a priority, requiring continuous risk assessment.

Transmission assets located in coastal or high-rainfall regions face challenges arising from severe soil erosion, river meandering and accelerated deterioration of foundations. Polymer insulators in these geographies are vulnerable and require systematic upgradation. Moreover, frequent switching operations due to grid compensation requirements are putting stress on equipment, leading to deterioration well before the 30–35-year lifecycle. Revisions in seismic zoning norms have further necessitated reassessment and modernisation of assets in newly classified high-risk zones.

(From left) Alok K. Brara, Publisher, Power Line*; Dr Nilesh Kane, Tata Power; Sanil Namboodiripad, IndiGrid; Nihar Raj, Adani Energy Solutions; and Sandip Maity, Resonia*

Emerging practices

Digitalisation has emerged as a critical enabler of modern O&M activity across utilities. Digital platforms, drones and robotics are increasingly being used to improve safety, efficiency and decision-making. Drones support commissioning and inspection activities, while robotics are being deployed for asset condition and performance tracking. Asset health cards are being adopted to consolidate dissolved gas analysis results, lightning arrester leakage current data and residual life calculations. These inputs are integrated into centralised platforms supporting risk-based and opportunity-based zero-breakdown maintenance. Meanwhile, dynamic load studies, numerical relay-based feeder monitoring, thermal imaging in air-insulated substations and ultrasound-based diagnostics are strengthening proactive maintenance strategies.

The way forward

India's transmission sector is entering a new phase, marked by large-scale grid expansion and rapid digitalisation. Regions such as desert corridors, wind-intensive zones and renewable energy hubs are experiencing heightened exposure to extreme winds, lightning and transient faults, reinforcing the need for predictive maintenance and robust resilience frameworks.

Digitalisation is redefining asset management practices, with a growing emphasis on workforce upskilling, workflow redesign and field-level adoption. As utilities move towards remote operations and leaner on-site staffing models, cybersecurity has become critical to ensure secure and reliable connectivity between field assets and central control centres. Integrated asset performance management approaches that combine historical asset data with real-time operational information are helping optimise maintenance planning. Climate-focused risk management, including analysis of weather patterns and fault correlations, is enabling targeted interventions and measurable improvements in transmission line availability.

Digital tools such as mobile applications for real-time patrolling, dashboards for decentralised decision-making and IoT sensors for continuous equipment monitoring are strengthening field operations. AI is expected to play a central role in future O&M strategies. Overall, transmission O&M is moving decisively towards data-driven, technology-enabled and climate-resilient frameworks to meet the evolving demands of the country's power system. ■

Timely Execution

Aligning transmission expansion with renewable growth

The recent Power Line TransTech India 2025 conference and exhibition featured a session on "Focus on Renewable Energy Evacuation", wherein the panellists discussed the status of interstate and intra-state transmission planning, regional congestion, connectivity and regulatory challenges. The panellists included Deepak Consul, Head, Grid & Connectivity, Gentari Renewables; Manju Gupta, Executive Director, Power Grid Corporation of India Limited (POWERGRID); Deepak Khare, Senior Vice-President and Head of Projects, BluPine Energy; and Mahesh Vipradas, Vice-President, Sembcorp India. Edited excerpts…

Planning and execution challenges

At the national level, renewable evacuation planning is anchored in the interstate transmission system (ISTS), which is expected to carry a significant share of future renewable capacity. Of the 400 GW of solar and wind capacity targeted by 2030, around 230 GW is planned to be connected through the ISTS, and the remaining capacity being linked through intra-state networks. Transmission systems corresponding to most of the identified ISTS-linked renewable capacity have already been planned, with a substantial portion under construction and some projects under competitive bidding. However, execution challenges continue to delay asset creation on the ground. Right-of-way (RoW) constraints remain the most persistent obstacle, particularly in densely populated and agriculture-intensive regions. These issues are compounded by land access challenges, procedural delays and supply chain disruptions, extending construction timelines and inhibiting transmission infrastructure from keeping pace with rapidly commissioned renewable generation projects. The concentration of renewable capacity in a limited number of solar and wind-rich states has further intensified pressure on transmission networks in these regions. While there is congestion during peak generation periods, other parts of the network experience low utilisation, highlighting imbalances in network loads. Transmission lines built specifically for renewable evacuation often operate at low average utilisation levels due to the variable nature of solar and wind generation, while curtailment risks increase during periods of high output. Moreover, while renewable projects can be commissioned within two years, transmission systems often take over three years, creating a persistent mismatch that affects project timelines, asset utilisation and investor confidence.

(From left) Alok K. Brara, Publisher, Power Line*; Deepak Khare, Blupine Energy; Manju Gupta, POWERGRID; Deepak Consul, Gentari Renewables; Mahesh Vipradas, Sembcorp India*

Storage and integrated project structures

The divergent utilisation patterns have exposed the limitations of evacuation infrastructure designed primarily around installed capacity. Stand-alone solar and wind projects are particularly vulnerable, as they depend entirely on evacuation availability at the time of commissioning. In contrast, round-the-clock (RTC) and hybrid renewable projects, which combine multiple generation sources and storage, are better positioned to manage scheduling and connectivity constraints. Integrated project structures are increasingly being viewed as a means of improving grid utilisation while reducing congestion and curtailment risks. Energy storage is emerging as a key enabler in this transition. While pumped storage projects offer large-scale balancing capability, deployment is constrained by site availability, delays in environmental clearances and long development timelines. Battery energy storage systems provide a more flexible alternative, with shorter gestation periods and the ability to be deployed alongside renewable plants.

The way forward

Transmission connectivity is governed by a structured regulatory framework, with planning based on declared renewable potential and available margins at substations. While there is progress at the interstate level, intra-state transmission development continues to face challenges. Land acquisition and RoW approvals remain key bottlenecks, even as the Green Energy Corridors scheme provides financial and planning support to accelerate state-level transmission build-out. While some states have made significant progress under earlier phases of the programme, implementation delays persist in others due to local administrative and regulatory constraints. As renewable penetration increases, transmission planning is shifting from capacity expansion to system integration and optimisation. Storage, hybrid configurations and flexible connectivity arrangements are becoming central to this approach. Competitive tariffs discovered in RTC renewable energy tenders indicate growing confidence in integrated models that combine generation, storage and efficient evacuation. Going forward, sustaining India's renewable energy growth will depend on timely transmission execution, effective regulatory coordination and deeper integration of storage into grid planning. ■

Building Power Ties

India's expanding cross-border electricity interconnections

The session on "Cross-border Transmission" featured a discussion between Kedar Silwal, Director, Nepal Electricity Authority, and V. Thiagarajan, Senior General Manager, Power Grid Corporation of India Limited (POWERGRID). They spoke about India's expanding cross-border electricity interconnections and the growing role of regional power trade in South Asia. They also discussed the economic rationale for interconnections, ongoing and planned transmission links with neighbouring countries, and the regulatory and operational framework enabling cross-border power exchanges. Edited excerpts from their interaction...

As larger, interconnected grids are more efficient, reliable and cost-effective, India has been focusing on strengthening cross-border electricity links. Expanding the power system across borders also supports the development of a regional electricity market in South Asia.

India's cross-border interconnections are being built using three main configurations: HVDC links, AC synchronous connections and radial links. HVDC systems are typically deployed for very long distances, undersea cables, or where electrical isolation between grids is required. Back-to-back HVDC stations are used to prevent disturbances in one grid from affecting another. AC synchronous interconnections, on the other hand, are preferred where multiple links and large power transfers are required. Nepal, for instance, is being connected to India largely through AC interconnections.

India, Bhutan and Nepal interconnections

Bhutan was India's earliest and most significant cross-border power partner. The Tala Hydropower Project, which allocated about 1,000 MW of generation to India, marked a major milestone. This was supported by the double-circuit Tala-Siliguri transmission line. Over time, additional projects such as Chukha and newer developments including Punatsangchhu have expanded bilateral capacity. Today, interconnections between India and Bhutan can carry around 2,300 MW of capacity, with further expansions under consideration to support future hydropower development in the Himalayan nation.

(From left) Alok K. Brara, Publisher, Power Line*; Kedar Silwal, Nepal Electricity Authority; and V. Thiagarajan, POWERGRID*

Nepal is blessed with an estimated hydropower potential of 83 GW – about 42 GW of which is technically and financially viable. The country has so far developed only a fraction of this resource. Its current installed capacity stands at roughly 4 GW, but power purchase agreements totalling about 11.4 GW have been signed. The installed capacity is expected to grow by about 1 GW each year, creating significant surplus power in the near term.

Nepal currently exports about 1.2 GW of electricity to India, primarily through the Dhalkebar-Muzaffarpur 400 kV transmission line, supplemented by the Tanakpur-Mahendranagar 132 kV line. The Dhalkebar-Muzaffarpur line is operated through a joint venture between the Nepal Electricity Authority and Power Grid Corporation of India Limited, and has been functioning smoothly. Several new interconnections are under construction or at advanced planning stages. These include the Butwal-Gorakhpur 400 kV line, expected to be operational by mid-2026, and additional 400 kV corridors such as Duhabi-Purnia and Dodhara-Bareilly, scheduled for commissioning by 2029. Each of these lines will be capable of transferring up to 2,500 MW, significantly strengthening cross-border capacity. India's power exchanges with Bhutan and Nepal benefit from seasonal complementarity, with hydropower peaking in summer when India's demand is highest and imports rising in winter, improving grid stability and resource use. In 2024, this cooperation expanded further with the signing of a tripartite agreement between Nepal, India and Bangladesh. Since November 2024, Nepal has been exporting power to Bangladesh through the Indian grid.

Towards "One Sun, One World, One Grid"

India's expanding network of cross-border interconnections represents more than just infrastructure development; it is a strategic move toward regional energy integration. By building a strong South Asian regional grid, India is taking steps towards the broader vision of "One Sun, One World, One Grid".

A 500 MW to 1,000 MW HVDC undersea cable linking India and Sri Lanka is under detailed study, with an estimated project cost of Rs 127 billion. While the technical feasibility has been established, work is ongoing to finalise a viable business model. Further studies are also under way for undersea cable connections to Saudi Arabia and Singapore, reflecting a longer-term vision of intercontinental power trade. As technical studies progress and regulatory frameworks evolve, cross-border power trade is poised to become a cornerstone of sustainable energy cooperation in the region. ■

Supply Chain Scenario

Growing scale and challenges in transmission equipment procurement

G.S. Budiyal, Director (Operations), Power Transmission Corporation of Uttarakhand Limited (PTCUL); K.K. Gupta, Executive Director, Power Grid Corporation of India Limited (POWERGRID); and Rajan M.P., Chief Engineer, Kerala State Electricity Board (KSEB) shared their insights on procurement scale, supply chain constraints, and execution challenges at Power Line TransTech India 2025. The discussion focused on rising capital expenditure, equipment availability, manpower shortages, cost pressures, indigenisation priorities and evolving procurement practices in the transmission sector. Edited excerpts…

India's transmission sector is undergoing rapid expansion, driven by large-scale renewables integration and rising electricity demand. This growth has significantly increased procurement volumes, while exposing structural challenges in equipment supply, skilled manpower availability and project timelines.

Scale of procurement

POWERGRID currently handles an annual capital expenditure of Rs 200 billion-Rs 300 billion. This level of investment has remained consistent in recent years and is expected to continue, or even rise, at least until 2030. Procurement is largely focused on 765 kV and 400 kV transmission lines and substations, HVDC transmission lines and converter stations, STATCOM projects for reactive power compensation, synchronous condensers and associated transmission equipment.

While manufacturing capacity for most transmission equipment has improved, the sector is facing a fundamental shift in project timelines. Renewable energy generation projects now come online within a year, whereas transmission systems face inherent constraints such as right-of-way issues, land acquisition challenges, forest clearances, and cross-country construction requirements. Even with process optimisation, transmission project gestation periods cannot realistically be compressed to below two years. This mismatch has intensified pressure on supply chains and project execution.

Issues and challenges

Today, not only is equipment availability a challenge but so is the shortage of skilled manpower. While manufacturing capacity can be expanded through capital investment, skilled manpower development requires time and effort. Transformers and reactors were equipment of concern a few years ago and were subject to price escalations and supply delays. With government intervention, this situation has stabilised. POWERGRID has adopted advance and bulk procurement of transformers and reactors, even ahead of project awards, to smoothen supply and reduce uncertainty.

(From left) Alok K. Brara, Publisher, Power Line*; K.K. Gupta, POWERGRID; G.S. Budiyal, PTCUL; and Rajan M.P., KSEB*

Gas-insulated switchgear (GIS), particularly gas-insulated bus ducts, remain a concern due to limited domestic manufacturing capacity. HVDC systems are another critical bottleneck, as global suppliers are few and often unable to execute multiple large projects simultaneously. Additional constraints arise from technology-specific limitations for voltage source converters and line-commutated converters. STATCOMs also face supply pressures due to limited manufacturers and rising demand. Cost escalation remains a concern, especially for transformers and reactors, where prices have increased sharply over the past years. This has been partly driven by higher copper prices.

State transmission utilities face similar constraints, albeit on a smaller scale. To address this, utilities are bundling projects into larger EPC packages to attract major players. State utilities also experience extended delivery timelines, particularly for large transformers, GIS equipment and breakers. They also faces difficulties competing with bigger utilities that are bulk buyers. To improve bidder participation, utilities have relaxed EPC contract conditions, revised payment terms, reduced bank guarantees and ensured quicker payments.

The way forward

Indigenisation and the Make in India initiative are increasingly important for the transmission sector. POWERGRID has developed indigenous 1,200 kV tower designs and established testing facilities, although commercial manufacturing has yet to scale up due to limited demand. Payment timelines have also improved significantly.

Overall, addressing procurement challenges in the transmission sector will require coordinated efforts across equipment manufacturing, skilled workforce development, standardisation of specifications, and sustained indigenisation to support India's power system. ■

Creating a Talent Pipeline

Initiatives to overcome manpower shortages and fill the skill gap

At Power Line TransTech India 2025, the session on "Skill Development for Transmission" featured a panel discussion among Dr Yatindra Dwivedi, Director, Personnel, Power Grid Corporation of India (POWERGRID); Srinivasan Ravi, Chief General Manager, HRD, TG Transco; and Dr V.K. Singh, Chief Executive Officer, Power Sector Skill Council. The discussion focused on workforce requirements arising from rapid sector growth, emerging skill gaps, and initiatives to build a sustainable talent pipeline for the transmission sector. Edited excerpts from the interaction…

Current scenario and challenges

The key challenge facing the power sector today is not attrition, but the workforce requirement that is emerging from the sheer scale and pace at which the sector is growing. As generation capacity continues to expand rapidly across the country, the transmission network is also being scaled up to keep pace. This expansion is driving a sharp increase in manpower requirements in the transmission sector. Notably, there is a need for skilled professionals who can plan, construct, operate and maintain this increasingly complex network.

While the availability of engineers is not a major constraint, skill gaps are evident in specialised areas such as undersea cabling, cybersecurity and management of renewable energy. Renewable energy assets often require night-time maintenance, adding pressure on workforce deployment. Another significant challenge is the acute shortage of ground-level manpower in the engineering, procurement and construction (EPC) contracting segment. Transmission line construction depends heavily on fitters, linesmen and technicians. These roles involve working in remote and difficult locations, frequent migration, and exposure to harsh conditions. Many trained workers also tend to exit soon after training, making mobilisation and retention difficult. For contractual construction workers, health and safety risks are also higher due to the mobile nature of the work and short project cycles.

Skill gaps are also visible in the operations and maintenance segment. While there are structured induction programmes, incidents and equipment-related issues require deeper, hands-on training for field staff, particularly in substations and line maintenance. Several state utilities are also facing the consequences of limited recruitment in earlier years and an upcoming wave of retirements, even as network size continues to expand. Moreover, younger engineers increasingly prefer urban, desk-based and IT-oriented roles, creating a mismatch with the transmission sector's largely remote and field-based work.

(From left) Alok K. Brara, Publisher, Power Line*; Srinivasan Ravi, TG Transco; Dr Yatindra Dwivedi, POWERGRID; and Dr V. K. Singh, Power Sector Skill Council*

Ongoing initiatives

In response to these challenges, utilities and institutions are improving their hiring, training and retention frameworks. Classroom learning is being combined with extended on-the-job training. Entry-level engineers are being trained on transmission systems, substations, construction, testing and commissioning, followed by supervised field exposure before regularisation. As a part of the skill upgradation efforts, mid-career employees receive functional, cross-functional and leadership training, in addition to mandatory e-learning when moving between roles. Training content is also evolving to reflect new technologies. Utilities are imparting training in advanced construction methods, including the use of cranes, helicopters and drones, along with focused modules on safety and cybersecurity. Large-scale programmes in artificial intelligence and machine learning are also being launched to prepare the workforce for future operational and asset management needs.

Notably, given the acute shortage at the ground level, the Power Sector Skill Council has prioritised large-scale skilling of fitters and line workers. It plans to train personnel in this area over the next two years through programmes focused on practical, site-based learning. As a part of its corporate social responsibility, the council is also mobilising unemployed rural youth, training them in transmission line erection and stringing, and linking them directly with EPC contractors.

To improve retention, facilities such as housing and connectivity are being provided at remote locations. Furthermore, utilities are strengthening health, safety and environment practices through mandatory safety training.

Through these initiatives, the transmission sector will be better positioned to meet its growing manpower and operational demands. ■

Technology Solutions

Increasing digitalisation and AI application in transmission

TransTech India 2025 featured a series of focused technical sessions covering key themes such as the application of artificial intelligence (AI) and digitalisation in transmission operations, developments in cables and conductors, transformers, towers and substations, as well as the growing use of drones in the power transmission sector. Edited excerpts…

AI and digitalisation

The session on AI and digitalisation in transmission operations featured Mayank Bhardwaj, Director, Power and Utilities, KPMG; Mahendra Kumar Kaloria, Deputy General Manager, Power Grid Corporation of India Limited (POWERGRID); and Nihar Raj, Head, Operations and Maintenance, Adani Energy Solutions.

According to the panellists, AI is still largely at the pilot stage across the Indian transmission sector. Transcos are adopting AI and digital solutions to expedite project execution and optimise network operations and maintenance (O&M). They are adopting AI-based transmission line patrolling systems capable of processing over 400 images per minute to identify defects, and reliability-centred maintenance tools for transformers, circuit breakers and transmission lines. To make the grid more flexible, utilities are using DLR and digital asset assessment tools, especially in renewable-rich states. Technologies such as STATCOMs, intelligent substation inspections, and drone-based patrolling systems are also being adopted. Digital tools are being adopted, from design to project execution, to compress project timelines. Moreover, utilities are deploying digital twins of substations to optimise maintenance.

Cables and conductors

The session on "Cables and Conductors" was addressed by Abhishek, Chief General Manager, POWERGRID; S.K. Jana, Senior Vice-President, R&D, APAR Industries; and D. Latha Vinod, Director Projects, TGTRANSCO.

The speakers noted that the transmission sector is moving from traditional ACSR conductors to high-conductivity aluminium alloys and special high-performance conductors (SHPCs). These allow utilities to upgrade existing lines and increase capacity by over 50 per cent without building new infrastructure. Covered conductors improve safety and are better suited for urban areas. Trenchless and modular technologies are needed to make underground cable installation and maintenance easier and less disruptive. Cables and conductors require minimal O&M and are robust and reliable in nature. Most issues arise from external activities such as accidental digging or tower damage. Utilities are also adopting sensors and AI-based monitoring tools for real-time condition tracking and predictive maintenance.

Transformers

The session on transformers featured insights from Deepak Kumar Jha, Chief Engineer, Bihar State Power Transmission Company; Abhay Kumar, Chief General Manager, POWERGRID; and Dinesh Kumar Singh, Executive Director (T&D System), DVC.

The panellists highlighted that transcos are adopting transformers with better bushing designs, improved oil processing and stronger protection systems, which are helping reduce avoidable failures. Digital diagnostics are also growing, with condition monitoring tools now consolidating transformer performance data to identify insulation and bushing issues. Transformers are under increasing operational stress as grids now handle higher harmonics, fluctuating loads and reverse power flows. This is leading to early transformer failures and operational challeng-

(from left) Priyanka Kwatra, Associate Director, Power Line*; Mayank Bhardwaj, KPMG; Mahendra Kaloria, POWERGRID; and Nihar Raj, Adani Energy Solutions Limited*

(from left) Reya Ramdev, Director, Power Line*; D. Latha Vinod, TGTRANSCO; S.K. Jana, APAR Industries; and Abhishek, POWERGRID*

(from left) Reya Ramdev, Director, Power Line*; Dinesh Kumar Singh, DVC; Abhay Kumar, POWERGRID; and Deepak Kumar Jha, Bihar State Power Transmission Company*

es. On the supply side, manufacturing facilities for transformers are operating at high utilisation with multi year order books, resulting in delivery cycles of close to three years for large units.

Towers

The session on towers featured a panel discussion among Arup Kalita, Chief General Manager, Assam Electricity Grid Corporation Limited (AEGCL); Dayanand Swamy Kuna, President and CEO, Salasar Techno Engineering; and G.P. Payasi, Chief General Manager, POWERGRID. The session focused on how transmission expansion is increasingly moving into tougher geographies, necessitating a fundamental shift in tower design and engineering approaches.

Newer tower designs are characterised by lower right-of-way (RoW) requirements, improved aesthetics and enhanced performance. For tower monitoring, LiDAR surveys, AI-based defect analytics, thermal imaging, and geo-verified field inspections are reducing errors and optimising maintenance. Construction efficiency is being improved through standardised foundation templates and precast solutions. This is helping to compress execution timelines and reduce labour dependency. Shifting wind zones necessitate a re-evaluation of the tower selection methodology for new towers and for strengthening existing towers. Tower failures are mostly linked to foundation stress and changing wind zones. To tackle this, transcos are adopting stronger preventive maintenance protocols and risk-based asset assessment.

(from left) Priyanka Kwatra, Associate Director, Power Line*; Arup Kalita, Assam Electricity Grid Corporation Limited; Dayanand Swamy Kuna, Salasar Techno Engineering; and G.P. Payasi, POWERGRID*

Substations

The session on substations was addressed by K. Dinesh, Chief Engineer (Transmission), Kerala State Electricity Board Limited (KSEB); and Atul Mathur, Deputy General Manager, POWERGRID.

The speakers examined the evolving role of substations in a rapidly changing grid environment, marked by renewable integration, land constraints and digitalisation.

Substations in India are shifting from passive assets to active enablers of grid stability as demand rises, renewables scale up and land becomes scarce. Compact solutions such as gas-insulated, containerised and modular substations are increasingly being adopted for faster execution and a reduced footprint. The growing share of inverter-based renewable energy has introduced voltage variability, low inertia and bidirectional power flows, prompting the deployment of dynamic reactive power support solutions such as STATCOMs and synchronous condensers. At the same time, digitalisation – through fibre-based communication, digital protection and process bus systems – is enabling remote monitoring and unmanned operations. As grid complexity grows, substations are evolving into intelligent hubs, critical for reliability and renewable evacuation.

Drones

The session on drones was addressed

(from left) Alok Brara, Publisher, Power Line*; Atul Mathur, POWERGRID; and K. Dinesh, Kerala State Electricity Board*

(from left) Priyanka Kwatra, Associate Director, Power Line*; Pradeep Singh Chauhan, POWERGRID; and Kanav Kumar, Better Drones*

by Pradeep Singh Chauhan, Chief Manager, POWERGRID; and Kanav Kumar, Co-Founder and Director, Better Drones.

The session highlighted how emerging tools such as drones, AI, LiDAR and mechanised construction techniques are transforming transmission line inspection, maintenance and project execution, particularly in challenging terrain and high-risk operating conditions. Utilities are increasingly deploying digital and mechanised technologies to enhance the reliability, safety and efficiency of India's transmission network. Drones have become integral to EHV line patrolling, enabling tower inspections, clearance checks and vegetation monitoring across difficult terrain such as hilly areas, river crossings and RoW constrained corridors. They also support rapid damage assessment and emergency patrolling during disasters.

Drone inspections are supported by AI and machine learning-based tools that automatically analyse imagery to identify defects and prioritise maintenance. Programmable drones with embedded analytics are also being used for substation inspections, improving accuracy and safety.

TransTech India 2025 also featured technology presentations by Skipper, Bentley, Andritz Hydro GmbH, Mtandt Group, Polycab, Kanohar Electricals, Bajel, Enline, Indore Composite and Elegrow Technology. In addition, the "Innovation in Action" session featured presentations by Resonia and Amber Wings. ■

Snapshots from the Event


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20
Years of
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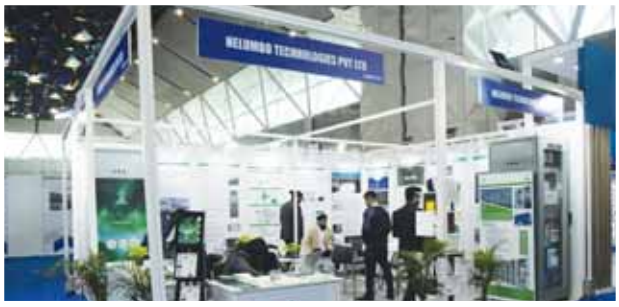


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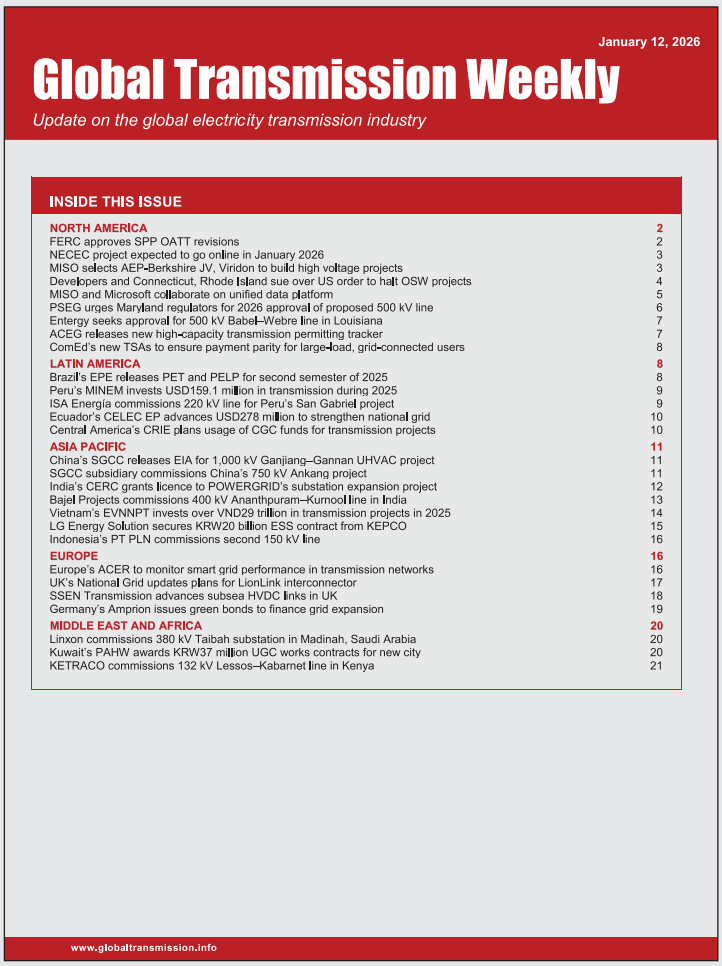
Global Transmission is a leading provider of information and analysis on the global electricity transmission industry. We publish newsletters and market intelligence reports, offer custom research and advisory services, and organise conferences on crucial and topical issues relevant to the industry.



January 12, 2026

Global Transmission Weekly

Update on the global electricity transmission industry

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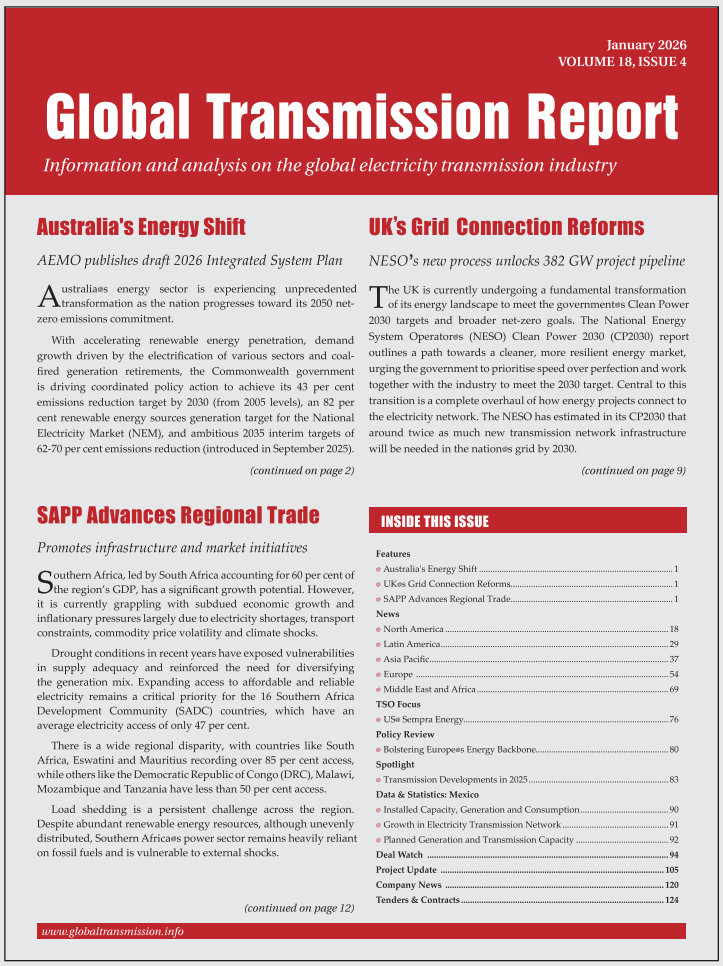

January 2026
VOLUME 18, ISSUE 4

Global Transmission Report

Information and analysis on the global electricity transmission industry

Australia's Energy Shift

AEMO publishes draft 2026 Integrated System Plan

Australia's energy sector is experiencing unprecedented transformation as the nation progresses toward its 2050 net-zero emissions commitment.

With accelerating renewable energy penetration, demand growth driven by the electrification of various sectors and coal-fired generation retirements, the Commonwealth government is driving coordinated policy action to achieve its 43 per cent emissions reduction target by 2030 (from 2005 levels), an 82 per cent renewable energy sources generation target for the National Electricity Market (NEM), and ambitious 2035 interim targets of 62-70 per cent emissions reduction (introduced in September 2025).

(continued on page 2)

UK's Grid Connection Reforms

NESO's new process unlocks 382 GW project pipeline

The UK is currently undergoing a fundamental transformation of its energy landscape to meet the government's Clean Power 2030 targets and broader net-zero goals. The National Energy System Operator's (NESO) Clean Power 2030 (CP2030) report outlines a path towards a cleaner, more resilient energy market, urging the government to prioritise speed over perfection and work together with the industry to meet the 2030 target. Central to this transition is a complete overhaul of how energy projects connect to the electricity network. The NESO has estimated in its CP2030 that around twice as much new transmission network infrastructure will be needed in the nation's grid by 2030.

(continued on page 9)

SAPP Advances Regional Trade

Promotes infrastructure and market initiatives

Southern Africa, led by South Africa accounting for 60 per cent of the region's GDP, has a significant growth potential. However, it is currently grappling with subdued economic growth and inflationary pressures largely due to electricity shortages, transport constraints, commodity price volatility and climate shocks.

Drought conditions in recent years have exposed vulnerabilities in supply adequacy and reinforced the need for diversifying the generation mix. Expanding access to affordable and reliable electricity remains a critical priority for the 16 Southern Africa Development Community (SADC) countries, which have an average electricity access of only 47 per cent.

There is a wide regional disparity, with countries like South Africa, Eswatini and Mauritius recording over 85 per cent access, while others like the Democratic Republic of Congo (DRC), Malawi, Mozambique and Tanzania have less than 50 per cent access.

Load shedding is a persistent challenge across the region. Despite abundant renewable energy resources, although unevenly distributed, Southern Africa's power sector remains heavily reliant on fossil fuels and is vulnerable to external shocks.

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Recent reports:

Global High Voltage Transmission Line Projects Database and Report, 2025
Global Electricity Conductors and Cables Market Report, 2026-35
Global Transmission Substation Market Report, 2025-2034
Electricity Transmission in the US Report, 2025
Global Electricity Transmission Report and Database, 2025-34
Global Electricity Transmission System Operator Profiles and Benchmarking Report, 2025

Upcoming conferences:

EV Charging Infrastructure West on January 27, 2026 in San Francisco, California
Transmission Infrastructure Australia on February 11-12, 2026 in Sydney
Offshore Wind Transmission Europe on February 19, 2026 in Amsterdam, The Netherlands
Airport Electrification US on March 10-11, 2026 in New York
Transmission Infrastructure South on March 18, 2026 in Austin, Texas
Energy Needs of Data Centers Texas on March 19, 2026 in Austin, Texas
Floating Solar in Europe on March 18-19, 2026 in Amsterdam, The Netherlands
Airport Electrification UK on March 26, 2026 in London, UK

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