INDUSTRY ANALYSIS

INDIAN ELECTRICAL SECTOR EVOLVING WITH RENEWABLES AND SMART TECHNOLOGIES

Industry events like ELECRAMA are vital platforms for showcasing innovations, fostering collaborations and driving the industry's continued evolution towards a more sustainable and technologically advanced future.

SPECIAL REPORT

NATIONAL ENERGY SHORTAGES REDUCE TO 0.1 PC

The progress in improving power supply has also led to an impressive surge in per capita electricity consumption, which reached 1,395 kWh in 2023-24. This marks a 45.8 percent increase from 957 kWh in 2013-14, a significant leap that reflects the country's economic development and improved access to electricity.

CASE STUDY

DECENTRALISED POWER GRID SYSTEM PAVING THE WAY FOR A CLEAN ENERGY TRANSITION

The Decentralised Power Grid System (DPGS) encourages consumers to participate in energy efficiency and demand-side management programmes, reduces energy losses, and enhances energy security, affordability, and reliability.

EXCLUSIVE FEATURE

INDIA PROPELS RENEWABLE ENERGY TO UNPRECEDENTED HEIGHTS

Decentralised grid systems enable homes, businesses, and communities to generate, store, and manage energy locally. This reduces reliance on central networks, minimises transmission losses, and enhances energy security and efficiency.

MARKET REPORT

SPECIAL FEATURE

SPECIAL FEATURE

How V2G and energy storage are transforming India's RE landscape

Automation through advanced distribution management systems (ADMS), self-healing networks and deployment of digital grid technologies enhances real-time monitoring, fault detection and operational efficiency, making the grid more resilient, responsive and reliable.

Emerging technologies are vital for modernising the power grid to meet India's growing energy demands. Innovations like AI, machine learning, energy storage, V2G systems, and automation enhance grid reliability, efficiency, and sustainability. These advancements enable better integration of renewable energy, improve operational efficiency, and support rural electrification efforts.

HC Sharma from Tata Power DDL shares more insights.

Which emerging technologies are essential for strengthening and modernising India's power grid?

Emerging technologies are pivotal in modernising and strengthening India's power grid to meet evolving energy demands reliably. The present renewable Generation installed capacity share is about 32-33 percent at national level and expected to reach 50 percent by Financial Year 29-30. The renewable sources majorly coincide with nature hence come with the limitation of availability predictions. Therefore, the energy storage systems at different levels like generation, grid and distribution are required for grid stability and effective integration of renewable energy in the system. The pilots are also in progress for utilising community resources like electric vehicles (EVs), charging stations by utilising technologies such as vehicle-to-grid (V2G) for reverse flow of energy in time of need of peak demand on the grid.

With so many equipment having dynamic behaviour in terms of energy generation/consumption and number of distribution energy resources being hooked to the grid, it has become highly complex and dynamic with a need to handle these variations by way of automatic acquisition of various data from field, monitoring and control of grid. The technologies such as GIS mapping and digital twins, optimisation of grid capacity, grid planning and maintenance would play a critical role. Operations technology with more smart and communicable devices in the field and advanced cybersecurity measures ensure safe and seamless grid operations. Automation through advanced distribution management systems (ADMS), self-healing networks and deployment of digital grid technologies enhances real-time monitoring, fault detection and operational efficiency, making the grid more resilient, responsive and reliable. Smart meters integrated with data analytics improve energy consumption tracking and enhance grid predictability and control. AI/ML-powered demand forecasting and demand-side management (DSM) enable accurate predictions of energy demand and grid frequency, ensuring grid stability and efficient load balancing. AI/ML accelerates fault management and decision-making for faster and better effective control.

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Tata Power DDL

Environmental sustainability is supported by SF6-free switchgear to minimise greenhouse gas emissions and fuel-efficient generation systems to lower carbon footprints. Collectively, these advancements create a reliable, efficient, sustainable, and adaptive power grid, ready to meet India's growing energy requirements.

How is Tata Power-DDL leveraging AI for load forecasting to enhance grid reliability and efficiency?

Tata Power-DDL is using artificial intelligence (AI) and machine learning (ML) in many different ways to enhance grid reliability and efficiency through advanced load forecasting, frequency forecasting, and predicting weather and its impact on energy demand. Machine learning models analyse historical load data, weather patterns, and other relevant factors to accurately predict future electricity demand. This helps with proactive resource allocation and grid management.

Meter data analysis provides real-time consumption data, which AI analyzes to identify patterns, anomalies, and potential issues like energy theft. This data-driven approach helps in demand-side management and targeted interventions. It also provides insights into energy consumption trends, customer behaviour, and operational performance. This data-driven decision-making optimises grid operations, improves service quality, and helps Tata Power-DDL create a more resilient, efficient, and customer-centric Power Distribution System.

What role do pilot projects like vehicle-to-grid (V2G) and power voltage transformer (PVT) systems play in Tata Power-DDL's renewable energy strategy?

Tata Power-DDL is at the forefront of adopting innovative technologies, actively exploring pilot projects like vehicle-to-grid (V2G) to advance its renewable energy strategy. V2G technology enables electric vehicles to not only draw power from the grid but also feed excess energy back into it when needed, creating a dynamic and interactive energy ecosystem.

By integrating V2G technology, Tata Power-DDL aims to enhance grid stability by leveraging electric vehicles as distributed energy storage resources. During peak demand periods, stored energy from electric vehicles can be used to support the grid and reduce strain on it. Experiments and pilots in this area are taking place across the Globe, and the results will definitely impact the deployment of V2G technology and its adoption.

However, the successful implementation of V2G requires significant customer participation and the development of a robust regulatory framework to incentivise and facilitate the bidirectional flow of energy between electric vehicles and the grid.

How is automation incorporated into T&D systems to improve operational efficiency and reduce human error?

Tata Power-DDL is significantly enhancing operational efficiency by incorporating automation into its sub-transmission and Distribution systems. All 66 KV and 33 KV substations are fully automated and are not physically deployed in the grids. The Grid substations are also automated, and all 11 KV feeders emanating from grid substations are capable of remote operation.

The electric distribution system in the field is automated at all critical locations, making the critical part of the system centrally monitored and controlled. A complete mapping of customers and assets within the GIS system serves as the foundation for the SCADA system. The Advanced Distribution Management System (ADMS) facilitates real-time control, supervision, and analysis of grid operations.

The actual strength of Tata Power-DDL system lies in Real-time integrations of data from GIS, meter data management system (MDMS), SCADA, customer relationship management (CRM), and SAP systems enables accurate load, network, and outage management. The result is continuous and seamless flow of system data across all the systems identifying potential issues proactively, fault detection and improved outage prediction and enhanced asset utilisation thus improving the reliability and availability of the system for consumers.

How can large-scale energy storage systems (e.g., batteries, pumped hydro storage) be integrated into T&D networks to mitigate the intermittency of renewable energy sources?

Large-scale energy storage solutions like Battery Energy Storage systems, pumped hydro, or any other energy storage are essential to address the intermittency challenges of renewable energy sources. Energy storage usage is now moving from peak shaving to meeting energy requirements during non-solar hours. Integrating such systems into T&D networks ensures surplus energy is stored during peak generation periods and dispatched when demand rises later. At Tata Power-DDL, we are exploring pilot projects and collaborations to implement energy storage solutions that strengthen grid resilience while supporting India's energy transition to renewables.

How is the government supporting T&D infrastructure expansion to electrify rural and remote areas?

The Government is actively supporting the expansion of T&D infrastructure in rural and remote areas through various initiatives and schemes. These efforts aim to improve power supply reliability, enhance grid monitoring and control, and reduce underserved regions.

Key initiatives like the Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY), the Integrated Power Development Scheme (IPDS), and the Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya) have played a crucial role in strengthening sub-transmission and distribution infrastructure, improving power supply reliability, and achieving 100 percent household electrification.

RDSS (Revamped Distribution Sector Scheme) is another crucial initiative to improve the quality, reliability, and affordability of power supply to consumers through a financially sustainable and operationally efficient distribution sector. The focus has been continuous on the power sector for quite some time, and definitely, it is giving positive results. However, its reach can also be further enhanced to include all state and private Discoms.