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The Changing Role of Data and AI in Green Energy

The imperative to adopt low-carbon energy is driving revolutionary changes in the power sector value chain across the globe. Renewable generation sources are proliferating, unidirectional distribution networks are slowly evolving into bidirectional networks, consumers are changing into prosumers, and dynamic energy markets are emerging.

India is still in the nascent stages of this revolution. Nevertheless, the journey towards a green energy future has begun. Artificial intelligence (AI) and the data that feed it are vital tools in this journey.

AI in the power sector

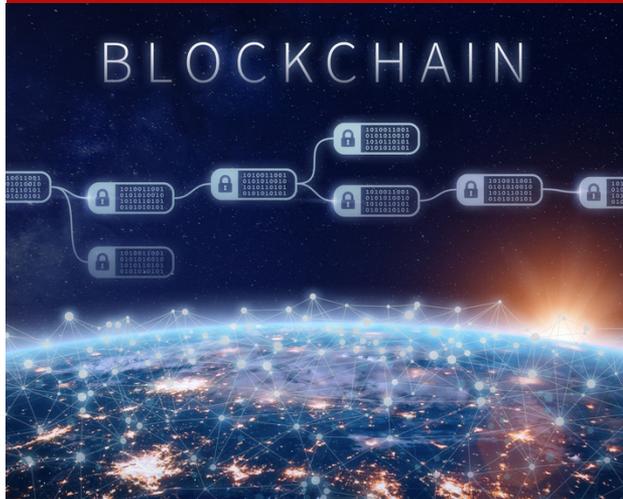
AI's role is evolving from supporting point solutions to large-scale distributed solutions, supporting a multi-actor ecosystem of energy markets, smart grids, and distributed generation and storage capabilities.

Currently, AI is being used in labs to develop new solar fuels and improve battery technologies. In plant operations and maintenance, AI provides solutions for detection and management of plant performance (historical data), automated fault detection (thermal and image processing), and asset management (digital twinning, predictive maintenance). Automated fault detection on the transmission grid (e.g., detect vegetation overgrowth) is also being pursued actively.

AI solutions for solar, wind, and hydel power forecasts are actively used in dispatch centres in a few developed countries such as the United Kingdom and the United States. AI-based demand prediction solutions, day-ahead and intraday, are already used by some distribution companies (DISCOMS) in India. In the future, AI solutions might borrow climate modelling techniques (develop hybrid models: physical simulation and AI learning models) to increase the accuracy and range of predictions.

AI techniques (neural nets, reinforcement learning, and genetic algorithms) have the potential to tackle power system optimisation problems and are being researched and developed. These aim to support dynamic scheduling for real-time automated grid balancing. Demand response solutions, aimed at shaping consumption patterns in favour of green energy by letting consumers or prosumers respond to real-time prices, are maturing. AI solutions for targeting the right customer base (data analytics), deriving real-time prices (neural nets, reinforcement learning, and genetic algorithms), and maximising the reward for prosumers (AI agent-based model) are being developed. However, these need to be tested and developed further for deployment at scale. The feasibility of partially decentralised scheduling and dispatch, with support from AI, is also under examination.

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The success of these AI solutions depend on the quality of data that can be fed to them. Data on plant operations, generation, consumption and storage, weather/climate data, and digitised data on the transmission and distribution network are essential, and AI is generating some of this data through image processing and other techniques.

The potential of blockchain in the emerging value chain

Current technologies and industry structures do not support the participation of many small-scale prosumers in wholesale energy markets or support them in peer-to-peer trading.

Virtual aggregation models, which promote cooperation among small-scale community prosumers and co-ordinate their distributed resources into virtual power plants, are slowly emerging. Blockchains that can record, verify, and enforce smart contracts between various parties while addressing data privacy might play a critical role in enabling this ecosystem of aggregators, virtual operators, and prosumers, making energy markets accessible to them and helping in managing the traceability of green energy.

The application of AI in the power sector, especially in India, has barely begun. The power sector and the supporting AI technology are both evolving globally, and innovations are being tried every day. There is a long and interesting journey ahead of us.