

# The Expanding Role of AI in Power Systems

by Hassan Zaheer  
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Artificial Intelligence (AI) is becoming deeply integrated into our lives. Ever since the inception of Large Language Models (LLMs) like ChatGPT, the impact of AI-driven data centers has been a key topic of discussion in our industry. Rightfully so, as according to IEA, the electricity demand from data centers is expected to double by 2030. For this editorial, however, I wanted to share insights from the flip side of

this coin. Instead of looking at how our industry is helping address the electricity demand increase due to AI, I wanted to look at what AI is doing for our sector. In recent years, the global power grid has faced unprecedented challenges. As electrification accelerates and renewable energy sources proliferate, traditional grid systems are under pressure to operate with greater

flexibility, resilience, and intelligence. Compounded by aging infrastructure and growing demands for reliability, these pressures are prompting grid operators and utilities to rethink how they manage energy systems. AI, once a buzzword, is transforming our daily lives as individuals, and it is also emerging as a transformative force within the power sector. From generation to distribution and beyond, AI is reshaping the power grid's future.

**As the power grids become increasingly complex, AI will not just support decisions, it will make them, in real time and with less and less human oversight.**



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## The Case for AI in Power Grids

The application of AI in power grids is being driven by three converging trends: the increasing deployment of digital infrastructure and monitoring systems, the exponential growth of data coming from these systems, and the declining cost of computational power. Utilities today have access to a wealth of operational data from smart meters, sensors, SCADA systems, and other Intelligent Electronic Devices (IEDs). AI algorithms can extract actionable insights from this data to support faster, more informed decisions.

Our sector's core challenges today, like managing demand volatility, integrating distributed energy resources (DERs), and enhancing system resilience, need solutions that go beyond traditional tools. AI provides utilities with predictive capabilities, enabling them to move from a reactive to a proactive grid management approach. Here are some examples of use cases, where AI is already being utilized, even at a pilot stage, to optimize power grids.

### Key Use Cases Across the Grid

#### Power Generation

Leading generation companies (power producers) are deploying AI to monitor and optimize the performance of their renewable energy assets. For example, Enel Green Power has implemented AI-based systems to predict solar irradiance and wind availability, enhancing asset utilization and operational efficiency<sup>[1]</sup>. In thermal generation, GE Power has developed digital twin models powered by AI and machine learning to simulate and optimize operational efficiency of gas turbines and reduce unplanned downtime<sup>[2]</sup>.

#### Transmission and Distribution

AI driven predictive maintenance is also helping utilities identify and address equipment failures before they occur. National Grid in the UK, for example, leverages AI to analyze transformer and cable health data, enabling risk-based asset

management<sup>[3]</sup>. Several utilities, like Iberdrola, use AI powered drones and image recognition to detect faults on transmission lines, improving inspection accuracy, vegetation management and reducing manual fieldwork<sup>[4]</sup>.

Beyond these examples, on the grid operations side, system operators like California ISO (CAISO) are using AI for load and renewable generation forecasting. By using quantile regression with historical load patterns, CAISO is able to calculate net load uncertainty<sup>[5]</sup>. In Germany, 50Hertz has committed to adopt AI to optimize generation, consumption and load forecasts for the grids and operating facilities to handle greater loads and make the grid more flexible<sup>[6]</sup>.

### Customer Experience and Interfaces

AI is also changing how utilities engage with their customers. EDF in the UK employs Machine Learning and smart meter analytics to detect irregular consumption, identifying financially vulnerable users and offering appropriate support, in addition to helping customers to improve energy<sup>[7]</sup>. Utilities have also developed AI-powered smart assistants (e.g. Rammas by Dubai Electricity & Water Authority) which is available 24/7 to address any customer queries and services like billing<sup>[8]</sup>.

### The Strategic Impact and Challenges

The strategic advantages of AI extend beyond operational efficiency. By automating routine tasks and delivering real-time intelligence, AI allows utilities to optimize capital and operational expenditures. It also strengthens grid resilience by enabling faster response to disruptions.

However, despite its promise, AI adoption in the power sector is not without its challenges at this time. Data silos, poor data quality, and lack of standardization remain major hurdles. Cybersecurity is another pressing concern, especially as AI systems become embedded in

critical infrastructure. There is also a skills gap: implementing AI effectively requires interdisciplinary teams that blend domain knowledge with data science expertise. Finally, governance and regulatory frameworks must evolve to accommodate AI-driven

decision-making in grid operations.

**What's Next:  
AI and the Future Grid**

Our sector is undergoing a once-in-a-generation transformation. AI based

solutions will inevitably be at the heart of this transformation. As the power grids become increasingly complex, AI will not just support decisions, it will make them, in real time and with less and less human oversight. Innovations like federated learning



will lower the barriers for utilities to share sensitive data, allowing them to train AI models collaboratively. Digital twins and AI-powered edge computing will bring intelligence closer to the assets and users they serve.

However, to unlock the full potential of AI, utilities must integrate AI into their strategic planning processes. This means moving beyond pilot projects and embedding AI in core operations, asset management, and customer engagement strategies.

For utilities, regulators, and technology providers alike, the imperative is clear: collaborate, innovate, and scale AI solutions that meet the evolving needs of the energy transition. The future grid is not just digital, it is intelligent.

**The future grid is not just digital, it is intelligent.**

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