



Power grid optimization

Focus area

The problem

The global electricity grid, a complex network of over 7 million kilometers of transmission lines serving billions of people, is in urgent need of transformation to meet our climate goals. The grid must become smarter, more flexible, and more resilient to harness the full potential of renewables, enhance efficiency, and enable widespread electrification. However, the variability of some clean energy generation such as solar and wind power pose challenges for the grid, threatening stability and increasing the occurrence of power outages.

Despite the advancements in renewable energy technologies, the grid infrastructure has not kept pace, hindering the seamless integration of these clean energy sources. The current grid system lacks the necessary optimization, resilience, and inclusivity to support the transition to a sustainable future. Without significant improvements in grid operations and management, the potential of renewable energy remains untapped, and the goal of mitigating climate change becomes increasingly difficult to achieve.

The opportunity

AI emerges as a potential game-changer in addressing some of the challenges faced by electricity grids globally. By optimizing grid operations, anticipating and mitigating disruptions, and supporting the seamless integration of variable renewable energy (VRE) into grid operations, AI can accelerate the clean energy transition while enhancing grid resilience for communities. AI-driven solutions have the potential to optimize grid operations, saving an estimated \$300 billion in efficiency gains within this decisive decade alone, according to one study.

Recent advancements in AI technologies, such as predictive modeling, real-time data analysis, and intelligent automation, offer unique opportunities to transform the grid system. These advancements can be leveraged to optimize transmission siting, enhance power flow, improve renewable energy forecasting, and efficiently coordinate distributed energy resources such as rooftop solar installations on homes. By harnessing the power of AI, we can create a more efficient, sustainable,

and cost-effective grid that seamlessly integrates renewable energy sources, as many countries are striving to decrease the reliance of their grids on fossil fuels.

Opportunity areas include:

- **Grid optimization:** How might AI optimize power flows, reduce congestion and enable seamless integration of renewable energy sources to create a more efficient, sustainable and cost-effective grid? By leveraging predictive models, AI can provide a solution to optimize transmission siting, enhance power flow and dynamically increase transmission capacity. These optimizations can lead to significant cost savings and facilitate the accelerated integration of variable renewable energy sources, such as solar and wind, into the grid. Specific use cases of AI applications in grid optimization include predictive maintenance, renewable energy forecasting, and dynamic grid control.
- **Energy management:** How might AI enable intelligent demand response, improve renewable energy forecasting, and efficiently coordinate distributed energy resources to balance supply and demand in real time? AI can analyze vast amounts of data from smart meters, weather forecasts, and consumer behavior to predict energy demand accurately. This enables the grid to intelligently shift loads to match renewable energy supply, optimize energy storage and coordinate distributed energy resources, such as electric vehicles and battery storage, to maintain a stable and efficient grid.
- **Resilience and inclusivity:** How might AI enhance grid resilience, predict and mitigate outages, and ensure reliable, affordable, and clean electricity access for all, particularly in the face of increasing climate change-related disruptions? AI can analyze historical data, weather patterns, and grid performance to predict potential outages and better inform future preventive maintenance. By automating fault detection, isolation, and service restoration, AI can significantly reduce the duration and impact of outages. Moreover, AI can help identify and prioritize underserved communities, ensuring that the benefits of a modernized grid are distributed equitably and that no one is left behind in the transition to a clean energy future.