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(57) Abstract :

The invention presents a real-time monitoring and management system for smart electrical grids that leverages Internet of Things (IoT) technologies to enhance grid performance, reliability, and efficiency. By integrating a network of IoT sensors, smart meters, and actuators deployed across the grid, the system continuously collects critical grid data, such as voltage, current, power quality, and energy consumption, which is transmitted securely in real-time to cloud or edge computing platforms for advanced processing and analysis. This enables utilities to gain granular insights into grid operations, detect potential faults or inefficiencies, and take corrective action immediately. The system employs machine learning algorithms for predictive maintenance, forecasting equipment failures before they occur, minimizing downtime, and reducing maintenance costs. It also supports dynamic load management and demand response strategies, which optimize the distribution of energy across the grid, prevent overloading, and ensure efficient energy use during peak periods. Additionally, the system facilitates the seamless integration of renewable energy sources like solar and wind, overcoming the challenges of their intermittency by adjusting energy flows in real-time to stabilize the grid. Consumer participation is encouraged through smart metering and automated appliance control, allowing consumers to monitor and adjust their energy usage based on real-time data, leading to greater energy conservation and cost savings. Advanced cybersecurity protocols safeguard the integrity of the grid, protecting both operational data and the grid infrastructure from potential cyber threats. By combining real-time monitoring, machine learning, dynamic load balancing, and renewable energy integration, the invention not only improves the reliability and efficiency of the electrical grid but also provides a scalable, future-proof solution to meet the evolving demands of modern energy systems, contributing to a more sustainable and resilient energy infrastructure.

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