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## **Design and Simulation of an Adaptive Voltage Regulation-Based Smart Power Distribution Network for Energy Efficiency Improvement in the Oman Electrical System**

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### **Abstract**

This study suggests designing a smart power distribution network based on adaptive voltage regulation (AVR) in order to meet the growing demand for efficient and sustainable energy systems. In order to improve distribution capacity and lower energy losses, the suggested system integrates AI-based control strategies that react to real-time voltage fluctuations. In keeping with Oman Vision 2040's goals, the design also facilitates the integration of renewable energy sources while guaranteeing reactive power compensation and adherence to standard voltage profiles. Digital simulations using MATLAB/Simulink and DIGSILENT Power Factory under varied load conditions were used to assess the system's performance. The results show increases in voltage stability, energy efficiency, and operational cost reduction, providing a workable route to a more resilient and intelligent electrical network in Oman.