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Renewable Energy Systems Optimization Using Deep Learning and Quantum Computing Applications

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Abstract:

The increasing integration of renewable energy sources into modern power systems necessitates advanced optimization techniques to manage variability, improve efficiency, and ensure grid stability. This study investigates a hybrid approach that combines deep learning models with quantum computing applications for the optimization of renewable energy systems. Deep learning techniques, particularly Long Short-Term Memory (LSTM) networks and Convolutional Neural Networks (CNNs), are utilized to forecast energy generation and demand based on historical and real-time data from solar, wind, and hybrid sources. Quantum computing, through algorithms such as the Quantum Approximate Optimization Algorithm (QAOA) and Variational Quantum Eigensolver (VQE), is applied to solve complex optimization problems involving resource allocation, load balancing, and energy storage management with unprecedented speed and accuracy. The synergy of deep learning and quantum optimization enables real-time, adaptive, and highly scalable energy system management, demonstrating substantial improvements in performance, cost-efficiency, and sustainability across diverse deployment scenarios.

Keywords:

Renewable energy, deep learning, quantum computing, energy optimization, smart grid, sustainability.

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