Paper 245

Multi-Objective Optimization-Based Configuration Study of Wind-Solar-Storage Complementary Energy Systems

With the continuous growth of global energy demand and increasing environmental concerns, the development and utilization of clean renewable energy have become a critical focus in the energy sector. Among various renewable sources, wind and solar energy are considered highly promising due to their abundant availability and wide application potential. However, the intermittent and variable nature of wind and solar resources poses significant challenges to the stability and reliability of power systems. To address this issue, integrating wind, solar, and energy storage into a complementary multi-energy system can effectively enhance the continuity of energy supply, improve economic performance, and reduce dependence on conventional fossil fuels.

The configuration of a multi-energy complementary system plays a decisive role in its overall performance. It involves not only the capacity selection of wind turbines, photovoltaic panels, and storage units but also the energy management strategies and operational optimization. Multi-objective optimization approaches can balance multiple performance criteria, such as system reliability, investment cost, energy efficiency, and environmental impact, simultaneously. By establishing mathematical models and applying advanced optimization algorithms, optimal system configurations can be determined, providing scientific guidance and decision support for practical design.

This study aims to investigate the configuration of wind-solar-storage complementary systems based on a multi-objective optimization framework, analyzing the performance of different design schemes in terms of economy, reliability, and sustainability. The findings are expected to offer practical insights for engineering design of multi-energy systems and contribute to the large-scale integration of renewable energy into modern power grids.