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Special Issue Reprint

The Future of Energy Systems

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This Reprint gathers recent research on the modelling, optimisation, cybersecurity, and operation of modern electric power systems with high penetrations of renewable energy sources, electric vehicles, and distributed energy resources. The contributions address system-level transformation, distribution network operation, and digital innovation for smart grids. Included studies examine modelling pathways toward net-zero power systems, the impact of digital technologies on sustainability, and technical frameworks for distribution system operators integrating distributed energy resources. Distribution-level challenges such as network reconfiguration, medium-voltage islands with high prosumer penetration, and flexible demand-side management are also explored. Data-driven and artificial intelligence methods feature prominently, including comparative analyses of gradient boosting and deep learning for short-term load forecasting and optimisation-based approaches to enhance smart grid reliability. Cybersecurity and resilience are central themes, with investigations of cyber attacks, intrusion detection, authentication in electric vehicle charging infrastructure, and secure EV grid integration strategies. Collectively, the contributions offer an integrated perspective on the technical, operational, and security challenges shaping resilient, intelligent, and sustainable power systems in the era of deep electrification.

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