Initial Post

Industry 4.0, defined by digitalization, automation, and cyber-physical system integration, has transformed the design, operation, and management of power and energy systems. Technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence (AI), and blockchain enable smart grids capable of coordinating distributed energy resources (DERs), renewable generation, and demand-side assets with greater efficiency (Makala & Bakovic, 2020; Liberati et al., 2021). Real-time monitoring, predictive maintenance, and digital twins enhance reliability, extend asset lifecycles, and lower operational costs (Fuller et al., 2020). Advanced forecasting and intelligent load management further support the integration of variable renewables, strengthening system stability (Hasan et al., 2025). Additionally, blockchain-based peer-to-peer (P2P) trading platforms are reshaping electricity markets by empowering prosumers and enhancing transparency (Aghahadi et al., 2024). Collectively, these technologies drive the decentralization, digitalization, and decarbonization of modern grids.

Building on these foundations, Industry 5.0 emphasizes human-centricity, sustainability, and resilience. While Industry 4.0 prioritized efficiency and automation, Industry 5.0 seeks to align advanced technologies with human intelligence and societal values (Ghobakhloo et al., 2023; Skėrė et al., 2025). In power systems, this shift strengthens clean energy transitions, decarbonization, and resilience against climate and cyber risks (IEA, 2021; Lopez et al., 2025). Human–machine collaboration, AI, and quantum technologies will enable adaptive, secure, and optimized operations (Alam et al., 2025; Hallo et al., 2025).

Together, Industry 4.0 and 5.0 are shaping smarter, greener, and more resilient infrastructures, ensuring greater renewable integration, consumer participation, and sustainability-driven innovation.

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