ICRERA 2025

14th INTERNATIONAL CONFERENCE ON RENEWABLE ENERGY RESEARCH AND APPLICATIONS

Professor Seref Sagiroglu

Gazi University, Ankara, Türkiye

Abstract

Title: Empowering the Renewable Energy and Smart Grid with Generative AI: Opportunities, Risks, and the Road Ahead

The global energy landscape is undergoing an unprecedented transformation, driven by the urgent need for decentralized, resilient, and sustainable infrastructures. Within this dynamic shift, Generative Artificial Intelligence (GenAI) is emerging as a pivotal force, poised to fundamentally redefine the capabilities of renewable energy systems and smart grids. This talk will explore the profound impact of GenAI, moving beyond conventional automation to unlock new paradigms in energy forecasting, distribution, management, and security. The speech would focus on the most recent advancements and cutting-edge applications, showcasing how GenAI is revolutionizing the sector. This includes sophisticated AI-driven demand response mechanisms that adapt to real-time fluctuations, the creation of hyper-realistic synthetic data for robust grid simulations and training next-generation energy models, proactive anomaly detection that anticipates and mitigates disruptions, and intuitive natural language interfaces that make complex energy systems more accessible and manageable.

However, this transformative potential is accompanied by critical considerations. In the talk, these topics will be critically examined by evolving challenges presented by GenAI within critical infrastructure, specifically focusing on heightened cybersecurity risks, the imperative for explainable AI to ensure transparency and trust in autonomous decisions, and the complex landscape of regulatory uncertainties. Drawing upon insights from recent real-world pilot programs, pioneering academic research, and prevailing industry trends, this presentation will purpose a future-ready framework. This framework seamlessly integrates trustworthy GenAI principles with established grid reliability and resilience standards, providing a roadmap for secure and sustainable implementation. Our objective is to empower a diverse audience, from engineers and data scientists to policymakers, to leverage GenAI not merely as a tool for efficiency, but as a strategic catalyst for constructing the next generation of sustainable, secure, and truly intelligent renewable energy networks.