Special Session XII

Special Session Basic Information:

专栏题目 Session Title	中文：面向高比例可再生能源系统的人工智能驱动建模与决策方法 英文：AI-Driven Modeling and Decision-Making in Renewable-Rich Energy Systems

专栏介绍和征稿主题
Introduction and topics

中文：在“双碳”目标和能源系统深度转型背景下，可再生能源高比例接入正成为电力系统和综合能源系统发展的常态。然而，风电、光伏等可再生能源固有的随机性、波动性与气候敏感性，使得系统在规划、运行与调控层面面临前所未有的复杂性与不确定性挑战。传统基于物理机理和确定性优化的方法在应对高维不确定性、跨时间尺度耦合以及实时决策需求方面逐渐显现出局限性。

近年来，人工智能（AI）与数据驱动方法的快速发展，为高比例可再生能源系统的建模与决策提供了新的技术路径。通过机器学习、深度学习、强化学习和生成式模型等手段，AI 能够从多源数据中挖掘系统内在规律，提升预测精度，加速复杂优化问题求解，并支持在不确定环境下的自适应决策。然而，如何在保障物理一致性、可解释性和工程可落地性的前提下，将 AI 方法与能源系统机理模型和优化框架深度融合，仍是当前研究的核心挑战。

本专栏旨在汇聚面向高比例可再生能源系统的 AI 驱动建模、优化与决策方法的最新研究进展，重点关注 AI 与传统能源系统方法的协同机制，以及其在规划、运行、韧性提升和气候适应性分析中的应用，为构建安全、高效、低碳的未来能源系统提供理论与方法支撑。

征稿主题（包括但不限于）：

- 可再生能源与负荷的 AI 预测建模方法
- 面向高比例可再生能源系统的机器学习与深度学习应用
- 强化学习在能量管理、调度与灵活性控制中的应用
- AI 辅助的电力系统与综合能源系统规划方法
- AI 与物理机理、优化模型的融合建模框架
- 生成式模型在场景生成与不确定性建模中的应用
- 电–氢–热等综合能源系统中的 AI 决策方法
- 面向能源系统的可解释与可信 AI 方法
- AI 在高比例可再生能源系统工程实践中的挑战与案例研究

英文：With the rapid transition toward low-carbon energy systems, renewable-rich power and integrated energy systems are becoming the new norm. However, the inherent variability, uncertainty, and climate sensitivity of renewable energy sources pose significant challenges to system modeling, planning, and operational decision-making. Conventional physics-based and deterministic optimization approaches often struggle to cope with high-dimensional uncertainties, multi-timescale coupling, and the increasing demand for adaptive and real-time decisions.

Recent advances in artificial intelligence (AI) and data-driven techniques offer promising new avenues for enhancing modeling and decision-making in renewable-rich energy systems. By leveraging machine learning, deep learning, reinforcement learning, and generative models, AI-enabled approaches can extract latent patterns from large-scale data, improve forecasting accuracy, accelerate complex optimization, and enable adaptive decision-making under uncertainty. Nevertheless, ensuring physical consistency, interpretability, robustness, and practical deployability remains a critical research challenge.

This Special Session aims to bring together recent advances in AI-driven modeling, optimization, and decision-making for renewable-rich energy systems, with particular emphasis on hybrid AI – physics frameworks and their applications in planning, operation, resilience enhancement, and climate-adaptive energy systems.

Topics of Interest (including but not limited to):

- AI-based forecasting of renewable generation and load
- Machine learning and deep learning for renewable-rich energy systems

- Reinforcement learning for energy management, dispatch, and flexibility control
- AI-assisted planning of power systems and integrated energy systems
- Hybrid AI–physics-informed modeling and optimization frameworks
- Generative models for scenario generation and uncertainty representation
- AI applications in power–hydrogen–heat integrated energy systems
- Explainable and trustworthy AI for energy system applications
- Practical deployment and real-world case studies of AI in renewable-rich energy systems

Special Session Chair(s):

姓名 **Name**	阮嘉祺 Jiaqi Ruan
称谓 **Prefix**	副研究员 Associate Professor
部门 **Department**	电气工程学院 College of Electrical Engineering
单位 **Organization**	四川大学 Sichuan University
城市/地区 **City/Region**	成都，中国 Chengdu, China
邮箱 **Email**	jiaqiruan@scu.edu.cn

Organizer's Brief Biography

中文：**阮嘉祺**现为四川大学电气工程学院副研究员，研究方向包括智能电网、人工智能算法及其应用、信息物理系统安全、气候风险与能源系统脆弱性分析等。他已发表 SCI/EI 收录论文 40 余篇，其中多篇发表于 *Nature Reviews Electrical Engineering* 和 *The Innovation* 等高水平期刊，其研究成果被 *IEEE Transactions on Smart Grid* 评选为热门论文。阮嘉祺主持了多项科研项目，包括国家自然科学基金项目等。他曾担任多个国际会议的专题分会和圆桌论坛主席，并多次受邀在国际学术会议上作报告。目前，他担任《*Protection and Control of Modern Power Systems*》《*Energy Conversion and Economics*》等期刊青年编委。

英文：Jiaqi Ruan is an Associate Professor in the College of Electrical Engineering at Sichuan University, Chengdu, China. His research interests include smart grids, artificial intelligence algorithms and applications, cyber-physical security, climate risk, and vulnerability analysis. He has published over 40 SCI/EI indexed papers, including work in Nature Reviews Electrical Engineering and The Innovation, and one of his papers was featured as a popular paper in IEEE Transactions on Smart Grid. He has led several research projects, including a National Natural Science Foundation of China. He has chaired several panel and special sessions and has been an invited speaker at multiple international conferences. He also serves on the Youth Editorial Board of Protection and Control of Modern Power Systems and Energy Conversion and Economics.

姓名 **Name**	古宸嘉 Chenjia Gu
称谓 **Prefix**	助理研究员 Postdoctoral Fellow
部门 **Department**	电气工程学院 College of Electrical Engineering
单位 **Organization**	四川大学 Sichuan University
城市/地区 **City/Region**	成都，中国 Chengdu, China
邮箱 **Email**	gcj0629@scu.edu.cn

Organizer's Brief Biography

中文：古宸嘉现为四川大学电气工程学院助理研究员，研究方向包括新型电力系统规划与运行优化、电力系统气候适应性、人工智能算法及其应用等。他已发表 SCI/EI 收录论文 20 余篇，其中多篇发表于 *IEEE Trans* 系列高水平期刊。古宸嘉博士主持和参与了多项科研项目，包括国家重点研发计划，国家自然科学基金等，并多次受邀在国际学术会议上作报告。

英文： Chenjia Gu is an Assistant Researcher in the College of Electrical Engineering at Sichuan University. His research interests include planning and operational optimization of new-type power systems, climate adaptability of power systems, and artificial intelligence algorithms and their applications. He has published more than 20 SCI/EI-indexed journal and conference papers, with several appearing in high-impact IEEE Transactions series journals. Dr. Gu has led and participated in multiple research projects, including those supported by the National Key Research and Development Program of China and the National Natural Science Foundation of China. He has also been invited to deliver presentations at several international academic conferences.

姓名 **Name**	陶悦川 Yuechuan Tao
称谓 **Prefix**	研究助理教授 Research Assistant Professor
部门 **Department**	电气工程系 Department of Electrical Engineering
单位 **Organization**	香港城市大学 City University of Hong Kong
城市/地区 **City/Region**	香港，中国 Hongkong, China
邮箱 **Email**	yuechuan.tao@outlook.com

Organizer's Brief Biography

中文：陶悦川，香港城市大学，研究助理教授。陶悦川于 2023 年获得澳大利亚悉尼大学博士学位。2023 年至 2024 年，他担任南洋理工大学瓦伦堡-南洋理工大学校长博士后研究员。目前，他是香港城市大学的全球研究助理教授。他被评选为 2025, 2024 年斯坦福世界顶尖 2%科学家。他的研究兴趣在数据驱动的低碳能源转型，电力系统规划、电力市场建模、交通电气化以及智能电网运营、可再生能源整合及能源管理。

英文：Yuechuan Tao received the B.Eng. degree in Electrical Engineering and Automation from Shanghai Normal University, Shanghai, China, in 2017, and an M.P.Eng. degree in Electrical Engineering from the University of Sydney, Australia in 2019, and a Ph.D. degree in the University of Sydney, Australia in 2023. From 2023-2024, he was the Wallenberg-NTU Presidential Postdoctoral Fellow in Nanyang Technological University. Currently, he is a Global Research Assistant Professor in City University of Hong Kong. His research interests lie in data-driven low-carbon energy transitions, with a focus on power system planning, electricity market modeling, transportation electrification and AI-driven solutions for smart grid operations, renewable energy integration, and optimal energy management.