

Special Session 4

Special Session Basic Information:

专栏题目 Session Title

中文：面向极端自然灾害的城市能源系统韧性评估与提升
英文：Resilience Evaluation and Improvement of Urban Energy System for Extreme Natural Disasters

专栏介绍和征稿主题 Introduction and topics

中文：随着城市能源系统由单一供能网络向电、气、热、冷、交通等多能源深度耦合发展，高比例可再生能源、储能、电动汽车与柔性负荷的广泛接入显著增强了系统运行的不确定性和动态复杂性。与此同时，台风、洪涝、冰冻雨雪、地震等极端自然灾害频发，使城市能源系统面临多灾害扰动、设备群发失效、故障链式传播、跨能源网络耦合失效以及灾后供能恢复困难等严峻挑战。如何准确揭示灾害作用下城市能源系统故障演化机理，构建可量化、可预测、可调控的韧性评估体系，形成贯穿灾前预防、灾中调控与灾后恢复全过程的韧性提升方法，已成为新型能源系统安全运行的重要研究方向。本专栏聚焦“极端自然灾害下城市能源系统韧性评估与提升”，面向多灾害复合作用、多能源系统耦合失效、源网荷储协同支撑和全过程韧性调控等关键问题，重点交流故障时空演化推演、多时空尺度韧性指标构建、实时快速准确韧性评估、异构资源协同规划以及分层分布式韧性提升等方面的最新理论、方法与工程应用成果，推动城市能源系统的韧性基础理论创新与应用实践发展。

征稿主题包括但不限于：

1. 极端自然灾害与多灾害复合场景建模及不确定性表征；
2. 灾害作用下城市能源系统设备失效、级联故障与跨能源网络故障传播机理；
3. 面向灾前、灾中、灾后的多时空尺度韧性指标体系与量化评估方法；
4. 模型-数据混合驱动、人工智能等支撑的韧性评估、预测预警与动态校正方法；
5. 面向韧性提升的源网荷储异构资源协同规划、高风险元件加固与应急资源配置；
6. 灾前主动预防、灾中紧急调控、孤岛/微网运行、移动应急资源调度与灾后多能协同快速恢复优化策略；
7. 面向城市能源系统韧性提升的鲁棒优化、随机优化、分布式优化等方法。

英文：As urban energy systems evolve from single energy supply networks toward deeply coupled multi-energy systems integrating electricity, gas, heating, cooling, and transportation, the large-scale integration of high-penetration renewable energy, energy storage, electric vehicles, and flexible loads has significantly increased operational uncertainty and dynamic complexity. Meanwhile, the frequent occurrence of extreme natural disasters, such as typhoons, floods, ice and snow storms, and earthquakes, has exposed urban energy systems to severe challenges, including multi-hazard disturbances, widespread equipment failures, cascading fault propagation, coupled failures across energy networks, and difficulties in post-disaster energy supply restoration. Therefore, accurately revealing the fault evolution mechanisms of urban energy systems under disaster impacts, developing a quantifiable, predictable, and controllable resilience assessment framework, and establishing whole-process resilience enhancement methods covering pre-disaster prevention, during-disaster control, and post-disaster restoration have become critical research directions for the secure operation of new energy systems. This special session focuses on “Resilience Assessment and Enhancement of Urban Energy Systems under Extreme Natural Disasters.” It addresses key issues such as compound multi-hazard impacts, coupled failures in multi-energy systems, coordinated support from source-network-load-storage resources, and whole-process resilience regulation. The session aims to exchange the latest theoretical advances, methodological developments, and engineering applications in fault spatiotemporal evolution simulation, multi-spatiotemporal-scale resilience indicator construction, fast and accurate real-time resilience assessment, coordinated planning of heterogeneous resources, and hierarchical distributed resilience enhancement, thereby promoting both fundamental theoretical innovation and practical applications for resilient urban energy systems.

Topics of interest include, but are not limited to:

1. Modeling and uncertainty characterization of extreme natural disasters and compound multi-hazard scenarios;

2. Equipment failures, cascading faults, and cross-energy-network fault propagation mechanisms in urban energy systems under disaster impacts;
3. Multi-spatiotemporal-scale resilience indicator systems and quantitative assessment methods for pre-disaster, during-disaster, and post-disaster stages;
4. Model-data hybrid-driven and artificial intelligence-supported methods for resilience assessment, forecasting, early warning, and dynamic correction;
5. Coordinated planning of source-network-load-storage heterogeneous resources, reinforcement of high-risk components, and emergency resource allocation for resilience enhancement;
6. Pre-disaster proactive prevention, during-disaster emergency control, islanded/microgrid operation, mobile emergency resource dispatch, and post-disaster multi-energy coordinated rapid restoration optimization strategies;
7. Robust optimization, stochastic optimization, distributed optimization, and related methods for resilience enhancement of urban energy systems.

Special Session Chair(s):

	姓名	张儒峰
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Organizer's Brief Biography

中文：张儒峰，博士，教授，东北电力大学电气工程学院电力工程系支部书记、系主任。长期从事极端自然灾害背景下电力系统韧性评估与提升、安全灵活运行及灾害防控优化研究。围绕严寒地区典型灾害特征与电力系统运行机理，提出多层级韧性评估方法及多灾种重大自然灾害下电力系统抗灾韧性评估与减灾防控优化策略，相关成果已在国网黑龙江省、国网吉林省等电网公司推广应用。主持国家自然科学基金面上项目、青年基金项目 and 吉林省自然科学基金优秀青年项目等，参与国家自然科学基金国际合作与交流项目、面上项目及国家重点研发计划课题等多项科研任务，承担国家电网公司横向课题 9 项。入选吉林省“长白计划”青年拔尖人才、中国电机工程学会“青年人才托举工程”，获中国电力优秀青年科技人才奖、IEEE PCCC Outstanding Young Engineer Award。研究成果获吉林省自然科学二等奖、吉林省科技进步一等奖、中国电工技术学会科技进步二等奖等奖励。兼任《Applied Energy》

《Protection and Control of Modern Power Systems》《Energy Storage and Applications》《电力自动化设备》《电力系统保护与控制》等期刊编委或青年编委，连续入选斯坦福全球前 2% 顶尖科学家榜单。发表 SCI/EI 论文 80 余篇（ESI 热点论文 3 篇、高被引论文 6 篇），并在 IEEE PES 国际会议作韧性评估与提升主题报告。

英文：Zhang Rufeng, Ph.D., Professor, serves as Party Branch Secretary and Head of the Department of Power Engineering at the School of Electrical Engineering, Northeast Electric Power University. His research has long focused on power system resilience assessment and enhancement under extreme natural disasters, secure and flexible operation, and disaster prevention and mitigation optimization. Considering the typical disaster characteristics of cold regions and the operational mechanisms of power systems, he has proposed multi-level resilience assessment methods and disaster-resilience evaluation and mitigation-control optimization strategies for power systems under multiple types of major natural disasters. These achievements have been applied in power grid companies such as State Grid Heilongjiang Electric Power Company and State Grid Jilin Electric Power Company. He has led several research projects, including the General Program and Young Scientists Fund of the National Natural Science Foundation of China, as well as the Excellent Young Scientists Fund of Jilin Province. He has also participated in multiple research tasks, including NSFC international cooperation and exchange projects, NSFC General Programs, and projects under the National Key Research and Development Program of China, and has undertaken nine industry-sponsored projects from the State Grid Corporation of China. He has been selected for the Jilin Province “Changbai Program” Young Top Talent Program and the Young Elite Scientists Sponsorship Program of the Chinese Society for Electrical Engineering. He has received the China Electric Power Outstanding Young Scientific and Technological Talent Award and the IEEE PCCC Outstanding Young Engineer Award. His research achievements have been recognized with awards including the Second Prize of Jilin Provincial Natural Science Award, the First Prize of Jilin

Provincial Science and Technology Progress Award, and the Second Prize of Science and Technology Progress Award of the China Electrotechnical Society. He serves as an editorial board member or young editorial board member for journals including Applied Energy, Protection and Control of Modern Power Systems, Energy Storage and Applications, Electric Power Automation Equipment, and Power System Protection and Control. He has been consecutively listed among Stanford University’s World’s Top 2% Scientists. He has published more than 80 SCI/EI-indexed papers, including three ESI hot papers and six highly cited papers, and has delivered invited presentations on resilience assessment and enhancement at IEEE PES international conferences.



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Organizer’s Brief Biography

中文：赵瑞锋，工学博士，正高级工程师，南网战略技术专家、广东电网电力调度控制中心自动化部经理，南网高层次人才特殊支持计划领军人才，中国研究生导师发展共同体首届优秀研究生行业导师。长期从事电网调度自动化、配电网自动化、电力现货和电力数字化技术与运行管理。负责或参与国家级项目 5 项、省级 2 项，南方电网重点科技项目 4 项多项重大科研任务，具有丰富的重大工程组织实施与科技成果转化经验，近几年获得省部级奖励 30 余项，其中中国电力科学技术奖一等奖 2 项、中国电工技术学会科学技术奖一等奖 1 项。IEEE 会员、中国电机工程学会高级会员、中国电工技术学会高级会员、中国计算机学会会员，并担任全国电力系统管理及其信息交换标准化技术委员会、中国电工技术学会主动配电网及分布式电源专业委员会、配网调度控制运行专家委员会，以及中国电力企业联合会能源互联网标准化技术委员会能源信息与物理交互工作组等多个专委会和标委会委员。发表学术论文 30 余篇，其中 SCI/EI 收录论文 20 余篇，获授权发明专利 30 余项。制定国行标 12 项，报批 4 项国行标。

英文：Zhao Ruifeng, Ph.D. in Engineering and Professorate Senior Engineer, is a Strategic Technology Expert of China Southern Power Grid, Manager of the Automation Department at the Power Dispatching and Control Center of Guangdong Power Grid Corporation, and a Leading Talent under the Special Support Program for High-Level Talents of China Southern Power Grid. He was also recognized as an inaugural Outstanding Industry Mentor for Graduate Students by the China Graduate Supervisor Development Consortium. He has long been engaged in research and operational management in power grid dispatch automation, distribution network automation, electricity spot markets, and power system digitalization. He has led or participated in five national-level projects, two provincial-level projects, four key science and technology projects of China Southern Power Grid, and several other major research initiatives. He has extensive experience in the organization and implementation of major engineering projects and the commercialization of scientific and technological achievements. In recent years, he has received more than 30 provincial and ministerial-level awards, including two First Prizes of the China Electric Power Science and Technology Award and one First Prize of the Science and Technology Award of the China Electrotechnical Society. He is a Member of IEEE and the China Computer Federation, and a Senior Member of both the Chinese Society for Electrical Engineering and the China Electrotechnical Society. He also serves on several professional and standardization committees, including the National Technical Committee for Power System Management and Associated Information Exchange Standardization, the Active Distribution Networks and Distributed Generation Professional Committee and the Distribution Network Dispatching, Control and Operation Expert Committee of the China Electrotechnical Society, as well as the Energy Information and Physical Interaction Working Group of the Energy Internet Standardization Technical Committee of the China Electricity Council. He has published more than 30 academic papers, including over 20 papers indexed by SCI or EI, and has been granted more than 30 invention patents. He has contributed to the development of 12 national and industry standards, with four additional national or industry standards submitted for approval.



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Organizer's Brief Biography

中文：吴昊，博士，曾赴比利时鲁汶大学联合培养，2023 年博士毕业后在天津大学王成山院士团队开展博士后研究，合作导师为长江学者、国家杰青贾宏杰教授。主要研究方向为电力系统韧性增强、灾后恢复优化、移动应急资源协同调度以及新型电力系统恢复控制。围绕极端自然灾害冲击下配电网抢修与运行调度协同、移动储能和移动应急发电弹性调度、可再生能源不确定性与时空相关性下负荷恢复优化等关键问题，系统开展了多阶段弹性调度、鲁棒恢复优化和应急资源协同配置研究，形成了涵盖灾害场景刻画、故障传播与恢复建模、源网荷储应急资源协同优化的研究体系。以第一/通讯作者发表 SCI/EI 论文 10 余篇，申请/公开极端灾害下配电网两阶段抢修恢复、可再生能源不确定性下灾后抢修运行、台风灾害下风机切机故障抢修等相关发明专利多项。主持国重子课题、联合基金课题及能源局咨询等纵向项目 3 项，获国家资助博士后计划、天津博士后创新岗、电工学会一等奖、日内瓦银奖等。相关研究进一步拓展至城市电网数据集构建、广州韧性提升平台开发等实际应用，具备从理论模型、优化算法到工程应用验证的综合研究能力。

英文：Wu Hao, Ph.D., received joint doctoral training at KU Leuven, Belgium. After obtaining his doctoral degree in 2023, he joined the research team led by Academician Wang Chengshan at Tianjin University as a postdoctoral researcher, under the co-supervision of Professor Jia Hongjie, a Changjiang Scholar and recipient of the National Science Fund for Distinguished Young Scholars. His research interests include power system resilience enhancement, post-disaster restoration optimization, coordinated dispatch of mobile emergency resources, and restoration control of new power systems. Focusing on critical challenges such as the coordination of distribution network repair and operational dispatch under extreme natural disasters, resilient dispatch of mobile energy storage systems and mobile emergency generators, and load restoration optimization considering renewable energy uncertainty and spatiotemporal correlations, he has conducted systematic research on multi-stage resilient dispatch, robust restoration optimization, and coordinated emergency resource allocation. His work has established an integrated research framework encompassing disaster scenario characterization, fault propagation and restoration modeling, and coordinated optimization of source-grid-load-storage emergency resources. He has published more than ten SCI/EI-indexed papers as first or corresponding author and has filed or published several invention patents related to two-stage distribution network repair and restoration under extreme disasters, post-disaster repair and operation considering renewable energy uncertainty, and repair scheduling for wind turbine tripping failures under typhoon conditions. He has led three research projects, including a subproject under the National Key Research and Development Program of China, a Joint Fund project, and a consultancy project commissioned by the National Energy Administration. He has been selected for the Nationally Funded Postdoctoral Researcher Program and the Tianjin Postdoctoral Innovation Position Program, and has received a First Prize from the China Electrotechnical Society and a Silver Medal at the International Exhibition of Inventions Geneva. His research has further extended to the development of urban power grid datasets and a resilience enhancement platform for Guangzhou, demonstrating comprehensive capabilities spanning theoretical modeling, optimization algorithm development, and engineering implementation and validation.