CONFERENCE PROGRAM

2025 International Conference on
Smart Power & Internet Energy Systems

SPIES 2025

October 17-20, 2025 / Shanghai, China

Sponsored By

Patrons

https://www.icspies.org/

TABLE OF CONTENT

WELCOME MESSAGE ..... - 5 -
ORGANIZING COMMITTEE ..... - 6 -
ONSITE CONFERENCE NOTICE ..... - 8 -
ONLINE CONFERENCE NOTICE ..... - 10 -
OPENING REMARK ..... - 18 -
KEYNOTE SPEECH I ..... - 19 -
KEYNOTE SPEECH II ..... - 21 -
KEYNOTE SPEECH III ..... - 22 -
KEYNOTE SPEECH IV ..... - 24 -
INVITED SPEECH I ..... - 25 -
INVITED SPEECH II ..... - 26 -
INVITED SPEECH III ..... - 27 -
INVITED SPEECH IV ..... - 28 -
ORAL SESSION 1 ..... - 29 -
PE0105 ..... - 29 -
PE0010 ..... - 29 -
PE0025 ..... - 30 -
PE0083 ..... - 30 -
PE0091 ..... - 30 -
PE0096 ..... - 31 -
PE0099 ..... - 31 -
POSTER SESSION 1 ..... - 33 -
PE0045-A ..... - 33 -
PE0008 ..... - 33 -
PE0017 ..... - 34 -
PE0032 ..... - 34 -
PE0039 ..... - 34 -
PE0047-A ..... - 35 -
PE0062 ..... - 35 -
PE0077 ..... - 36 -
PE0082 ..... - 36 -
PE0084 ..... - 37 -
PE0089 ..... - 37 -
PE0111 ..... - 37 -
PE0038 ..... - 38 -
PE0092 ..... - 38 -
PE0097 ..... - 39 -
PE0112 ..... - 39 -
PE2003 ..... - 40 -
PE2008 ..... - 40 -

PE2009 ..... - 41 -
ORAL SESSION 2 ..... - 42 -
PE0004 ..... - 42 -
PE0011 ..... - 42 -
PE0037 ..... - 43 -
PE0118 ..... - 43 -
PE0076 ..... - 43 -
PE2011 ..... - 44 -
PE0141 ..... - 44 -
POSTER SESSION 2 ..... - 45 -
PE0007 ..... - 45 -
PE0015 ..... - 45 -
PE0023 ..... - 46 -
PE0048 ..... - 46 -
PE0021 ..... - 47 -
PE0030 ..... - 47 -
PE0057 ..... - 48 -
PE0098 ..... - 48 -
PE0116 ..... - 48 -
PE0121 ..... - 49 -
PE0122 ..... - 49 -
PE0124 ..... - 50 -
PE2006 ..... - 50 -
PE0075 ..... - 50 -
PE0086 ..... - 51 -
PE0070 ..... - 51 -
ORAL SESSION 3 ..... - 53 -
PE0028 ..... - 53 -
PE0074 ..... - 53 -
PE0009 ..... - 54 -
PE0107 ..... - 54 -
PE0126 ..... - 55 -
PE0134 ..... - 55 -
PE0135 ..... - 55 -
PE0136 ..... - 56 -
ORAL SESSION 4 ..... - 57 -
PE0104 ..... - 57 -
PE0108 ..... - 57 -
PE0119-A ..... - 58 -
PE0123 ..... - 58 -
PE0131 ..... - 59 -
PE2012 ..... - 59 -
PE2013 ..... - 59 -
ORAL SESSION 5 (ONLINE) ..... - 61 -

PE0001 ..... - 61 -
PE0018 ..... - 61 -
PE0110 ..... - 62 -
PE0120 ..... - 62 -
PE0053 ..... - 63 -
ORAL SESSION 6 (ONLINE) ..... - 64 -
PE0061 ..... - 64 -
PE0067 ..... - 64 -
PE0073 ..... - 65 -
PE0078 ..... - 65 -
PE0066 ..... - 66 -
ORAL SESSION 7 (ONLINE) ..... - 67 -
PE0046 ..... - 67 -
PE0059 ..... - 67 -
PE0064 ..... - 68 -
PE0065 ..... - 68 -
PE0068 ..... - 68 -
PE0071 ..... - 69 -
ORAL SESSION 8 (ONLINE) ..... - 70 -
PE0052 ..... - 70 -
PE0063 ..... - 70 -
PE2010 ..... - 71 -
PE0081 ..... - 71 -
PE0103 ..... - 71 -
NOTES ..... - 73 -

WELCOME MESSAGE

Dear delegates,

On behalf of the organizing committees, it is our honor to extend a heartfelt welcome to all attendees of 2025 International Conference on Smart Power & Internet Energy Systems (SPIES 2025), taking place in Shanghai, China during October 17-20, 2025.

The SPIES conference series is held annually to provide an interactive forum for presentation and discussion on Smart Power, Intelligent Energy Systems and related fields. SPIES 2025 is sponsored by Shanghai University of Electric Power, China and technically co-sponsored by IEEE PES and IEEE IAS. And it is also technically supported by University of Vaasa, Macquarie University, Chiang Mai University, Université de Bretagne Occidentale, University of Nottingham and Auckland University of Technology.

After more than one year's preparation, we received more than 130 submissions from China, Japan, Malaysia, Republic of Korea, United States, Ghana, United Arab Emirates, United Kingdom and other countries. More than 100 Technical Program Committee Members participated in the review process. Thanks for their great efforts and excellent work.

There are 4 keynote speeches, 4 invited speeches and 10 technical sessions in SPIES 2025 conference program. We believe that over the four days you'll get the theoretical grounding, practical knowledge and personal contacts that will help you build long-term, profitable and sustainable communication among researchers and practitioners working in a wide variety of scientific areas with a common interest in Smart Power and Internet Energy Systems.

We sincerely would like to thank all the authors as well as the technical program committee members and reviewers. Their high competence, enthusiasm, time and expertise knowledge enabled us to prepare the high-quality final program and helped to make the conference become a successful event.

SPIES 2025
General Chair
Prof. Dongdong Li
Shanghai University of Electric Power, China
October 2025

ORGANIZING COMMITTEE

Honorary Chair

Prof. Chunhua Gu, Shanghai University of Electric Power, China

General Chair

Prof. Dongdong Li, Shanghai University of Electric Power, China

General Co-Chairs

Assoc. Prof. Xiaolu Li, Shanghai University of Electric Power, China

Prof. Shunfu Lin, Shanghai University of Electric Power, China

Advisory Chairs

Prof. Adrian Ioinovici, Shanghai University of Electric Power, China

Prof. S M Muyeen, Qatar University, Qatar

Prof. Mohamed Benbouzid, University of Brest, France

Prof. Ahmed Al-Durra, Khalifa University, UAE

Program Chairs

Prof. Ali Arefi, Murdoch University, Australia

Assoc. Prof. MD Rakibuzzaman Shah, Federation Unviersity, Australia

International Steering Committee

Prof. Syed Islam, Federation University, Australia

Prof. Innocent Kamwa, Laval University, Canada

Prof. Marcelo G. Simoes, University of Vaasa, Finland

Prof. Farhad Rachidi-Haeri, Swiss Federal Institute of Technology (EPFL), Switzerland

Prof. Mohamed Benbouzid, Brest University, France

Prof. Aman Maung Than Oo, Macquarie University, Australia

Publicity Chairs

Prof. Fan Yang, Shanghai University of Electric Power, China

Assoc. Prof. Yin Yao, Shanghai University of Electric Power, China

Asst. Prof. Arman Oshnoei, Aalborg University, Denmark

Asst. Prof. Jiangjiao Xu, Shanghai University of Electric Power, China

Chapter Chairs

Prof. Yufei Wang, Shanghai University of Electric Power, China

Assoc. Prof. Gaiping Sun, Shanghai University of Electric Power, China

Technical Committee Chairs

Prof. Yang Mi, Shanghai University of Electric Power, China

Assoc. Prof. C Dhanamjayulu, Vellore Institute of Technology, India

Publication Chairs

Prof. Ronghui Liu, Shanghai University of Electric Power, China

Asst. Prof. Haris Khalid, University of Dubai, UAE

Dr. Hafiz bin Ismail, Universiti Teknologi Petronas, Malaysia

Special Session/Tutorial/Workshop Chair

Prof. Aiqing Ma, Shanghai University of Electric Power, China

Treasurer

Dr. Zha Xiaogang, Fudan University, China

ONSITE CONFERENCE NOTICE

1 Conference Venue | 会议地点

Paradise Jinjiang Hotel

甸园锦江宾馆

Address: 2558 Chang Yang Road, Yang Pu District, Shanghai, China

地址：长阳路2558号, 杨浦区, 上海市, 中国

2 Transportation | 交通

• How to Reach Paradise Jinjiang Hotel

From Shanghai Pudong International Airport 从上海浦东国际机场出发

—By Public Transportation (1 hour and 19 minutes)

Take Metro Line 2 (National Exhibition and Convention Center direction) from Pudong Airport Terminal 1 & 2 Station to Century Avenue Station, then transfer to the outer loop of Metro Line 4 (Yishan Road direction) to the Dalian Road Station, then transfer to Metro Line 12 (Jinhai Road direction) and get off at Longchang Road (Exit 2).

乘坐地铁 2 号线（国家会展中心方向）在世纪大道下车，换乘地铁 4 号线外圈（宜山路方向）到大连路下车，再换乘地铁 12 号线（金海路方向）到隆昌路下车（2 号口出）。

—By Taxi (41.6km, 43 minutes)

From Shanghai Hongqiao International Airport 从上海虹桥国际机场出发

From Shanghai Hongqiao Station 从上海虹桥站出发

—By Public Transportation (1 hour and 2 minutes)

Take Metro Line 10 (Jilong Road direction) to Shanxi South Road Station, then transfer to Metro Line 12 (Jinhai Road direction) and get off at Longchang Road (Exit 2).

乘坐地铁 10 号线（基隆路方向）在陕西南路下车，换乘地铁 12 号线（金海路方向）到隆昌路下车（2 号口出）。

—By Taxi (23.4km, 45 minutes)

From Shanghai Station 从上海站出发

—By Public Transportation (30 minutes)

Take the inner loop of Metro Line 4 (Yishan Road direction) to the Dalian Road Station, then transfer to Metro Line 12 (Jinhai Road direction) and get off at Longchang Road (Exit 2).

乘坐地铁 4 号线内圈（宜山路方向）到大连路下车，换乘地铁 12 号线（金海路方向）到隆昌路下车（2 号口出）。

—By Taxi (11.2km, 25 minutes)

3 Conference Rooms | 会议室信息

Rooms	Activities	Time
The lobby of Paradise Jinjiang Hotel 甸园锦江宾馆大堂	Registration	10:00-17:00 October 17th
2nd Floor - Edison Conference Room 二楼 - 爱迪生厅	Opening Remark & Keynote Speeches Invited Speeches & Onsite Sessions	8:30-19:30 October 18th
3rd Floor - Qinshan Conference Room 三楼 – 秦山厅	Onsite Sessions	9:00-13:30 October 19th

4 Onsite Presentation | 现场报告

• Timing: a maximum of 15 minutes total, including speaking time and discussion. Please make sure your presentation is well timed.
• Each speaker is required to meet her / his session chair in the corresponding session rooms 10 minutes before the session starts and copy the slide file (PPT or PDF) to the computer.
• It is suggested that you email a copy of your presentation to your personal in box as a backup. If for some reason the files can't be accessed from your flash drive, you will be able to download them to the computer from your email.
• Please note that each session room will be equipped with an LCD projector, screen, point device, microphone, and a laptop with general presentation software such as Microsoft Power Point and Adobe Reader.
• Poster Presenters should bring your poster to the conference venue and put it on designated place.

5 Name Badge | 代表证

For security purposes, delegates, speakers, exhibitors and staff are required to wear their name badge to all sessions and social functions. Lending your participant card to others is not allowed. Entrance into sessions is restricted to registered delegates only. If you misplace your name badge, please ask the staff at the registration desk to arrange a replacement.

6 Gentle Reminder | 温馨提示

• Please ensure that you take all items of value with you at all times when leaving a room. Do not leave bags or laptops unattended. The conference organizer does not assume any responsibility for the loss of personal belongings of the participants.
• Accommodation is not provided. Delegates are suggested make early reservation.
• Please show the badge and meal coupons when dining.

ONLINE CONFERENCE NOTICE

1 Platform: Zoom

Download Link: https://zoom.us/download

2 Sign In and Join

***Join a meeting without signing in.**

A Zoom account is not required if you join a meeting as a participant, but you cannot change the virtual background or edit the profile picture.

***Sign in with a Zoom account.**

All the functions are available.

3 Time Zone | 时区

GMT+8

***You're suggested to set up the time on your computer in advance.**

4 Online Room Information | 线上会议号信息

Zoom ID: 845 3572 0120

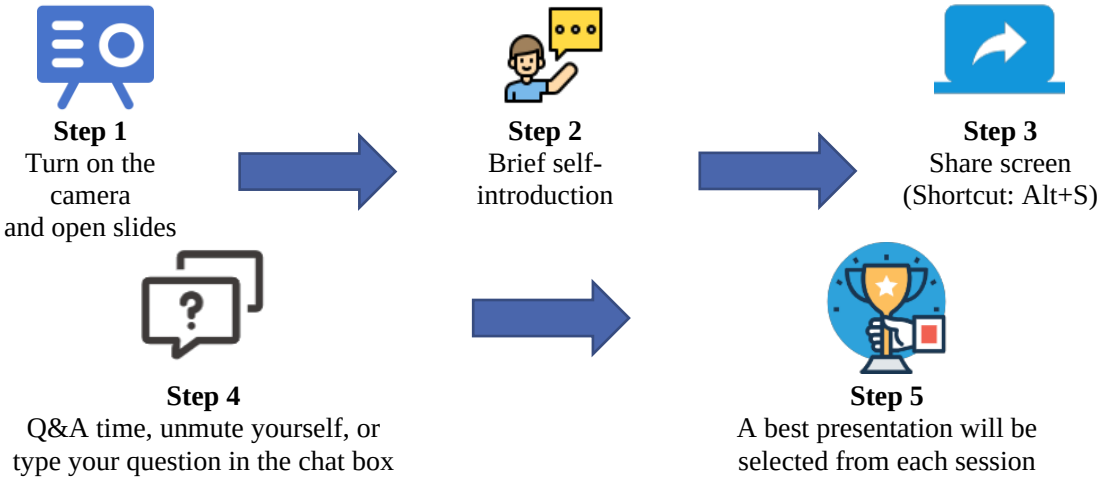
Zoom Link: https://us02web.zoom.us/j/84535720120

You can scan QR code to enter:

1. You can download the virtual background here.
2. Prior to the formal conference, presenter shall join the test room to make sure everything is on the right track
3. Note: Please rename your Zoom Screen Name in below format before entering meeting room.

Role	Format	Example
Conference Committee	Position-Name	Conference Chair-Name
Keynote/ Invited Speaker	Position-Name	Keynote/Invited Speaker-Name
Author	Session Number-Paper ID-Name	S1-PE0001-Name
Delegate	Delegate-Name	Delegate-Name

5 Presentation Process by Zoom Meeting | 报告流程



6 About Presentation | 线上报告

• Every presenter has 15 minutes, including Q & A. Each presentation should have at least 10 minutes.
• The best presentation certificate and all authors' presentation certificates will be sent after conference by email.
• It is suggested that the presenter email a copy of his / her video presentation to the conference email box as a backup in case any technical problem occurs.

7 Environment & Equipment Needed | 环境及设备要求

• A quiet place; Stable Internet connection; Proper lighting and background
• A computer with internet and camera; Earphone

8 Conference Recording | 会议录制

• We'll record the whole conference. If you do mind, please inform us in advance. We'll stop to record when it's your turn to do the presentation.
• The whole conference will be recorded. It is suggested that you should dress formally and we appreciate your proper behavior.
* The recording will be used for conference program and paper publication requirements. It cannot be distributed to or shared with anyone else, and it shall not be used for commercial nor illegal purpose.

AGENDA OVERVIEW

Friday, October 17th, 2025

Onsite Registration
Registration Time: 10:00-17:00

Venue: Paradise Jinjiang Hotel
地点: 甸园锦江宾馆

Address: 2558 Chang Yang Road, Yang Pu District, Shanghai, China
地址：长阳路2558号, 杨浦区, 上海市, 中国

1. Arrive at the lobby of Paradise Jinjiang Hotel;
2. Inform the conference staff of your paper ID;
3. Sign your name on the Participants list;
4. Sign your name on Lunch & Dinner requirement list;
5. Check your conference kits;
6. Finish registration.

Online Zoom Test
Time Zone: GMT+8

Zoom ID: 845 3572 0120
Zoom Link: https://us02web.zoom.us/j/84535720120

10:00-10:20	**Oral Session 5 (Online)**
10:20-10:40	**Oral Session 6 (Online)**
10:40-11:00	**Oral Session 7 (Online)**
11:00-11:20	**Oral Session 8 (Online)**

If you want to do online zoom test after 11:20, please contact your conference secretary.

AGENDA OVERVIEW

Saturday, October 18th, 2025	
Venue: 2nd Floor - Edison Conference Room 地点：二楼 - 爱迪生厅 Host: Prof. Xiaolu Li, Shanghai University of Electric Power, China 主持人：李晓露 教授，上海电力大学，中国	
8:30-8:40	Opening Remark 开幕式 Prof. Chunhua Gu, Shanghai University of Electric Power, China 顾春华 教授，上海电力大学，中国
8:40-8:50	Group Photo 合影
8:50-9:30	Keynote Speech I 大会报告I Prof. M. Fotuhi-Firuzabad, Sharif University of Technology, Iran M. Fotuhi-Firuzabad 教授，谢里夫理工大学，伊朗
9:30-10:10	Keynote Speech II 大会报告II Prof. Hua Geng, Tsinghua University, China 耿华 教授，清华大学，中国
10:10-10:30	Coffee Break 茶歇
10:30-11:10	Keynote Speech III 大会报告III Prof. Syed M Islam, Federation University, Australia Syed M Islam 教授，联邦大学，澳大利亚
11:10-11:50	Keynote Speech IV 大会报告IV Prof. S. M. Muyeen, Qatar University, Qatar S. M. Muyeen 教授，卡塔尔大学，卡塔尔
11:50-13:30	Lunch Time 午餐

AGENDA OVERVIEW

Saturday, October 18th, 2025	
Venue: 2nd Floor - Edison Conference Room 地点：二楼 - 爱迪生厅 Host: 主持人：	
13:30-13:50	Invited Speech I 特邀报告I Prof. Yu Wu, Northwestern Polytechnical University, China 吴宇 教授，西北工业大学，中国
13:50-14:10	Invited Speech II 特邀报告II Prof. Yu Wang, Chongqing University, China 王宇 教授，重庆大学，中国
14:10-14:30	Invited Speech III 特邀报告III Prof. Hui Hou, Wuhan University of Technology, China 侯慧 教授，武汉理工大学，中国
14:30-14:50	Invited Speech IV 特邀报告IV Prof. Zhenzhi Lin, Zhejiang University, China 林振智 教授，浙江大学，中国
14:50-15:10	Coffee Break 茶歇
15:10-16:55	Oral Session 1 New Electromechanical System Design and Integrated Control Method PE0105, PE0010, PE0025, PE0083, PE0091, PE0096, PE0099
	Poster Session 1 Control Models and Fault Diagnosis in New Power Systems PE0045-A, PE0008, PE0017, PE0032, PE0039, PE0047-A, PE0062, PE0077, PE0082, PE0084, PE0089, PE0111, PE0038, PE0092, PE0097, PE0112, PE2003, PE2008, PE2009
16:55-18:40	Oral Session 2 High-Voltage Power Transmission System and Key Equipment Status Monitoring PE0004, PE0011, PE0037, PE0118, PE0076, PE2011, PE0141

	Poster Session 2 **Load Forecasting, Parameter Control, and Optimal Scheduling in New Energy Power Systems and Integrated Energy Systems** **PE0007, PE0015, PE0023, PE0048, PE0021, PE0030, PE0057, PE0098, PE0116, PE0121, PE0122, PE0124, PE2006, PE0075, PE0086, PE0070**
18:40-19:30	**Award Ceremony & Dinner Time 颁奖仪式 & 晚餐**

AGENDA OVERVIEW

Sunday, October 19th, 2025	
Venue: 3rd Floor - Qinshan Conference Room 地点：三楼 – 秦山厅	
8:30-10:30	Oral Session 3 Hybrid Energy System and Power Market PE0028, PE0074, PE0009, PE0107, PE0126, PE0134, PE0135, PE0136
10:30-10:40	Coffee Break 茶歇
10:40-12:25	Oral Session 4 Digital Operation and Decision Analysis of Modern Power Grids PE0104, PE0108, PE0119-A, PE0123, PE0131, PE2012, PE2013
12:25-13:30	Lunch Time 午餐
Zoom ID: 845 3572 0120 Zoom Link: https://us02web.zoom.us/j/84535720120 Time Zone: GMT+8	
13:30-14:45	Oral Session 5 (Online) Control Models, Parameter Optimization, and Performance Evaluation in Power Systems PE0001, PE0018, PE0110, PE0120, PE0053
14:45-16:00	Oral Session 6 (Online) New Technologies for Integrated Energy Systems and Energy Storage PE0061, PE0067, PE0073, PE0078, PE0066

AGENDA OVERVIEW

Monday, October 20th, 2025	
Online Sessions Zoom ID: 845 3572 0120 Zoom Link: https://us02web.zoom.us/j/84535720120 Time Zone: GMT+8	
9:00-10:30	Oral Session 7 (Online) Application of Artificial Intelligence in Modern Power Electronics Systems and Optimized Scheduling PE0046, PE0059, PE0064, PE0065, PE0068, PE0071
10:30-11:45	Oral Session 8 (Online) Smart Grid Stable Operation and Reliability Evaluation PE0052, PE0063, PE2010, PE0081, PE0103

DETAILED PROGRAM

OPENING REMARK

Time 8:30-8:40, October 18th **Room** 2nd Floor - Edison Conference Room

Host Prof. Xiaolu Li, Shanghai University of Electric Power, China

Prof. Chunhua Gu

President of Shanghai University of Electric Power, China

KEYNOTE SPEECH I

Time 8:50-9:30, October 18th **Room** 2nd Floor - Edison Conference Room

Host Prof. Xiaolu Li, Shanghai University of Electric Power, China

Prof. M. Fotuhi-Firuzabad

Sharif University of Technology, Iran

(IEEE Fellow, Editor-in-chief of IEEE Transactions on Smart Grid)

M. Fotuhi-Firuzabad (IEEE Fellow, 2014) received the B.Sc. and M.Sc. Degrees in Electrical Engineering from Sharif University of Technology and University of Tehran in 1986 and 1989, respectively and the M.Sc. and Ph.D. Degrees in Electrical Engineering from the University of Saskatchewan, Canada, in 1993 and 1997, respectively, where he worked as the postdoctoral fellow and assistant professor from 1998-2001 and 2001-2002, respectively. Currently, he is a professor of Electrical Engineering Department at Sharif University of Technology, Tehran, Iran. He is a member of center of excellence in power system control and management in the same department. He was the president of Sharif University of Technology (2014-2021) and Head of the Department of Electrical Engineering (2005-2014). His current research interests include operation and planning of electric power systems, power system reliability, distributed renewable generation, demand response and smart grid technologies. His technical contributions in the field include more than 700 papers, and supervising more than 130 masters theses and doctoral dissertations. These publications have been well recognized in the scientific community with more than 26,000 citations with an h-index of 85. He is the recipient of several national and international awards including World Intellectual Property Organization (WIPO) Gold Medal for the outstanding inventor award, 2003, PMAPS International Society Merit Award for contributions of probabilistic methods applied to power Systems in 2016, Outstanding Researcher Award in the Iranian Power Industry (Iran-2017), Nationwide Outstanding Research Award (Iran-2012), Sixteen Khwarizmi International Award, and 2014 Allameh Tabatabaei Award. He has received the IEEE Transactions Prize Paper Award for the publication “Optimal PMU Placement Based on Probabilistic Cost/Benefit Analysis, IEEE Transactions on Power Systems, 2013”. He has been the PI of more than 40 industrial projects, and a keynote speaker in a number of national and international conferences. He has also offered a number of short courses in power systems reliability at academic institutions and industries in Iran and abroad. Dr. Fotuhi-Firuzabad has been a visiting professor in several internationally renowned institutions and universities (Finland-Aalto University, Denmark-Aalborg University, Malaysia- Universiti Teknologi MARA, China-North China Electric Power University). He served as the Editor-In-Chief of the IEEE Power Engineering Letters from 2017 to 2022. He also served as the Guest Associate Editor, Special Issue on “Electric Vehicle Charging Impacts on Power Systems”, ”Reliability and Resilience Modelling, Assessment, and Enhancement of Modern Power Systems with Proliferation of Grid-Edge Resources”, IET Generation, Transmission & Distribution, and Special Issue on ”Climate Change Mitigation and Adaptation in Electrical Power and Energy Systems”, International Journal of Electrical Power & Energy Systems. Dr. Fotuhi-Firuzabad is a Fellow of The World Academy of Sciences (TWAS), Associate Fellow of the Iran National Academy of Sciences, and a Fellow of IEEE for his contributions to the application of probabilistic techniques in power systems reliability assessment. Dr. Fotuhi-Firuzabad is currently Editor-in-Chief of the IEEE Transactions on Smart Grid.

Speech Contents

Advancing System Reliability in the Age of Distributed Power: The Strategic Role of Microgrids

Abstract: The accelerating shift toward decentralized, renewable-rich power systems is reshaping the operational and planning paradigms in electrical distribution networks. As these systems grow more complex and dynamic, traditional reliability assessment methods face new limitations. Microgrids, self-sufficient flexible energy systems, are increasingly recognized not only for their resilience benefits but also for their potential to support broader grid performance reliability in both connected and islanded modes.

This keynote explores new approaches to system performance reliability evaluation that integrates analytical and simulation-based techniques to better capture the operational realities of modern power distribution systems with multiple microgrids. By modeling microgrids as active participants capable of emergency energy support and adaptive resource management, this framework enables more accurate, scalable, and actionable reliability evaluation of the grid. The session will highlight how such an approach supports smarter investment decisions, enhances operational planning, and aligns with the evolving regulatory and technological landscape. Attendees will gain insights into how reliability evaluation is evolving, not in definition but in depth, precision, and strategic relevance, as we navigate the future of distributed energy systems.

KEYNOTE SPEECH II

Time 9:30-10:10, October 18th **Room** 2nd Floor - Edison Conference Room

Host Prof. Xiaolu Li, Shanghai University of Electric Power, China

Prof. Hua Geng

Tsinghua University, China
(IEEE Fellow and IET Fellow)

Hua Geng received the B.S. degree in electrical engineering from Huazhong University of Science and Technology, Wuhan, China, in 2003 and the Ph.D. degree in control theory and application from Tsinghua University, Beijing, China, in 2008. From 2008 to 2010, he was a Postdoctoral Research Fellow with the Department of Electrical and Computer Engineering, Ryerson University, Toronto, ON, Canada. He joined Automation Department of Tsinghua University in June 2010 and is currently a full professor.
His current research interests include advanced control on power electronics and renewable energy conversion systems, AI for energy systems. He has authored more than 300 technical publications and holds more than 30 issued Chinese/US patents. He was the recipient of IEEE PELS Sustainable Energy Systems Technical Achievement Award. He is the Editor-in-Chief of IEEE Trans. on Sustainable Energy, IEEE IAS Distinguish lecture. He served as general chair, track chairs and session chairs of several IEEE conferences. He is an IEEE Fellow and an IET Fellow, convener of the modeling working group in IEC SC 8A.

Speech Contents

Transient stability of power electronics-dominated power networks: principle and application

Abstract: With the increasing penetration of renewable energy and power electronics equipment, modern power networks are characterized by low inertia, control-dominated multi-time-scale dynamics, sequential-switching transient behaviors, couplings between individual units, and cascading failure risks under large disturbances. A few emerging converter-driven stability issues, such as the phase-locked loop (PLL) synchronization instability, have been observed in power electronics-dominated power networks. Additionally, the characteristics of conventional types of stability have also been affected by the extensive use of power electronics, leading to grid-converter interactive behaviors and unprecedented instability phenomena or cascading failure. Transient stability is of significant importance for the security of power networks, which concerns whether the ac electrical equipment (including converters and/or generators) in the network can remain in synchronism when subjected to large disturbances. In recent years, the transient stability of power electronics-dominated power networks has attracted wide attention. This talk will present the basic principle, the latest research progress, and the applications of transient stability for power electronics-dominated networks. Specifically, the content includes the principle, approaches, and classification of power electronic converter synchronization, the modeling, analysis, and stability evaluation methods of transient stability, the difference and connection with the conventional power network transient stability, transient stability improvements strategies, and important references for grid code specifications.

KEYNOTE SPEECH III

Time 10:30-11:10, October 18th **Room** 2nd Floor - Edison Conference Room

Host Prof. Xiaolu Li, Shanghai University of Electric Power, China

Prof. Syed M Islam

Federation University, Australia

(IEEE Fellow, International Research Partnerships, Advisor to the Vice Chancellor on New Energy and Advisory Director of Centre for New Energy Transition Research)

Syed M Islam received the B.Sc. MSc and PhD degrees all in Electrical Engineering in 1979 (BUET), 1983 (UPM), and 1988 (KFUPM) respectively. He is currently the Associate Deputy Vice Chancellor for International Research Partnerships and Advisor to the Vice Chancellor on New Energy at Federation University Australia. He was previously the Associate Deputy Vice Chancellor (Research) and the Executive Dean for the Institute of Innovation Science and Sustainability at Federation University Australia. He is also the founding Director of the Centre for New Energy Transition Research at Federation University. Prior to joining Federation University, he was the John Curtin Distinguished Professor in Electrical Power Engineering and the Director of Centre for Smart Grid and Sustainable Power Systems at Curtin University, Perth, Australia. He received the Dean's medallion for research at Curtin University in 1999. He received the IEEE T Burke Haye's Faculty Recognition award in 2000. He received the Curtin University inaugural award for Research Development in 2012. He received the Sir John Madsen medal in 2011 and 2014 for best electrical engineering paper in Australia. He was awarded the Distinguish Professor title in 2024 at Federation University. He has published over 400 technical papers in his area of expertise. His research interests are in Distributed Energy Resources, Control systems, Condition Monitoring of Transformers, Wind Energy Conversion, and Smart Power Systems. He has been a keynote speaker and invited speaker at many international workshops and conferences. He has been a Visiting Professor at Shanghai University of Electrical Power and Xian Jiatong University, China. He is a Fellow of the Engineers Australia, a Life Fellow of the IEEE, IEEE PES, IEEE IAS, and IEEE DEIS, a Fellow of the IET and a chartered professional Engineer in Australia. He is a founding Editor of the IEEE Transaction on Sustainable Energy and an Associate Editor of the IET Renewable Power Generation. He was the Guest Editor in Chief for the IEEE Transaction on Sustainable Energy special issue on Variable Power Generation Integration into Grid. He is a member of the C4NET Board. He has received over $25M in research funding from the Australian Research Council, CSIRO, Australian Power Industry, Qatar Foundation ARG program, The Research Council of Oman, various other industry and government agencies. He has published over 400 peer reviewed papers in his area of research interest. His h-index is 59 and his research work have been cited more than 15,000 times on Google Scholar.

Speech Contents

Model Predictive Control for Microgrids: From power electronic converters to energy management

Abstract: Microgrids have emerged as a promising solution for autonomous operation of DER connected electricity networks either in standalone or grid connected mode for improved economics, reliability and flexibilities. But the intermittency of renewable power generations has complexities of fluctuations of demand-supply, frequency, voltage and grid stability issues while connected to grid. Synthetic inertia or virtual inertia are sought after due to dwindling rotating mass related inertia in the system particularly as we embark on an era of hundred percent renewable based electricity systems. Inverter based systems (IBRs) whether in grid forming or grid following mode are increasingly made responsible to supply frequency and voltage references, inertial and voltage support. Simple PID controllers are not good enough for thisincreased and complex functions from performance point of view. Model Predictive Controls are one way of solving the complex nature of the problems. In this talk, we will focus on the control hierarchical structure and how MPCs can improve the overall performance in the operation of a controlled microgrid.

KEYNOTE SPEECH IV

Time 11:10-11:50, October 18th **Room** 2nd Floor - Edison Conference Room

Host Prof. Xiaolu Li, Shanghai University of Electric Power, China

Prof. S. M. Muyeen

Qatar University, Qatar

Dr. S. M. Muyeen is a full professor in the Electrical Engineering Department of Qatar University. He received his M. Eng. and Ph.D. Degrees from Kitami Institute of Technology, Japan, in 2005 and 2008, respectively, all in Electrical and Electronic Engineering. His research interests are power system stability and control, electrical machine, FACTS, energy storage system (ESS), Renewable Energy, and HVDC system. He has been a Keynote Speaker and an Invited Speaker at many international conferences, workshops, and universities. He has published more than 500+ articles in different journals and international conferences, including 500+ Journal papers. He has published seven books as an author or editor. He served/serving as Editor/Associate Editor for many prestigious Journals from IEEE, IET, and other publishers, including IEEE Transactions on Energy Conversion, IEEE Power Engineering Letters, IET Renewable Power Generation and IET Generation, Transmission & Distribution, etc. Dr. Muyeen is a Fellow of IEEE, Chartered Professional Engineers, Australia, and a Fellow of Engineers Australia.

Speech Contents

Achieving a Sustainable and Secure Energy Future in the Context of High Renewable Energy Penetration

Abstract: A nation's ideal energy future embraces a diverse mix of sources and suppliers, progressively reducing carbon emissions while remaining economically viable for consumers and stakeholders. Expanding renewable energy penetration worldwide must align with government policies and visions, yet achieving this requires substantial technical advancements and strategic innovations to prevent national energy crises.

Large-scale renewable energy deployment, primarily through photovoltaic systems and wind turbines, poses challenges such as reduced system inertia, potentially leading to instability and even blackouts. This presentation provides an overview of global renewable energy growth, followed by an in-depth analysis of the Australian blackout in September 2016. The root causes of the blackout are examined, and mitigation strategies are explored to enhance grid resilience in high-renewable energy systems.

INVITED SPEECH I

Time 13:30-13:50, October 18th **Room** 2nd Floor - Edison Conference Room

Host

Prof. Yu Wu

Northwestern Polytechnical University, China

Wu Yu was born in Chongqing, China in 1990. In 2013, 2016 and 2020, he received the B.S., M.S. and Ph.D degrees from Northwestern Polytechnical University, Chongqing University and Université de Technologie Belfort-Montbéliard , France, respectively, all in electrical engineering. He has been working at Northwestern Polytechnical University in China since 2020, and is currently a full professor and doctoral supervisor at the College of Civil Aviation. Professor Wu is a member of the Institute of Electrical and Electronics Engineers (IEEE), a national young talent, a leading talent in innovation and entrepreneurship in Gusu, Jiangsu Province, and a member of the Shanghai Young Scientific and Technological Talents - Sailling Program. In recent years, he has presided over the National Overseas High-level Talents Project, the National Natural Science Foundation, the first/fifth aerospace Academy and other sub-projects. Published IEEE Transactions on Industrial Electronics, Journal of Power Sources, Energy Conversion and Management, IEEE Transactions on Power Electronics, more than 10 high-level papers, one English monograph, more than 10 invention patents. His research interests include efficient energy management and robust control technology of hybrid power systems, reliability and condition monitoring technology of power electronic systems, etc.

Speech Contents

Stability-Oriented Modeling and Energy Management of Hybrid and More-Electric Aircraft Power Systems

Abstract: Aviation contributes about 2–2.5% of global CO_2 emissions and around 4% of total warming. More-electric aircraft offer a key pathway for low-carbon transformation. More-electric aircraft unify secondary energy in the form of electricity, enabling flexible power supply through converters. However, the use of constant power loads and the strong coupling between converters and generators introduce nonlinear behaviors, which can lead to power system instability. This report establishes an impedance-based modeling framework for variable-frequency AC power systems in more-electric aircraft, which serves as the foundation for stability assessment under different operating scenarios. The analysis is extended to hybrid-electric aircraft, where energy management is reformulated with explicit stability constraints. By coordinating power distribution among generators, batteries, and other sources while embedding stability considerations, the proposed approach achieves both efficient utilization of energy and enhanced system robustness.

INVITED SPEECH II

Time 13:50-14:10, October 18th **Room** 2nd Floor - Edison Conference Room

Host

Prof. Yu Wang

Chongqing University, China

Wang Yu is a Hongshen Outstanding Professor in Chongqing University. He has been selected for the "National-Level Young Talent Program" and the European Union's "Marie Skłodowska-Curie Fellowship" program. He has published over 100 papers in international journals and conferences. He serves as an editorial board member for international journals such as MPCE, IET GTD, and IET RPG, and Secretary of the IEEE PES Energy Internet Coordination Committee Working Group, Member of the New Energy and Energy Storage Systems Committee of the Chinese Association of Automation, and Member of the Smart Microgrid Committee of the Chinese Energy Society. He has been recognized as a Web of Science Highly Cited Researcher (top 1%) and included in the list of the World's Top 2% Scientists. His research focuses on power system dynamics and control, microgrid and distributed energy resource, and cyber-physical power system security.

Speech Contents

Knowledge-Data Integrated Operation and Control for Microgrids

Abstract: With the large-scale integration of distributed energy resources into multi-level power distribution systems, networked microgrids are gradually evolving into a new form of energy interconnection with regional autonomous capabilities. Characterized by massive device populations, significant dynamic heterogeneity, and operational uncertainty, this system poses substantial challenges to traditional centralized control paradigms. In recent years, machine learning methods have emerged as innovative solutions to address these challenges. By integrating multi-source measurement data from both internal and external systems to train intelligent agents, these approaches can effectively uncover latent evolutionary patterns and disturbance propagation characteristics in complex dynamic systems, thereby establishing environment-adaptive optimization decision-making models. This presentation will unfold across three dimensions: First, it will analyze typical application scenarios of microgrids and their core control requirements. Subsequently, it will examine critical bottleneck issues in knowledge-data fusion driven collaborative control. Finally, it will highlight our team's research advancements in AI driven control and operation in microgrids: 1) A dynamic optimization method for secondary control parameters based on deep reinforcement learning; 2) A safety-enhanced reinforcement learning framework incorporating customized energy storage constraints; 3) Privacy-preserving collaborative operation control through federated reinforcement learning. By constructing a knowledge-guided and data-driven collaborative intelligent control architecture, this work provides theoretical foundations and technical pathways for efficient coordination of diversified resources in next-generation power systems.

INVITED SPEECH III

Time 14:10-14:30, October 18th **Room** 2nd Floor - Edison Conference Room

Host

Prof. Hui Hou

Wuhan University of Technology, China

Prof. Hui Hou received the B.S. degree from Wuhan University, Wuhan, in 2003, and the Ph.D. degree from the Huazhong University of Science and Technology, Wuhan, in 2009. During 2015-2016, she was a visiting scholar at the University of Sydney. She is currently professor and Ph.D supervisor, as well as the Department Head of Electrical Engineering, School of Automation, Wuhan University of Technology. Her research interests include risk assessment of power system, energy internet, electric vehicles, etc. She has been AE for a number of journals such as PCMP (Protection and Control of Modern Power Systems), etc. She has been nominated as World's Top 2% Scientists by Stanford and Elsevier in 2024 and 2025.

Speech Contents

A Distributed Market-Aided Restoration Approach of Multi-Energy Distribution Systems Considering Comprehensive Uncertainties from Typhoon Disaster

Abstract: The extensive adoption of multi-energy distribution systems (MDSs) necessitates the coordinated restoration of power and thermal loads under disasters. Nevertheless, existing research often overlooks the inherent uncertainty of disasters and the flexibility of market mechanisms, leading to latent risks of over-investment and inefficient allocation of flexible resources. Thus, this paper presents a distributed market-aided restoration approach for MDS considering the comprehensive uncertainties from typhoon disasters. First, a stress intensity interference theory combined with a structural fragility model is utilized to characterize the uncertainty in distribution line damage caused by typhoons. Second, a tractable operational model for MDS, incorporating numerous auxiliary variables, is introduced to simplify the constraints of power and thermal networks. Then, a risk-averse two-stage restoration framework is developed to tackle comprehensive uncertainties from line damage and renewable generation. Meanwhile, a Cournot Nash-based joint bidding market-aided strategy is designed to facilitate the restoration of MDS and reduce the operational costs of multi-energy microgrids, fostering a win-win situation for all stakeholders. Further, a distributed algorithm named alternating search procedure is utilized to protect participants' privacy and alleviate the computation burdens. Finally, case studies based on real statistics of the 2024 super typhoon "Yagi" in China are conducted to verify the effectiveness and superiority of the proposed method.

INVITED SPEECH IV

Time 14:30-14:50, October 18th **Room** 2nd Floor - Edison Conference Room

Host

Prof. Zhenzhi Lin

Zhejiang University, China

Zhenzhi Lin is a professor in the School of Electrical Engineering, Zhejiang University, China. He has published over 100 SCI-indexed papers. He was Associate Editor of IEEE Transactions on Power Systems, IEEE Power Engineering Letters, Journal of Modern Power Systems and Clean Energy (MPCE), Protection and Control of Modern Power Systems (PCMP), Automation of Electric Power Systems (in Chinese), and Subject Editor of IET Energy Conversion and Economics. He was a Research Assisstant in the Department of Electrical Engineering at The Hong Kong Polytechnic University from 2007 to 2008, a Research Scholar in the Min Kao Department of Electrical Engineering and Computer Science at the University of Tennessee from 2010 to 2011, and a Reseach Associate in School of Engineering and Computing Sciences at Durham University from 2013 to 2014. His research interests include Big Data Mining of Power Systems and Artificial Intelligence Applications, Power System Situational Awareness, Power System Restoration, Planning and Operation of Power and Integrated Energy Systems.

Speech Contents

Data-driven User Phase Identification and Three-phase Unbalance Mitigation for Low-voltage Distribution Systems

Abstract: Unbalanced operation of a three-phase distribution system could incur more power losses, and the identification accuracy of low-voltage distribution consumer–transformer relationship and phase are crucial to three-phase unbalanced regulation and error correction in consumer–transformer relationships. This speech will focus on a low-voltage distribution network consumer–transformer relationship and phase identification method based on anomaly detection and the clustering algorithm, and a practical method for mitigating three-phase unbalance based on data-driven user phase identification.

ORAL SESSION 1

October 18th, 2025
Time Zone: GMT+8

Topic: New Electromechanical System Design and Integrated Control Method
Time: 15:10-16:55 (Duration for Each Presentation: 15 minutes)
Room: 2nd Floor - Edison Conference Room
Session Chair:

Onsite

PE0105

Experimental Study on Thermal Management Control of Liquid Immersion Cooling Package Module for Vehicle EPS Motor Driving

Hojong Kwak, Jaehyuk An, Sewoong Ahn, Byeongyu Kim, Simon Cho, Hyoseo Choi, Jian Lee and **Young-Jae Min**
Halla University, Republic of Korea

Abstract-This paper introduces a thermal management control of the liquid immersion cooling package module for motor-driving power electronics of the automotive electric power steering (EPS). Based on torque and angle sensor (TAS) information, the pump control logic activates and pauses the flow for liquid immersion cooling. This thermal management control logic is implemented in the cooling package module of power electronics that drive three-phase EPS motors. System effectiveness is verified and confirmed via thermal performance experiments and in-vehicle evaluations of the assistance performance afforded by EPS.

PE0010

Research and Simulation on Multi-Mode Operation Control Strategy of Combined Diesel and Energy Storage Power Supply System

Cunping Wang[1], Yanxia Chen[1], Ruoxi Liu[1], Jing Zeng[2], Yifan Wu[2] and Shuchang Wan[2]
1. State Grid Beijing Electric Power Research Institute, State Grid, China
2. Wuxi University, China

Abstract-This paper addresses the coordinated control problem of multi-mode operation in a photovoltaic-diesel generator-energy storage microgrid system under the context of renewable energy integration. A joint operation strategy based on the collaborative control of photovoltaic systems, diesel generators, and energy storage systems is proposed. By constructing five operational modes, the strategy achieves dynamic source-load matching and ensures stable system operation. The backup power mode guarantees rapid response during main grid failures, the load balancing mode optimizes energy distribution under low-load conditions, the peak shaving mode collaboratively handles load peaks, the fuel-saving mode reduces fuel consumption through the economic load rate of diesel generators, and the fast power balancing mode suppresses sudden power fluctuations. Simulation results based on MATLAB/Simulink demonstrate that the proposed strategy effectively enhances system stability and economic performance, supports smooth grid-connected/islanded transitions, and meets power demand under various operating conditions. The research findings provide a theoretical foundation and technical reference for

microgrid systems with high penetration of renewable energy, contributing significantly to the advancement of clean energy applications and the sustainable development of power systems.

PE0025

Development of Piezoelectric Vibration Energy Harvester (VEH) for Machine Condition Monitoring Purpose

Riady Siswoyo Jo[1] and Rachel Lee Xin[2]
1. Sunway University, Malaysia
2. Heriot-Watt University Malaysia, Malaysia

Abstract-This paper presents the development of a vibration energy harvester (VEH) that is applicable for machine condition monitoring purpose. Piezoelectric transducer-based VEH module is designed to harvest energy from vibrating machine. Combination of several VEH modules, either in series or parallel connections allow consolidated harvesting of the vibration energy. The harvested energy can be used to power remote sensors that are able to monitor the conditions of the vibrating machine, e.g. temperature, vibration amplitudes, etc. This paper also explores the design of vibration energy harvesting circuit and investigates the configuration that can bring about the best output power performance through experiments with different loading conditions. In the experiments, the source of vibration utilized is a direct forced vibration from a vibrating machine, resembling practical industrial scenarios where the VEH module and remote sensors are placed near rotating or reciprocating machines. Results show that the harvested energy at certain loading conditions are sufficient to supply for low-power remote sensors.

PE0083

Research on the Temperature Field of Shaftless Rim-Driven Motor Based on a Three-Dimensional Integrated Water-Cooling Structure

Li Chen, Jishuang Zhang, Tao Zhu, Leyan Xu and **Wei Zhang**
Nantong University, China

Abstract-Stator-type axial permanent magnet synchronous motors (APMSMs) are highly suitable for marine propulsion because of their high power density, large output torque, high efficiency, and strong fault tolerance. However, the presence of a sheath introduces additional eddy current losses, and it alters the magnetic circuit characteristics of the motor, thereby affecting the distribution of losses in both the permanent magnets and the windings, as well as the heat dissipation efficiency of the stator. In this paper, a finite element model of the stator-type APMSM is firstly established by Ansys software. Subsequently, the effects of different sheath materials and thicknesses on the eddy current losses in the permanent magnets and sheaths are investigated. In addition, based on the loss distribution of APMSM, a three-dimensional integrated water-cooling heat dissipation structure is proposed. Its cooling performance is compared with that of series and spiral water-cooling structures. The results demonstrate that the three-dimensional integrated water-cooling heat dissipation structure exhibits superior thermal dissipation performance.

PE0091

Stochastic Programming for Capacity Expansion Planning Method Considering Extreme Scenarios

Shu Xia[1], Yuan Zhang[1], Yue Yu[1], Enyu Jiang[2] and **Chen Wang**[2]
1. State Grid Shanghai Municipal Electric Power Company, China

2. Shanghai University of Electric Power, China

Abstract-This paper focuses on developing a capacity expansion planning model considering extreme scenarios. In order to achieve the carbon neutrality target of each country, the higher penetration of renewable energy will bring additional challenges to the power system. To address the inherent uncertainties associated with renewable energy, the model incorporates stochastic programming techniques that account for extreme scenarios. The proposed method is used to construct case studies, comparing experiments with and without power grid interconnection, as well as experiments with and without consideration of extreme scenarios The simulation results demonstrate that power grid interconnection can effectively contribute to achieving the carbon-neutral target. Furthermore, the proposed stochastic programming method offers higher computational efficiency compared to the traditional 8,760-hour based deterministic capacity expansion planning approach.

PE0096

Research on Model-Free Predictive Current Control Strategy for Axial Flux-Switching Shaftless Rim Driven Motor

Chenxuan Zhang, Ziyi Tai, Haoyu Wang, Yifei Ren and Wei Zhang
Nantong University, China

Abstract-To solve the issue of parameter mismatch in the axial field flux-switching permanent magnet motor (AFFSPMM) caused by the complex and dynamic marine environment, which adversely affects the robustness of the control system, this paper proposes a model-free predictive current control (MFPCC) strategy based on an extended state observer (ESO). Firstly, the mathematical model of the AFFSPMM under MFPCC is established. Then, the ultra-local model and the extended state observer are designed to enable online estimation and compensation of lumped disturbances. Finally, the control system simulation model and experimental platform are developed to validate the proposed control strategy. The simulation and experimental results demonstrate that, compared with traditional model predictive current control (MPCC), the proposed strategy improves the stability and robustness of control system.

PE0099

Analytical Calculation Method for Parasitic Capacitance of Annular Excitation Winding in Non-uniformly Distributed Motors

Jiaqiang Zou[1], Shengbo Mo[2], Qianqian Liu[3], **Ruxin Chen[1]** and Shushu Zhu[1]
1. Nanjing University of Aeronautics and Astronautics, China
2. Lanzhou Flight Control Co.,Ltd, China
3. Shanghai Institute of Space Power-Sources, China

Abstract-The excitation controller is the core component for regulating the excitation current and controlling the output voltage of a generator. By employing wide-band gap power devices (such as SiC and GaN), the excitation controller achieves the advantages of low losses and high switching frequency. However, parasitic capacitance in the circuit can significantly affect the switching performance of power devices, increase switching losses, and introduce oscillations and electromagnetic interference. Among these, the parasitic capacitance of the exci- tation winding is a critical part of the excitation control circuit, and reducing its value can effectively enhance the controller’s performance. For multi-layer, multi-turn annular windings, the calculation of the equivalent total parasitic capacitance Cp be- comes particularly complex due to strict slot-width constraints. In practical

applications, mismatches between conductor diameter and fixed slot width often cause coil displacement, leading to a non-uniform winding distribution, which makes the traditional uniform-winding assumption no longer applicable. To address this, this paper proposes an analytical modeling method for non- uniform annular windings. The winding is conceptually divided into a uniformly distributed Region I and a slot-constrained non-uniform Region II. Analytical expressions of inter-turn capacitance Ctt and inter-layer capacitance Cll between adjacent circular conductors are derived. Based on these, an equivalent capacitance network is established to represent both the uniform and non-uniform regions. The total parasitic capacitance Cp is then calculated using the principle of energy conservation, by equating the electrostatic energy stored in the equivalent network with that stored in the actual winding. Finally, finite element simulations are conducted to validate the proposed analytical model, demonstrating its accuracy and effectiveness.

POSTER SESSION 1

October 18th, 2025
Time Zone: GMT+8

Topic: Control Models and Fault Diagnosis in New Power Systems
Time: 15:10-16:55 (Duration for Each Presentation: 3 minutes)
Session Chair:

Onsite

PE0045-A

A Novel Event-Triggered Predefined-Time Sliding Mode Secondary Control for Islanded Microgrids

Dan Jiang
Shanghai University of Electric Power, China

Abstract-To address issues introduced by droop control—such as supply-demand imbalances and deviations of voltage and frequency from their nominal values in islanded microgrids—a distributed predefined-time sliding mode control (PTSMC) algorithm is proposed to regulate the estimated average voltage (EAV) and frequency, while ensuring accurate power sharing. The predefined-time control approach guarantees that the EAV and frequency converge to their nominal values within a user-defined time, which is explicitly determined by a tunable time parameter. The convergence time is independent of the system's initial conditions and does not rely on complex parameter tuning, thus overcoming the limitations of finite-time and fixed-time control schemes. To reduce communication overhead, a novel dual-triggering mechanism is introduced based on a combination of Lyapunov derivative and Lyapunov exponent. Unlike traditional event-triggered strategies that rely solely on instantaneous Lyapunov derivative conditions, the proposed method incorporates the exponential divergence trend of the error (i.e., Lyapunov exponent), calculated through a sliding window to assess the system's average divergence behavior. This design enables more informed triggering decisions, effectively reducing the risk of excessive triggering while preserving system stability and improving robustness. To verify the effectiveness of the proposed approach, comprehensive simulation studies are conducted under various scenarios, including load changes, plug-and-play operations, and different communication network conditions.

PE0008

Insulator Defect Target Detection Based on Improved YOLOv5s

Yugang Li, **Zheng Chen**, Zheng Zhang and Jiabao Zhu
Qufu Normal University, China

Abstract-Traditional deep learning-based insulator defect detection algorithms often face the dilemma between network model lightweighting and detection accuracy. This paper proposes a method that integrates the ShuffleNetV2 neural network model into the Backbone structure of the YOLOv5s network model and adds an ECA attention mechanism layer to the last layer of the Backbone. In the Neck structure of YOLOv5s, the traditional PANet structure is replaced with a BiFPN structure. Compared to the original YOLOv5s, the size of the improved network model is reduced from 13.7 MB to 7.7 MB, a decrease of 6 MB. The model's detection accuracy, measured by the mean Average Precision (mAP) value, increases from 92.2% to 94.5%, an improvement of 2.3%. While enhancing the network's accuracy, the proposed method also achieves a more lightweight network

model.

PE0017

Unintentional Islanding Detection Method based on Voltage and Reactive Power Adjustment in Grid-Forming Inverter Systems

Yejin Choi[1], Inchan Hong[1], Jaehoon Jung[1], Seungmin Jung[2] and Yeuntae Yoo[1]
1. Myongji University, Republic of Korea
2. University of Seoul, Republic of Korea

Abstract-As the proportion of inverter-based resources (IBRs) in the power systems increases, the problem of the grid inertia is becoming increasingly significant. To address this challenge, there is ongoing research into grid-forming (GFM). The prevalent inverter control method, known as the grid-following (GFL), is susceptible to faults and does not have the ability to maintain voltage and frequency. However, grid-forming inverters (GFMIs) overcome these shortcomings. Nevertheless, due to its ability to autonomously generate voltage and frequency, there is difficult to detect unintentional islanding, and there is a potential risk of encountering a Non-Detection Zone (NDZ) may occur. This paper analyzes the response characteristics of GFMIs when the reference values of voltage and reactive power injected into the GFMI are changed using PSCAD/EMTDC. Furthermore, it proposes a innovative unintentional islanding detection method (IDM) applicable to GFMIs, which is based on the rate of change voltage and reactive power before and after the reference adjustment.

PE0032

A Frequency-Tracking Quasi-Proportional Resonant Approach for Harmonic Suppression in PMSM

Siqi Peng, Chuchen Yang, Zhiwen Zhang and **Kun Zhu**
Xiangtan University, China

Abstract-This paper proposes an optimized quasi-proportional resonant (QPR) control technique for noise and harmonic suppression in permanent magnet synchronous motors (PMSM) used in electric vehicle drive systems. Although conventional PR/QPR controllers can effectively reduce stator current harmonics and noise, their suppression performance deteriorates when the fundamental frequency or speed of the motor varies, due to mismatches between the resonant frequency and the actual harmonic frequencies. To address this issue, a frequency-tracking QPR harmonic suppression method is presented. This approach first utilizes the Fourier transform to extract the fundamental frequency in real time, calculates the frequencies of target harmonics (such as the 5th, 7th, 11th, and 13th), and employs a recursive least squares algorithm to dynamically track these harmonic frequencies, thereby adjusting the resonant frequency of the QPR controller in real time for continuous and precise suppression of the target harmonics. Simulation results based on the MATLAB/Simulink platform demonstrate that this method significantly improves harmonic suppression under frequency or load variations, avoiding the reduction in resonant gain associated with conventional methods, and further enhances system performance and comfort. This method provides both theoretical and technical support for the efficient and low-noise operation of PMSM in electric vehicles, and is particularly suitable for applications with stringent noise and vibration requirements.

PE0039

Parameter Identification of Permanent Magnet Synchronous Motor Based on IRBMO Algorithm

Siqi Peng, **Kun Zhu**, Chuchen Yang and Zhiwen Zhang

Xiangtan University, China

Abstract-In response to the challenge of easily falling into local optima and achieving low parameter accuracy in the parameter identification of permanent magnet synchronous motor (PMSM), this paper proposes an improved Red-billed Blue Magpie Optimization (IRBMO) algorithm. Based on the construction of the full-rank identification equation, the motor resistance, d/q-axis inductances, and permanent magnet flux linkage are identified using the IRBMO algorithm. Firstly, this algorithm employs Sobol sequences and opposition-based learning strategies to ensure the uniformity and diversity of the initial population. Secondly, a dynamic exploration probability with attenuation is introduced during the optimization identification process to enhance the algorithm's ability to balance exploration and exploitation. Finally, a dynamic tournament selection strategy is introduced in the exploration stage to adaptively adjust the selection size and improve the global search capability. Simulation and experimental results show that the IRBMO algorithm achieves superior convergence speed, accuracy, and stability in PMSM parameter identification, with the identified parameters meeting the precision requirements for high-performance motor control.

PE0047-A

PSB-Net: Physics-Synergized Bidirectional Network for Robust Cross-Modal Fault Diagnosis of Permanent Magnet Synchronous Motors

Dongdong Li and **Yueqi Wang**
Shanghai University of Electric Power, China

Abstract-Accurate and robust fault diagnosis of permanent magnet synchronous motors (PMSMs) under industrial conditions remains a major challenge due to signal heterogeneity, noise interference, and data scarcity. To address these issues, this paper proposes PSB-Net, a Physics-Synergized Bidirectional Network that integrates physical priors into both the feature encoding and cross-modal fusion processes. Specifically, cyclic spectral coherence (CSC) and spectral harmonic coherence (SHC) maps are developed to extract physically meaningful representations from vibration and current signals, respectively. A Physics-Synergized Spectral Attention Module (PSSAM) further enhances diagnostic sensitivity to key fault frequencies. To effectively integrate multimodal information, a Bidirectional Cross-Modal Interaction Network (BCMIN) is introduced to adaptively establish and fuse modality-specific correlations. Experiments on both a custom PMSM testbed and a public dataset show that PSB-Net consistently outperforms five state-of-the-art fusion methods in accuracy, noise robustness, and generalization. This work provides a robust and interpretable solution for real-world PMSM fault diagnosis.

PE0062

An Enhanced Multi-Source Domain Adaptation Framework for Grounding Fault Diagnosis in Urban Rail Transit Systems under Varying Operating Conditions

Bo Chen[1], Qiaoyue Li[2], Guifu Du[1] and Yanrong Ren[1]
1. Soochow University, China
2. Suzhou City University, China

Abstract-With the extension of rail service life and the impact of surrounding environmental conditions, the running rail in the DC traction power supply system of urban rail transit is prone to insulation degradation, which can lead to ground faults. These types of faults can result in elevated rail potentials and excessive stray currents, which may induce electrochemical corrosion and compromise passenger safety. Consequently, effective diagnosis

of grounding faults in urban rail systems is of critical importance. In this paper, an Enhanced Multi-Source Domain Adaptation Framework (EMDAF) is proposed to diagnose grounding faults under varying operating conditions. The proposed EMDAF comprises three key modules: a ResNet-based feature extractor, a domain discrepancy minimization module and a classifier alignment strategy to improve diagnostic performance. It is ultimately employed to achieve accurate ground fault identification across various zones and operating conditions. Experimental comparisons indicate that EMDAF outperforms existing methods in both transfer learning performance and ground fault diagnosis accuracy, confirming its robustness and overall superiority.

PE0077

Suppression of Inrush Current in Rectifier Transformer of Mobile DC De-icing Device

Junjie Zhao[1], Wentong Chen[1], Yuqun Fang[1], Xiaoyu Zhou[2], **Bo Zhang[3]** and Wu Wen[3]
1. Jinhua Power Supply Company, State Grid Zhejiang Electric Power Co., Ltd., China
2. State Grid Zhejiang Electric Power Co., Ltd. China
3. Wuhan University, China

Abstract-During the de-icing operation of high voltage overhead transmission lines using a mobile DC de-icing device, the energization of the rectifier transformer will produce inrush current, which causes the relay protection to operate and makes the DC de-icing device unable to work. This paper conducts simulations on the inrush current of the rectifier transformer in a mobile DC de-icing device using a 10kV emergency generation vehicle as the AC power source. The influence of the winding connection type of the rectifier transformer on the inrush current is analyzed. This paper proposes an operation method of stepping up from zero voltage for the unloaded rectifier transformer by using the generator excitation control system of the generator in the emergency generation vehicle. The simulation results show that when the Δ/Y connected rectifier transformer is energized, the inrush current amplitude can reach 516.5A. With the application of the stepping up from zero voltage operation of the rectifier transformer, the inrush current can be limited to less than 1.0A. This ensures the mobile DC de-icing operation of transmission lines can be carried out safely and smoothly.

PE0082

Research on the Analytical-Model-Based Setting Method for Leakage Magnetic-Field Differential Protection for Transformer Early Fault

Ping Zeng[1], Wei Bao[1], Qian Feng[1], Jiayu Lian[1], Xiangli Deng[2] and **Hang Tu[2]**
1. State Grid Shanghai Municipal Electric Power Company, China
2. Shanghai University of Electric Power, China

Abstract-Leakage magnetic field differential protection, which uses the symmetry of the leakage magnetic field as the diagnostic criterion, can detect short-circuit currents within the faulted turns, thereby achieving high sensitivity. However, determining the precise setting values for leakage magnetic field differential protection is challenging, complicating its practical application. Considering core saturation characteristics and the dimensional parameters of the core, yoke, and windings, this study establishes a multi-winding, multi-state analytical model of winding currents and leakage magnetic fields with electrical-magnetic coupling. By varying the winding voltage and load impedance, the model calculates the winding current and leakage magnetic field distribution, enabling the determination of the magnetic balance coefficient for the "three measurement points" in magnetic differential protection. Using a dry-type transformer at a hydropower station as a case study, the electromagnetic composite multi-state analytical model is applied to set the values for magnetic differential protection, and the magnetic

balance coefficient is validated through ANSYS simulations.

PE0084

A Transformer Fault Diagnosis Approach Based on WCGAN-GP and Multimodal Deep Feature Fusion

Ping Zeng[1], Wei Bao[1], Desheng Zhou[1], Zhaoxin Du[1], **Yuqing Shen[2]** and Xiangli Deng[2]
1. Electric Power Research Institute, State Grid Shanghai Municipal Electric Power Company, China
2. Shanghai University of Electric Power, China

Abstract-To address the challenges in multimodal intelligent diagnosis of transformer faults, such as limited sample size, imbalanced data distribution, insufficient feature fusion capability, and consequently low diagnostic accuracy, this paper proposes a fault diagnosis method based on Wasserstein Conditional Generative Adversarial Network with Gradient Penalty (WCGAN-GP) and deep multimodal feature fusion. A WCGAN-GP model is constructed by integrating Wasserstein distance with conditional generative adversarial learning to achieve high-quality augmentation of small-sample data. An improved Residual Network (ResNet) and an enhanced Densely Connected Network (DenseNet) are employed to perform deep feature extraction from multimodal data. A Multi-Layer Cross-Attention (MLCA) mechanism is introduced within the network to fuse deep multimodal features, enabling early fault diagnosis of transformers. Finally, the proposed intelligent diagnosis method is validated using both simulation data and dynamic model test data, demonstrating its effectiveness in improving diagnostic accuracy.

PE0089

A Multi-stage Features and Attention Mechanism-Embedded Time Convolutional Network-Based Power System Transient Stability Assessment Method

Yutong Wang[1], Xiaobo Wang[2], Xinyao Zhu[2], **Haiqiang Zhou[1]**, Shengjun Wu[2] and Shuhuan Li[1]
1. Hohai University, China
2. Systems and New Energy Technology Center, Jiangsu EPRI State Grid Jiangsu Electric Power Company Co., Ltd, China

Abstract-A multi-stage features and attention mechanism-embedded time convolutional network-based transient stability assessment (TSA) method is proposed. Firstly, the multi-stage features are constructed with pre-fault, during-fault and post-fault time sequence, and the time convolutional network (TCN) is used to efficiently capture the causal correlation ship between time series in parallel. Secondly, balance of the samples is improved by adjusting the sample composition and the weight of the loss function during training. The model's ability to fit the classification boundary is enhanced through sample augmentation. Then, the attention mechanism is embedded in the TCN to capture the high-value features and improve the interpretability of the model. It helps the TCN to evaluate the power system transient stability more accurately. Finally, the proposed TSA algorithm is validated with the modified IEEE 39-bus system including 3 wind generators. Simulation results show that the TCN-based TSA method has good accuracy and efficiency.

PE0111

Anfis-Based Insulation Condition Diagnosis for Power Capacitors Using Secondary Side Information

Yanlong Zhao[1], Xuanyang Liu [1], Zihao Li[1], Fei Li[1] and **Weichen Yan[2]**
1. State Grid Zibo Power Supply Company, China
2. Zibo Polytechnic University, China

Abstract-To facilitate the realization of the 30 • 60 Dual Carbon Objectives, China is expediting the establishment of a new-type power system, with AI-enhanced intelligent monitoring of grid equipment being one of the key priorities. Aiming to overcome the limitations of conventional power capacitor fault diagnosis methods that either require power outages or rely heavily on empirical judgments, this study presents a diagnostic method for power capacitor insulation defects by analyzing secondary-side parameters including resistive current, capacitance, and dielectric loss using ANFIS to evaluate both moisture ingress and aging degradation levels. The training dataset, consisting of actual defect characteristics obtained from online monitoring and outage tests, demonstrates good agreement between ANFIS outputs and real insulation conditions, confirming the method's diagnostic accuracy. The proposed approach has been successfully implemented in practical operations at State Grid Zibo Power Supply Company, providing valuable reference for online monitoring and fault diagnosis of power equipment.

PE0038

Improved Sensorless Full-Speed Range Composite Control Strategy for IPMSM

Siqi Peng, Zhiwen Zhang, **Kun Zhu** and Chuchen Yang
Xiangtan University, China

Abstract-In sensorless full-speed range composite control of Interior Permanent Magnet Synchronous Motor (IPMSM), linear weighted switching and sliding mode observers(SMO) are commonly used in the transition and medium-high-speed range. However, these approaches often result in noticeable chattering during and after the switching process. This paper proposes an improved sensorless full-speed range composite control strategy for IPMSM. In the zero- and low-speed range, rotor position is estimated using a high frequency square wave injection method(HFSVI). In the medium- and -high speed range, the Frequency-adaptive complex-coefficient filter-Based Sliding Mode Observer(FACCF-SMO) is employed. During the transition range, a nonlinear weighted switching strategy is adopted to reduce chattering effects. In addition, the normalized position error is fused and processed through the single Luenberger observer to obtain the estimated rotor position. The proposed method is validated through MATLAB/Simulink simulations and effectively improves the estimation accuracy of rotor electrical angle and speed during and after the transition process (corresponding to 10% – 33% of the rated speed).

PE0092

Influence of Structural Geometry and Contamination Characterics on the Surface Electric Field distribution of HVDC Insulators

Minghao Du[1], Donglai Wang*[2], Chengze Li[3] and Shuo Gao[1]
1. Shenyang Institute of Engineering, China
2. Key Laboratory of Regional Multi-Energy System Integration and Control of Liaoning Province, Shenyang Institute of Engineering, China
3. State Grid Shenyang Electric Power Supply Company, State Grid Liaoning Electric Power Co., Ltd., China

Abstract-Electric field strength distribution on the insulator surface is an important factor to determine its insulation performance. To explore the influence of various factors on the surface electric field of insulators, 3D models of insulators under different working conditions are constructed based on finite element technology, and the effects of voltage level, structural parameters, and surface state on the surface electric field intensity are systematically studied. The results show that with the increase of voltage level, the electric field intensity on the insulator surface will show an obvious increasing trend, which puts forward higher requirements for its insulation

performance. Structural parameters such as the diameter of the umbrella skirt and the distance between umbrellas have a significant control effect on the electric field distribution. Increasing the radius of the umbrella skirt can increase the creepage distance, thus effectively reducing the maximum field strength at the edge of the umbrella skirt and improving the uniformity of the electric field distribution. Appropriately decreasing the distance and increasing the umbrella skirt are beneficial to improving the surface electric field and achieving the optimal field strength distribution. Contamination layer and water droplet adhesion on the insulator surface will induce a local concentration of electric field strength by changing surface conductivity, thus significantly increasing the risk of insulation failure. The research results can provide theoretical support and data reference for insulator structure optimization design, operation, and maintenance strategy formulation, and fault prevention.

PE0097

An Equivalence Method for PMSG-based Wind Farm with Virtual Synchronous Generator Control Considering the Whole Dynamic Process

Peicong Zhu[1], Qiang Ma[2], Shaoguang Chen[2], **Haiqiang Zhou[1]**, Tai He[2] and Yujie Wang[2]
1. Hohai University, China
2. Clean Energy Branch Huaneng International Power Jiangsu Energy Development Co., Ltd. China

Abstract-An equivalent method for permanent magnet synchronous generator (PMSG)-based wind farm with virtual synchronous generator (VSG) control is proposed in this paper. First, an improved Low Voltage Ride-Through (LVRT) control strategy for PMSG-VSG is introduced. The active power reference is modified to satisfy the current limitation during faults. Additionally, the internal voltage is compensated to avoid overvoltage at the moment of fault clearance. Then, the whole dynamic process of the VSG is analyzed. It is found that the current limiting action has a great influence on the dynamics during faults. The spectral clustering method is used to analyze the power angle after fault clearance. The VSGs are clustered into four groups based on the similarities of the dynamic responses during and after faults. And the equivalent PMSG and the collection grid are aggregated. Finally, the proposed equivalent method is applied in the test system including 12 PMSGs. Simulation results show that the proposed method effectively improves the precision of the equivalent model and simulation efficiency.

PE0112

High-Resolution FBG Interrogation Using Microwave Photonics for Real-Time Temperature Monitoring of Power Equipment

Minhao Hu[1], Xuecheng Kong[1], Fei Li[1] and **Weichen Yan[2]**
1. State Grid Zibo Power Supply Company, China
2. Zibo Polytechnic University, China

Abstract-Overheating faults represent a prevalent and hazardous failure mode in substation power equipment. Online monitoring methods offer distinct advantages by enabling real-time detection without requiring power interruption. To detect rapid temperature changes within a short time frame, this study proposes a high-resolution fiber Bragg sensor (FBS) temperature monitoring method based on microwave photonics, demonstrating its effectiveness through experimental validation. Online temperature monitoring system based on proposed method is designed and applied in field measurement and operation. Measurement results indicate a sensitivity of ~36 MHz/με, confirming the proposed FBS-based approach as an effective solution for real-time thermal monitoring. Online temperature monitoring system based on proposed method has been put into practice by State Grid Zibo

Power Supply Company.

PE2003

Development of a B-type leakage current sensor for wide range accurate detection

Yi Wei, Jian Zhibo, Liang Guobang, Huang Mingxin, Zhang Wenzhen and Huang Menghua
China Southern Power Grid Technology Co.,Ltd. Guangdong Provincial Key Laboratory of New Technology for Smart Grid, China

Abstract-The detection capability of traditional AC-type and A-type leakage current sensors is limited. Particularly, their detection accuracy for smooth DC current can no longer meet application requirements. This paper proposes a B-type leakage current sensor suitable for wide-range and accurate detection, which enables simultaneous, wide-range, comprehensive and precise detection of both AC leakage current and DC leakage current.Through the analysis of existing iron core magnetic materials, alloys made of different magnetic components are selected as the iron cores for the front winding columns of the Btype leakage current sensor. Specifically, iron cores made of nanocrystalline alloy are adopted in high-current low-voltage distribution network systems, while iron cores made of ironnickel alloy are used in low-power converter systems. This material selection is intended to meet the measurement requirements of small size, wide detection range and high accuracy. Additionally, fluxgate technology is applied to realize the simultaneous measurement of AC and DC. This solves the problem of coil measurement failure in leakage current sensors caused by DC leakage, thereby enabling the detection of smooth DC, pulsating DC, power frequency AC and high-frequency AC leakage currents.

PE2008

Wind Speed Prediction for Smart Grid Using a Hybrid GNN-Transformer Model

Huayue Huang, **Shaoyu Mao**, Ye Feng, Wenke Pan, Qingtian Ge and Jiangjiao Xu
Shanghai University of Electric Power, China

Abstract-In recent years, there has been significant progress in the development of ultra-high voltage (UHV) transmission lines and their associated micro-meteorological monitoring systems. Accurate prediction of micro-meteorological variables, such as wind speed and temperature, plays a crucial role in the efficient operation of UHV lines and the stability of power transmission systems. Traditional wind speed forecasting methods mainly focus on time-series data, but fail to effectively capture the complex spatial correlations. The continuous advancement of artificial intelligence (AI) technologies, particularly deep learning, offers great potential for improving prediction accuracy. This paper proposes a hybrid model that combines Graph Neural Networks (GNN) and Transformer to address both the temporal and spatial aspects of wind speed prediction. Specifically, the Transformer is used to capture long-range temporal dependencies in wind speed data, while the GNN models the spatial dependencies between geographically distributed towers, allowing the model to effectively learn both time-series dynamics and spatial correlations.The model is trained on a real-world dataset and evaluated using metrics such as MAE, MAPE, and RMSE. Experimental results show that the proposed model significantly improves prediction accuracy by effectively capturing spatial dependencies and temporal features of wind speed. This highlights the importance of leveraging advanced deep learning techniques for wind speed forecasting, especially when dealing with complex environments and large-scale datasets. Future work will focus on enhancing the model’s generalization capabilities and exploring its applications in other energy systems.

PE2009

Global Optimization of Micro-Meteorological Station Siting for Ultra-High-Voltage Transmission Lines

Qingtian Ge, **Kai Yang**, Wenke Pan, Ye Feng, Huayue Huang and Jiangjiao Xu
Shanghai University of Electric Power, China

Abstract-Micro-meteorological monitoring along ultra-highvoltage (UHV) transmission corridors is crucial for risk-aware operation, but limited station counts and uneven layouts create a persistent accuracy – cost trade-off. Empirical spacing rules secure coverage yet do not guarantee reconstruction accuracy in complex terrain, whereas optimization-based siting often lacks an interpretable sampling scale and a unified evaluation. We present a physics- and data-driven framework that couples an empirically estimated correlation scale with constrained global optimization, semivariograms from historical records define a maximum interstation spacing used as a hard coverage constraint, then a genetic algorithm minimizes weighted-interpolation error subject to right-of-way, accessibility, and minimum-separation constraints and is benchmarked under a unified protocol against uniform and terrain-weighted layouts. In a real UHV corridor, the framework achieves full coverage with a maximum spacing of about 8 km and reduces wind-speed reconstruction error relative to uniform placement—RMSE from 2.41 to 2.10 m/s , MAE from 2.14 to 1.88 m/s , and MAPE from 26.93% to 23.82% —while improving network compactness. By linking an interpretable correlation scale with global optimization, the approach provides a practical basis for planning, staged densification, and rapid emergency deployment of corridor monitoring networks.

ORAL SESSION 2

October 18th, 2025
Time Zone: GMT+8

Topic: High-Voltage Power Transmission System and Key Equipment Status Monitoring
Time: 16:55-18:40 (Duration for Each Presentation: 15 minutes)
Room: 2nd Floor - Edison Conference Room
Session Chair:

Onsite

PE0004

Neural Network-Based Detection of Open and Closed-Circuit Faults in Single-Phase Voltage Source Inverters

George Owusu[1] and Joshua Afosa-Baffoe[2]
1. University of Mines and Technology, Ghana
2. Montana Technological University, United State of America

Abstract-The single-phase Voltage Source Inverter (VSI) is one of the most commonly used converters for transforming a DC source into an AC source to supply power to a connected load. However, during operation, the system may experience an open-circuit (OC) or short-circuit (SC) fault, resulting in an interruption of power supply to the load. To reduce the frequency of such interruptions, this study proposes an Artificial Neural Network (ANN)-based technique to support the restoration of continuous operation in the event of a fault. The proposed controller manages two conventionally designed VSI circuits connected in parallel, enabling the system to switch power supply to the alternate circuit in the event of an OC or SC fault in the primary circuit. The design incorporates two additional switches between the inverter output lines to prevent backflow of current within the system. A simulation analysis was performed using MATLAB/Simulink to evaluate the performance of the proposed system. Simulation results demonstrate the system's capability to restore continuous power supply from the DC source to the load during an OC or SC fault in either circuit. The proposed approach can be extended to other categories of VSI to improve the efficiency and reliability of power delivery from source to load.

PE0011

A novel traveling wave fault location method for MMC-HVDC transmission lines based on complementary ensemble empirical mode decomposition and Hilbert transform

Xiangyang Liu, Zhong Tang, Haoyang Cui and Hong Qian
Shanghai University of Electric Power, China

Abstract-When a fault occurs in the direct current transmission line of the modular multilevel converter high voltage direct current (MMC-HVDC) grid, the sub-module capacitors discharge, causing the fault current to rise rapidly, posing a threat to the safe operation of the grid. Fast and accurate fault location is crucial for the stable operation of the system. Therefore, this paper proposes a novel fault location method by combining complementary ensemble empirical mode decomposition (CEEMD) and Hilbert transform (HT) algorithm. This method calculates the instantaneous frequency of the fault signal, identifies the fault moment by detecting its change points, and achieves fault location for the MMC-HVDC transmission line. This method has excellent time-

frequency analysis capabilities, better noise robustness, and higher frequency resolution. Finally, use PSCAD/EMTDC to validate this method. The results show that this method accurately locates faults under different fault conditions, and has strong anti-noise ability and tolerance to large transition resistance.

PE0037

Multi-Time-Scale Adaptive Defense Response Strategy for Cyber-Physical Distribution Systems

Yang Liu[1], Mi Wen[1], Yunsheng Xue[2], Jiaju Yu[1], Yi Gao[1] and Qiuling Yu[1]
1. Shanghai University of Electric Power, China
2. Beijing Jiaotong University, China

Abstract-With the increasing digitalization and intelligence of power distribution systems, the deep integration of physical and cyber layers has exposed cyber-physical distribution systems (CPDS) to complex and dynamic threats. Existing defense resource strategies are often static and lack the flexibility to adapt to the spatio-temporal evolution of risks, leading to inefficient resource usage and delayed responses. To address this, we propose a multi-time-scale adaptive defense response strategy for power CPDS. The proposed approach integrates real-time risk assessment and dynamic defense resource allocation into a Markov Decision Process (MDP) model, which accounts for risk stage transitions and asynchronous defense actions. A deep reinforcement learning framework is developed to optimize decision-making under multi-scale temporal constraints, enabling intelligent scheduling of defense resources. Experimental results demonstrate that the strategy effectively mitigates risk propagation and enhances defense efficiency, offering both theoretical insight and practical value for resilient power CPS security.

PE0118

Transient Fault Analysis of Renewable Energy DC Collection and Transmission System with High-Voltage DC-DC Converters

Dazhen Xu[1], Zhibo Zhang[2], Zhiguang Lin[2], Jianjun Ma[1] and Miao Zhu[1]
1. Shanghai JiaoTong University, China
2. China Electric Power Research Institute, State Key Laboratory of Advanced Power Transmission Technology, China

Abstract-This paper develops a transient fault current calculation method for renewable energy DC collection and transmission system. Fault transient equivalent circuits are established for critical power electronic devices and the whole system under typical fault locations. System matrix differential equations are formulated to enable accurate current computation. Comparison with MATLAB/Simulink simulations validates the effectiveness of the purposed method.

PE0076

Inertia Evaluation Method for Power Systems with Integration of Wind Farms Under Colored Measurement Noise

Yongkang Luo[1], Mingjiang Liu[2], Yu Zhang[2], Ziwen Liu[1], Xingwei Che[2] and Xiangyu Meng[2]
1. Hohai University, China
2. Huaneng International Power Jiangsu Energy Development Co., Ltd. Clean Energy Branch, China

Abstract-With the integration of high proportion of new energy, the power system gradually exhibits low inertia characteristics. Accurately evaluating the system inertia is of great significance for the safe and stable operation of

the power system. However, the colored measurement noise greatly influences on the collection data resulting bias of inertia evaluation. This paper proposes a power system inertia evaluation method based on Improved Adaptive Kalman Filter (IAKF) algorithm. Firstly, the filtering state equation and measurement equation are derived by applying the forward Euler method on the swing equation. Then to decrease the influence of colored noise and data saturation, this article estimates the statistical characteristics of the colored measurement noise, imports the forgetting factor to form the improved filtering gain and proposes the IAKF algorithm. Finally, the effectiveness and superiority of the algorithm proposed in this paper are verified through simulation examples.

PE2011

A Robust Optimization Method for Distribution System Considering Mobile Emergency Resource under Extreme Weather

Di Yang[1], Jun Lu[1], Jisheng Jia[1], Mingyi Qiu[1], Lei Sun[1], Fei Zeng[1], **Jiahao Sun[2]** and Haijun Xing[2]
1. State Grid Shanghai Electric Power Company Pudong Power Supply Company, China
2. Shanghai University of Electric Power, China

Abstract-To enhance distribution network resilience against extreme weather, this paper proposes a coordinated strategy synergizing Mobile Energy Storage Systems (MESS) and repair crews. A two-stage optimization framework is presented. A robust optimization model determines the optimal pre positioning of resources, considering photovoltaic (PV) and load uncertainties at the pre-disaster prevention stage. At the post disaster restoration stage, a multi-period dispatch model dynamically coordinates the spatiotemporal movement of MESS, including relocation and battery swapping, with the progress of repair crews to accelerate critical load restoration. The effectiveness of the algorithm is verified on the IEEE33-node distribution system.

PE0141

Multi-dimensional Feature-Fusion-Based Cooling and Heating Load Identification Model for Distribution Substations

Bingbing Lu[1], Fan Yang[1], Jun Liu[1], Jiashuai Li[2], Gaiping Sun[2] and Ziqi Ye[2]
1. The State Grid Shanghai Municipal Electric Power Company, China
2. Shanghai University of Electric Power, China

Abstract-To overcome the key limitations of conventional cooling/heating load identification in distribution substations—namely, the insufficient characterization of temperature-response lags and the low dimensionality of features—this paper presents a multi-feature fusion model. First, a dynamic thermal-response event detector is built. It employs a sliding-window standard-deviation algorithm to capture abrupt temperature events and verifies load-response characteristics with Pearson correlation, extracting spatio-temporally coupled features. Second, a high-dimensional feature set covering load spectral entropy, period sensitivity, and lagged correlations is designed. Third, an improved LightGBM classifier is proposed: SMOTE is used to oversample cooling and heating loads to 80 % of the normal-load size, while principal-component analysis retains components explaining 95 % of the variance. Finally, a seasonal-priority strategy combined with a confidence-tier mechanism is established; samples whose predicted probabilities fall between 0.4 and 0.6 are manually reviewed to resolve classification conflicts. Validation on 1,133 actual substations shows the method achieves 92.3 % accuracy and an F1-score of 0.87 for cooling and heating load classification.

POSTER SESSION 2

October 18th, 2025
Time Zone: GMT+8

Topic: Load Forecasting, Parameter Control, and Optimal Scheduling in New Energy Power Systems and Integrated Energy Systems
Time: 16:55-18:40 (Duration for Each Presentation: 3 minutes)
Session Chair:

Onsite

PE0007

Proportional-Integral-and-Data-Driven Load Frequency Controller for Microgrid Systems

Weichao Wang, Ronghu Chi and Yang Liu
Qingdao University of Science and Technology, China

Abstract-This paper proposes a novel proportional-integral-and-data-driven control (PIDDC) for microgrid (MG) frequency regulation. The PIDDC combines a proportional-integral (PI) control loop for rapid dynamic response to the frequency fluctuations and a data-driven model free adaptive control (MFAC) loop to enhance robustness against unmodeled system uncertainties by leveraging real-time input/output data from the MG system. Therefore, the synergistic integration of two loops ensures high robustness and adaptive capability, enabling effective mitigation of frequency fluctuations. To validate its effectiveness, the proposed PIDDC is implemented in an MG system considering wind turbine power, photovoltaic, and disturbances. Simulation results demonstrate that the proposed PIDDC can effectively maintain the MG frequency deviations within the desired range, which is superior to other methods.

PE0015

Optimal Placement of Constrained Micro PMUs Using Phasor Measurement based State Estimation

Seungyeop Baek, Jinhyeok Kim, Byeongchang Lim and Yeuntae Yoo
Myongji University, South Korea

Abstract-The deployment of Micro PMUs, capable of providing high resolution with time synchronized data in real time at the distribution level, is gradually expanding. The phase angle information obtained from these devices enables more accurate state estimation and real-time anomaly detection in the network. However, due to the high capital cost of Micro PMUs, it is not practically feasible to install them at every bus intended for monitoring within the distribution system, unlike conventional current and potential transformers which can be widely deployed. This paper proposes an optimal Micro PMU placement strategy that accounts for the practical constraint of using only a limited number of devices, with the aim of improving the correction accuracy of time-synchronized voltage states in distribution networks. The proposed approach combines a state estimation method based on Weighted Least Squares with a heuristic optimization algorithm. Utilizing high-resolution measurement data from Micro PMUs, the method corrects voltage phasors across the entire network and identifies the most effective PMU placement configuration. The simulation is conducted based on the IEEE 15 bus test system, which represents a three-phase balanced distribution network integrated with renewable-based distributed energy resources. Real time analog voltage signals are applied to Micro PMUs using an RTDS, and the corresponding phasor measurements are utilized in a python-based environment to perform state estimation using the Weighted

Least Squares method. In each iteration, OpenDSS performs power flow analysis to compute voltage phasors, and the proposed optimization algorithm determines the optimal Micro PMU placement that minimizes the state estimation error based on these results. The Micro PMU placement method proposed in this paper is expected to provide a foundation not only for the efficient deployment of measurement devices but also for improving the overall operational performance of distribution systems. In particular, by using the accuracy of phasor estimation based on high-resolution time-synchronized data as the criterion for determining PMU placement, the method enables precise correction of voltage phasors across all buses under a unified time reference. The proposed approach is also scalable and can be flexibly applied to various network configurations and load conditions in future studies.

PE0023

Research on breakdown performance of DC model cable based on Chinese cross-linked polyethylene insulating material

Wang Chuan-Bo, Jiao Yong-hui, Xu Peng-cheng, Han Ben, Pang Gong-he, Jiao kun, Xu Shi-ming and Ye Jian-cheng

State Key Laboratory of Technology and Equipment for Defense against Power System Operational Risks, Nari Technology Co., Ltd, China

Abstract-In order to simulate the structure and production process of high-voltage direct current (DC) cables more efficiently, the preferred Chinese low-density polyethylene-based resin, nanoparticles and additives are added, and the high-voltage DC cable insulation material is mixed by a twin-screw extruder, which can solve the problem of difficult dispersion of nanoparticles. In addition, the HVDC cable insulation material production process was used to produce model cables with insulation thicknesses of 3.4mm, 5.5mm and 7.6mm, and DC breakdown experiments with different temperatures and different terminal accessories were carried out to evaluate the feasibility of Chinese insulation materials as HVDC cable insulation materials. The test results show that the cable material has excellent DC breakdown performance at different insulation thicknesses and temperatures. Moreover, it is found that different termination forms can increase the breakdown voltage of the cable, and the overall breakdown level of the cable can be improved by improving the terminal accessories in the future.

PE0048

An Adaptive Model Predictive Load Frequency Control Strategy for Low-Inertia Power Systems

Hayato Nagaosa[1], Yutaka Sasaki[1], Helin Yang[2], Yoshifumi Zoka[1], Naoto Yorino[1,3], Ahmed Bedawy[1] and Weichao Wang[4]

1. Hiroshima University, Japan
2. Hitachi Energy, Shanghai, China
3. National Institute of Technology (KOSEN), Kure College, Japan
4. Qingdao University of Science and Technology, China

Abstract-As renewable energies (REs) are rapidly penetrating existing power systems, maintaining frequency stability has become increasingly difficult. Load frequency control (LFC) operations are very important under these circumstances. Classical PI controllers are widely used as LFC controllers; however, the system operator must retune the parameters whenever system configurations are changed. To address this issue, the authors have developed an adaptive model predictive LFC (AMPC-LFC) to improve the frequency stability by using an automatic parameter update. This paper proposes a modified AMPC-LFC for power systems with high penetration

of wind turbine (WT) power generation in an interconnected two-area network. An extended Kalman filter (EKF) is applied to AMPC-LFC to estimate the parameters of the simplified internal model in real time. Furthermore, a high voltage direct current (HVDC) transmission system with inertia emulation control (INEC) can reduce frequency deviations caused by WT and load changes. Simulation results show that the HVDC-AC hybrid transmission system can improve frequency control performance by up to 56% compared to AC-only systems. Additionally, when AMPC is compared with PI controllers and particle swarm optimization (PSO)-tuned adaptive PI controllers, AMPC can reduce frequency deviation for each controller by up to 64% and 44% respectively.

PE0021

Research on the Development Paths of New Energy Industry in Rural Areas for Dual Carbon Goals

Yanfei Pan[1] and Qiong Li[2]

1. China Electric Power Planning & Engineering Institute, China
2. Economics and Technology Research Institute, State Power Investment Corporation Limited, China

Abstract-In recent years, how to consolidate the achievements of poverty alleviation in rural areas in China after getting rid of absolute poverty has become an urgent issue for governments. The extensive use of fossil energy in rural areas has become a pressing issue in rural revitalization and energy transition, and the expenditure on fossil energy has become a heavy burden on rural residents. Wind energy and solar energy resources, as the dominant resources in vast rural areas in China, are not restricted by the original industrial base, and can become a new income source for village collectives and residents, and also bring new opportunities to the development of rural industries. This paper analyzes the challenges during energy transition in rural areas and the development paths of new energy industry in rural areas for carbon reduction and prosperity, and proposes policy suggestions to promote the high-quality development of new energy industry in rural areas.

PE0030

Influence of New Energy Power Fluctuation on the Power System Frequency Safety Under High New Energy Penetration

Wenbo Yang[1]**,** Zhen Huang[2], Lei Chen[1], Kaiyuan Hou[3], Deming Xia[3] and Xingwei Xu[3]

1. Tsinghua University, China
2. State Grid Northeast China Branch, State Grid, China
3. Power Dispatching and Control Center, State Grid Northeast China Branch, China

Abstract-With the rapid increase of new energy penetration, the increase of fluctuation of new energy power and the decrease of frequency regulation capability will affect the frequency safety of power system. In order to study the specific effect of new energy power fluctuation on the system frequency of power system under high penetration, the power fluctuation characteristics of new energy at different time scales and how they affect the system frequency are analyzed firstly. Then, based on empirical mode decomposition, the wind and solar fluctuation model and the maximum power fluctuation range estimation model are established, and then the primary frequency regulation upward capability model of thermal power unit is established. Finally, based on the above models, the time-domain simulations of power system with different new energy penetration are carried out, and the changes of system primary frequency regulation upward capability, disturbance power margin are analyzed.

PE0057

Credit Evaluation Method for New Market Entities Based on Credibility Entropy Evidence Theory

Kong Shuqin[1], Sheng Jiansheng[1], Tian Lin[1], Zheng Wei[1], Wu Jinghui[1] and **Xue Shumin[2]**
1. Guangdong Power Exchange Centre, China
2. Shanghai University of Electric Power, China

Abstract-To construct a credit evaluation system for new electricity market entities, this paper constructs a credit evaluation indicator system based on the characteristics of the new electricity system and new types of electrical energy commodities, and proposes an evaluation method based on the theory of credibility entropy evidence. First, the characteristics of new types of electrical energy commodities are analyzed, and key indicators that can characterize the creditworthiness of market entities are extracted to construct an indicator system for evaluating the credit of new market entities. Second, it employs order relationship analysis to determine the initial weight of each credit evaluation indicator, applies a fusion method based on credibility entropy and improved evidence to combine these initial values, and generates comprehensive credit evaluation results for each new market entity. Ultimately, this method is verified as effective in evaluating the credit status of typical entities through case studies.

PE0098

A Fuzzy Adaptive Parameter Control Method for Wind Farm Active Frequency Support Considering Wind Speed Difference

Jiangwei Bi[1], Zhongyuan Yao[2], Tianyi Huang[2], **Haiqiang Zhou[1]**, Yi Zheng[2] and Youwei Zhang[2]
1. Hohai University, China
2. Clean Energy Branch Huaneng International Power Jiangsu Energy Development Co., Ltd., China

Abstract-A fuzzy adaptive parameter control method for wind farm active frequency support considering wind speed difference is proposed. First, the principles of conventional synthetic inertia (SI) control and secondary frequency drop (SFD) mechanisms are analyzed, revealing limitations of fixed SI parameters. Subsequently, to exploit wind power's frequency regulation potential and suppress SFD well, rotor speed and frequency variables are employed as fuzzy controller inputs to dynamically adjust SI droop and inertia coefficients. During rotor speed recovery, two methods redesign the recovery trajectory to mitigate SFD. Finally, for wind farm with speed difference, parameters are optimized via particle swarm optimization (PSO) at a base wind speed to minimize maximum frequency deviation. Validation on a modified three-machine nine-bus system demonstrates that the proposed method effectively supports system frequency, reduces SFD, and elevates the frequency nadir for wind farm considering wind speed difference.

PE0116

A Multi-Scale Spatio-Temporal Model for Eletric Load Forecasting

Muyang Tian, Ruirui Ji, Xinxin, Chenxi Bai, Tong Jia and Anjie Song
Xi’an University of Technology, China

Abstract-Existing electric load forecasting models often focus on a single scale, making it difficult to simultaneously capture long-term trends and short-term disturbances. This paper proposes a multi-scale spatio-temporal deep learning model that models the long-term dependencies within nodes and the short-term correlations between nodes. In the temporal dimension, a Periodic Decomposition Module is introduced to

decompose historical sequences into periodic and disturbance components, which are then modeled and fused through a dual-branch Temporal Fusion Transformer to obtain long-term predictions. In the spatial dimension, multi-scale features are extracted based on geographical maps, similarity maps, and weather maps, dynamically fused through an Inter-Graph External Attention Mechanism， and time dependencies are captured through LSTM to obtain short-term predictions. Finally, the block adaptively integrates long-term and short-term results, simultaneously outputting single-day and single-week predictions. On the NYISO dataset, the MAPE for single-day and single-week predictions is 2.05% and 2.33%, respectively, which significantly outperforms existing methods, validating the model's high accuracy and multi-scale adaptability.

PE0121

A Layered Optimization Scheduling Method of Energy Storage Stations for Supporting Grid-Province Coordination

Wei Ma[1], Bin Xu[1], Ze Li[2], Bingjian Fan[2], Zhe Li[1] and **Guigang Han[2]**

1. State Grid Anhui Electric Power Research Institute, China
2. China Electric Power Research Institute, China

Abstract-A layered optimization scheduling method of energy storage stations for supporting grid-province coordination is proposed. The model on the second layer is responsible for coordinating the inter-provincial peak-shaving resources, aiming to minimize load fluctuations and operational costs. The thermal power plant outputs, energy storage charge/discharge powers and interconnection line planned outputs are coordinated. The model on the primary layer is responsible for the power distribution among energy storage stations within provinces, aiming to maximize the net revenue from optimization scheduling of provincial energy storage stations. Particle swarm optimization and mixed-integer linear programming methods are adopted to solute the layered scheduling models of interconnected regions. Simulation analysis of two inter-connected regions is performed. The effectiveness and superiority of the proposed method are validated.

PE0122

Online Energy Management of FCHEVs based on Multi-Time Scale Dynamic Game Theory

Zhuang Tian[1,2], **Junqi Wang[1]**, Yigeng Huangfu[3], S. M. Muyeen[4] and Daming Zhou[1]

1. Northwestern Polytechnical University, China
2. Lis-Lab, Aix-Marseille University, France
3. Northwestern Polytechnical University, China
4. Qatar University, Qatar

Abstract-Efficient energy management is critical for fuel cell hybrid electric vehicles (FCHEVs). To address non-stationary demand and competing objectives, a multi-time scale energy management strategy based on dynamic game theory is proposed. The outer layer optimizes hydrogen consumption, high-efficiency operation, and overall economy over a long horizon. The inner layer performs reference tracking and suppresses power fluctuation on a fast horizon, thus improving durability. On this basis, a dynamic-game algorithm with an online multi-objective equilibrium updates weights via constrained projection and smoothed best response. Real-time trade-offs among hydrogen consumption, efficiency, and fluctuation are achieved. Validation on 10-kW sightseeing cars under typical cycles shows 75.3% operation in the high-efficiency region while meeting constraints on hydrogen use and fuel-cell fluctuation. Average computation time is 38 ms per step, confirming real-time feasibility.

PE0124

Short-term hybrid forecasting method for multi-type customer loads in extreme weather based on BiLSTM-Seq2seq model

Gaiping Sun[1], **Jiashuai Li[1]**, Ronghui Liu[1], Deyong Yu[2], Shunfu Lin[1] and Ziqi Ye[1]
1. Shanghai University of Electric Power, China
2. Longgang Power Supply Company, State Grid Zhejiang Electric Power Co., Ltd., China

Abstract-Extreme weather events may cause load fluctuations for multiple types of customers in a certain field, which poses challenges for load forecasting on the customer side. Therefore, this paper proposes a short-term load hybrid prediction method based on the Bilstm-Seq2Seq network. Firstly, the weather load dataset under extreme weather conditions is divided by meteorological standards, and a differentiated meteorological feature set is established for multiple types of customers through Pearson correlation analysis. Then, point prediction is conducted through the Bilstm-Seq2Seq model containing meteorological features to obtain the point prediction results and total prediction error data of the loads of multiple types of customers. The proposed model is verified using the total load dataset and its four subordinate loads in an eastern coastal city in China. The results show that the proposed model has high accuracy in both point prediction and probability prediction.

PE2006

Research and Development Status of Domestic and Foreign Solid Power Controllers and Industrialization Insights

Xu Wang[1], Huiyao Li[2], Xing Liu[1], Mi Liu[2] and Bei Zhang[3]
1. China Academy of Space Technology, China
2. Beijing Space Power Conversion and Control Engineering Research Center, China
3. Beijing Spacecrafts Co. Ltd, China

Abstract-This paper systematically reviews the technological development trajectory of solid-state power controllers (SSPCs), compares and analyzes the technological gap between domestic and foreign levels, and deeply explores the industrialization path. The full text is divided into five major parts: Firstly, it elaborates on the technical principles and classification of SSPCs; Secondly, it analyzes in detail the leading technologies in the United States and Europe and the current domestic development status; Then, it dissects the industrialization bottlenecks from the dimensions of materials, processes, and standards; Subsequently, it proposes targeted development suggestions; Finally, it looks forward to the technological trends and market prospects. The research shows that there are still significant gaps in domestic high-voltage and high-current technology, modular integration, and reliability, and it is urgent to achieve breakthroughs through the application of wide bandgap semiconductor materials and collaborative innovation among industry, academia, and research. This paper aims to provide a systematic reference for the technological upgrade and industrialization of SSPCs in China.

PE0075

Hierarchical multi-objective collaborative optimization of electric vehicle, station and distribution network considering reactive power compensation capacity of V2G charging piles

Tao He[1], Suwo Wu[1], Chongcheng Zhou[1], **Xingzhuang Li[2]** and Aiqing Yu[2]
1. State Grid Shanghai Electric Power Company, Jiading Power Supply Company, China
2. Shanghai University of Electric Power, China

Abstract-In response to the voltage fluctuation challenges induced by the high integration of electric vehicles (EVs) into power grids, this research presents a two-tier collaborative control strategy for charging stations. The strategy leverages the surplus capacity of vehicle-to-grid (V2G)-capable charging piles to achieve reactive power demand response. By constructing a residual capacity model of charging piles considering spatiotemporal coupling characteristics, a two-stage optimization framework is developed to achieve coordinated optimization between active regulation of charging loads and reactive power demand response. This approach aims to enhance the capacity utilization rate of charging facilities while ensuring grid voltage quality. Simulation results demonstrate that the proposed model not only achieves optimal charging costs for EVs within charging stations but also significantly improves the capacity utilization efficiency of charging infrastructure, ultimately achieving overall optimal voltage quality at the grid nodes where charging stations are connected.

PE0086

A Random Forest based Construction Method of New Distribution Network Planning Evaluation Indicators

Ning Luo[1], Wei Xiong[2], **Yuan Zhang[2]**, Jinsen Liu[1], Ludong Chen[1], Hongyan He[1], Pengcheng Zhang[1] and Guo Chen[2]

1. Power Grid Planning & Research Center, Guizhou Power Grid Co., Ltd. China

2. Guizhou University, China

Abstract-To address the challenge of static rigidity in the indicator system for evaluating new distribution grid planning, a random forest (RF) based constructing method of planning evaluation indicators for new distribution networks is proposed. First, typical planning scenarios are built and matched through quantitative analysis of county-level distribution grids in terms of regional energy positioning and digital intelligence dimensions. Based on the proposed scenario-driven approach, candidate indicators are initially screened based on expert experience, followed by an objective quantitative assessment of indicator importance using the RF model. This ultimately results in an evaluation indicator system highly adaptable to different scenarios. Validation using a typical county-level case study demonstrates that the proposed method can accurately match the core evaluation dimensions and key indicators under different scenarios, effectively distinguish the advantages and disadvantages of planning schemes, and significantly enhance the scientific rigor and specificity of planning evaluations.

PE0070

Short-term wind PV output and electrical load forecasting for microgrids based on peak-valley weighted CNN-BiLSTM

Yu Huiqun[1], Meng Yanyu[1], Yang Yifan[1] and Qiu Yaming[2]

1. Shanghai University of Electric Power, China

2. Intelligent Control Department, Energy Science and Technology Research Institute of State Power Investment Corporation, China

Abstract-Accurate forecasting of energy demand is essential to ensure the operational efficiency and reliability of microgrid renewable energy. A source-load forecasting method based on convolutional neural network (CNN), bidirectional long and short-term memory neural network (BiLSTM) and peak-valley weighting (PVW) is proposed. Firstly, the influencing factors with high correlation with power load and wind power output are selected as inputs to the model by combining the Pearson correlation coefficient (PCC) and MIV scores; then, the joint forecasting of microgrid wind-photovoltaic load is realized by CNN-BiLSTM combined with the PVW

mechanism. Finally, the forecasting accuracy of the proposed model is tested by combining the measured electric load and wind and solar power data of a region in China. The results show that the proposed model has higher forecasting accuracy in peak-underestimation forecasting.

ORAL SESSION 3

October 19th, 2025
Time Zone: GMT+8

Topic: Hybrid Energy System and Power Market
Time: 9:00-11:00 (Duration for Each Presentation: 15 minutes)
Room: 3rd Floor - Qinshan Conference Room
Session Chair:

Onsite

PE0028

The Bidding Strategy of Energy Storage in the Power Spot Market Based on the Adaptive McCormick Method

Hao Tong, Jiang Li and Zishuo Zhan
Shanghai University of Electric Power, China

Abstract-To enhance the economic benefits of energy storage stations in the electricity spot market environment, this paper proposes a bidding strategy for energy storage based on an adaptive McCormick method. First, a model framework for energy storage participation in the electricity spot market is constructed, and a bilevel bidding model is established. By employing duality theory and the Karush-Kuhn-Tucker (KKT) optimality conditions to replace the market clearing process, the bilevel model is transformed into a single-level model. To address the bilinear terms in the model's objective function, an adaptive piecewise McCormick method is proposed, incorporating dynamic relaxation interval contraction techniques and a relaxation interval backtracking mechanism. Finally, the effectiveness of the proposed strategy is verified using a modified IEEE 39-bus test system.

PE0074

Decision Optimization for Virtual Power Plants Participating in the Coupled Electricity-Carbon Market

Na Wang[1], Tiantian Chen[1], Chen Wang[1], **Pengwei Wang[2]**, Linxuan Zhao[1] and Jing Liu[1]
1. Shanghai Electric Power Research Institute, State Grid Shanghai Municipal Electric Power Company, China
2. Shanghai University of Electric Power, China

Abstract-Under the dual goals of carbon peaking and carbon neutrality, Virtual Power Plants (VPPs) are emerging as pivotal market participants and are becoming integral to the future of smart grid infrastructure. To investigate bidding strategies that balance economic efficiency with carbon reduction objectives, this study proposes a bi-level optimization model for VPP participation in the coupled market. The upper level focuses on profit maximization for VPPs, while the lower level models the clearing mechanisms of the integrated electricity and carbon markets. A collaborative optimization algorithm based on the Markov Decision Process (MDP) is developed to solve the model. Simulation results show that VPPs can increase their market-clearing volumes through coupled transactions, while simultaneously reducing the clearing volume of conventional coal-fired units. This not only enhances the environmental value of VPPs but also facilitates the low-carbon transformation of the modern energy system and improves the synergistic operation across multiple energy markets.

PE0009

Virtual Inertial Response and Frequency Regulation Control Method for Combined Systems of Renewable Energy and Hybrid Energy Storage

Wenxin Guo[1], Ruifeng Zhao[1], Yumin Li[2], Jiangang Lu[1], Huijuan Tan[1] and Shiming Li[1]

1. Power Dispatching and Control Center, Guangdong Power Grid Co., Ltd.., China

2. NARI Group Nanjing Control System Co., Ltd. China

Abstract-As the penetration of renewable energy continues to rise and conventional synchronous generators are progressively retired, the decline in system inertia and the shortage of primary frequency-regulation capability have become increasingly prominent. Renewable-energy-driven hydrogen-production systems, whose electrolyzes feature fast and controllable electrochemical processes, offer a promising avenue for providing virtual inertia support and ancillary frequency regulation. To address the transient non-linearity and multi-physics coupling characteristics of electrolyzers, this paper proposes a virtual-inertia response and frequency-regulation control method for renewable-energy-based hydrogen-production systems that explicitly accounts for electrolyzer dynamic characteristics. First, a high-fidelity electrolyzer–hydrogen-production model is developed on the basis of electrochemical kinetics, thermodynamic equilibrium, and gas–liquid mass-transfer coupling, furnishing a rigorous platform for control-strategy design. Second, within a virtual synchronous generator (VSG) framework, a hierarchical coordinated-control scheme is implemented: a dynamic-inertia compensation loop collaborates with an adaptive power–frequency (P–f) regulation module to achieve rapid, coordinated virtual-inertia support and primary-frequency response. Third, to mitigate power fluctuations caused by electrolyzer operating constraints, an energy-conservation-based dynamic-matching mechanism is formulated between hydrogen-production capacity and grid frequency-regulation demand, thereby ensuring safe and economic system operation. Finally, time-domain simulations on a modified IEEE 30-bus test system demonstrate that the proposed method significantly enhances key frequency metrics—including maximum deviation and settling time—while surpassing benchmark strategies in both hydrogen-production efficiency and regulation economics. The results provide effective technical support for boosting grid inertia, improving frequency stability, and enabling high-efficiency green-hydrogen utilization under high renewable-energy penetration.

PE0107

Economic analysis of replacing a combustion vehicle with an electric vehicle supported by residential photovoltaic systems in Brazil

Daywes Pinheiro Neto[1], Isabela Lopes Magalh˜aes[1], Thiago Augusto Mendes[1], Let´ıcia Chaves Ucker[1], Ant´onio Paulo Coimbra[2], Pedro Moura[2] and An´ıbal T. de Almeida[2]

1. Center for Experimental and Technological Research and Studies, Federal Institute of Goi´as, Brazil

2. Institute of Systems and Robotics, Dpt. of Electrical and Computer Engineering, University of Coimbra, Portugal

Abstract-This study assesses the economic viability of replacing conventional internal combustion vehicles with electric vehicles (EVs) in a residential context, considering the use of photovoltaic (PV) systems. A case study for a residence in Goiˆania, Brazil, was performed, analyzing Net Present Value (NPV) sensitivity to daily vehicle mileage and PV system size. Results show that, without a PV system, economic viability is achieved for daily mileage above 35 km. Incorporating a 3 kWp PV system reduces the minimum required daily mileage to 26 km. Furthermore, for this daily mileage, optimal PV sizing corresponds to 4.9 kWp, significantly improving NPV. These results highlight the economic advantages of combining EV adoption with residential PV systems to

enhance financial outcomes.

PE0126

Day-Ahead Net Load Forecasting Based on Similar-Period Selection and CNN-BiLSTM-Attention

Wei Wang, Shunfu Lin, Bo Zhou and Liang Qian
Shanghai University of Electric Power, China

Abstract-Accurate day-ahead net load forecasting is critical to the reliable and economical operation of modern power systems. Traditional deep learning models typically train on the entire available historical dataset without explicitly considering temporal similarities across different days. To address this limitation, this paper proposes a novel forecasting framework that integrates similar-period selection into a CNN-BiLSTM-Attention model to improve predictive performance. First, the autocorrelation function (ACF) is utilized to determine the optimal length of similar historical periods. Then, Shape Dynamic Time Warping (ShapeDTW) is employed to identify the most similar historical sequences. These selected periods are processed by convolutional layers to extract local features, followed by a BiLSTM-Attention model that captures bidirectional dependencies and highlights key temporal patterns. Experimental results demonstrate that the proposed approach outperforms models without similarity-based preprocessing and those using similarity based clustering based on weather conditions, achieving higher forecasting accuracy.

PE0134

Research on Integrated Energy System Planning Considering Multiple Uncertainties and Operational Risks

Zhuoxiang Wu, Shunfu Lin, Jin Tan and Liang Qian
Shanghai University of Electric Power, China

Abstract-In the planning phase of an Integrated Energy System (IES), it is crucial to consider multiple uncertainties and the associated risks they introduce, in order to avoid economic losses and ensure stable energy supply. This paper comprehensively accounts for the multiple uncertainties in IES operations, including wind and photovoltaic power output, carbon emission factors, load demand, and multiple cost coefficients. A stochastic planning model is then developed by employing the Conditional Value-at-Risk (CVaR) to quantify operational risks. Case studies demonstrate that the proposed planning model effectively reduces economic risks and enhances energy supply reliability.

PE0135

Risk-Averse Optimization of Medium- and Long-Term Power Procurement Under Available Transfer Capability Uncertainty

Ronghui Liu, **Weicheng Wang**, Gaiping Sun and Shunfu Lin
Shanghai University of Electric Power, China

Abstract-This paper conducts a risk assessment study on medium- and long-term power procurement in the face of the uncertainty of Available Transfer Capacity (ATC). We construct a risk-aware optimization model incorporating the CVaR tail risk measure and compare it with the deterministic arbitrage model. The ATC uncertainty is characterized by the channel capacity scenarios generated by Prophet + SARIMA and corrected with safety margins. The model also constrains the supply-demand balance, the upper limit of channel capacity, and the requirements for green power consumption. The method is quantitatively evaluated from VaR/CVaR and

operational indicators. A case study based on the annual historical data shows that, compared with the deterministic baseline, the proposed method achieves a smoother monthly allocation, higher and more stable utilization rate on the key channels, and significantly reduces the congestion risk. The results verify that introducing risk measures for optimization under ATC uncertainty can improve the reliability of medium- and long- term procurement decisions and the interpretability at the channel level.

PE0136

Study on Dual-Time-Scale Mid-to-Long-Term Spot Electricity Procurement Optimization Model Considering Inter-Provincial Channel Constraints

Ying Fan[1], Pengfei Zhang[1], Na Wang[1], Yuxin Chen[1], **Huan Zhou[2]** and Gaiping Sun[2]
1. State Grid Shanghai Municipal Electric Power Company, China
2. Shanghai University of Electric Power, China

Abstract-To address cost control and power supply stability challenges posed by the diversity of grid agency electricity procurement resources, and the limitations of existing single procurement modes (poor adaptability, intra-provincial resource constraints), this are paper develops a monthly-hourly dual-time-scale mid-to-long-term spot optimization model. First, variables unified mid-to-long-term by time scale: intra-provincial procurement and renewable energy procurement are set as monthly variables, while inter-provincial mid-to-long-term procurement and spot procurement are hourly variables, with scale connection via aggregation and equalization. Then, aiming to minimize total procurement cost, multi-space resource allocation is achieved by incorporating special constraints of three inter-provincial channels. Simulations with full-year 2024 load and electricity price data, verified against a control group, show the model effectively connects mid-to-long-term and spot markets, ensures full renewable energy consumption and power supply stability, and cuts procurement cost significantly compared to the control group, achieving cost optimization.

ORAL SESSION 4

October 19th, 2025
Time Zone: GMT+8

Topic: Digital Operation and Decision Analysis of Modern Power Grids
Time: 11:10-12:55 (Duration for Each Presentation: 15 minutes)
Room: 3rd Floor - Qinshan Conference Room
Session Chair:

Onsite

PE0104

A Unified Energy Management System Framework for Active Distribution Networks with Hybrid Energy Storage and Decentralized Voltage Control

Ahmed Bedawy[1], Yutaka Sasaki[1], Chiraz Krifa[1], Yoshifumi Zoka[1] and Naoto Yorino[1,2]
1. Hiroshima University, Japan
2. National Institute of Technology (KOSEN), Kure College, Japan

Abstract-High penetration of renewable energy sources (RES) and inverter-based resources (IBRs) in active distribution networks presents two major operational challenges: maintaining voltage quality and managing the variability of distributed generation. This paper proposes a unified Energy Management System (EMS) framework that brings together several established methods into one conceptual platform. The first component is a neural network-based forecasting module for photovoltaic (PV) generation and load demand, which supports a two-stage storage management strategy, day-ahead mixed-integer linear programming (MILP) scheduling, and intraday model predictive control (MPC) corrections, for the coordinated operation of battery energy storage systems (BESS) and hydrogen energy storage systems (HESS). The second component is a sensitivity-based voltage control layer, implemented using a multi-agent system (MAS) to coordinate voltage regulators and inverter reactive power in real time. While the forecasting-based storage management and the decentralized voltage control operate as separate modules in the current study, the proposed framework outlines how they could be combined in future work. Each algorithm is validated individually through simulations on benchmark distribution test feeders, demonstrating reduced voltage deviations, minimized tap changes, improved energy scheduling, and enhanced state-of-charge (SOC) and level-of-hydrogen (LOH) tracking.

PE0108

A Transformer-based Approach for Operating situation Prediction in Distribution Networks

Li Zeke[1], Chen Bin[1], Guo Jiuyu[1], Fan Haiwei[1], Ding Linglong[1] and Liu Bijing[2]
1. State Grid Fujian Electric Power Co., Ltd., China
2. NARI Group Corporation State Grid Electric Power Research Institute Co., Ltd., China

Abstract-Accurate perception and prediction of distribution network operating conditions are critical for enabling rapid response and risk mitigation, especially under extreme scenarios such as large-scale integration of renewable energy, sudden load fluctuations, or equipment failures. In response to the growing measurement capabilities and increasing operational complexity of active distribution networks, this paper proposes a Transformer-based method for predicting distribution network operating conditions. First, a time series forecasting model based on

the Transformer architecture is constructed, leveraging the model's ability to extract features and capture both temporal patterns and correlations among key operational elements from large volumes of measurement data, thereby significantly improving prediction accuracy. Next, a heuristic optimization algorithm based on Ant Colony Optimization (ACO) is employed to explore the hyperparameter space and determine the optimal configuration for the proposed model, further enhancing its predictive performance. Finally, the feasibility and effectiveness of the proposed method are validated using the IEEE 33-bus test system.

PE0119-A

Optimal Dynamic Network Reconfiguration Using Hybrid Quantum Deep Q-Networks

Wenzhuo Shi[1,2], Yigeng Huangfu[1], Yuhua Du[1], Shengrong Zhuo[1], Aili Fan[1] and **Zhao Xu[2]**

1. Northwestern Polytechnical University, China

2. Hong Kong Polytechnic University, China

Abstract-This paper explores the application of a Hybrid Quantum Deep Q-Network (HQDQN) for solving the dynamic network reconfiguration (DNR) problem in distribution networks. Modern power distribution systems face increasing challenges due to the integration of renewable energy sources, fluctuating demand, and the need for enhanced reliability and efficiency. To address these issues, we propose a hybrid approach that combines the strengths of quantum computing with deep reinforcement learning. By leveraging parameterized quantum circuits integrated with classical neural network components, the HQDQN is capable of efficiently encoding high-dimensional system states and optimizing reconfiguration decisions with significantly fewer parameters than traditional models. The proposed method is evaluated using the IEEE 33-node test feeder, a widely adopted benchmark in distribution network studies. Simulation results demonstrate that HQDQN achieves substantial improvements in energy efficiency, voltage stability, and decision-making accuracy compared with conventional Deep Q-Network (DQN) frameworks. These findings highlight the promise of quantum-enhanced machine learning as a transformative tool for future smart grid operations, offering both computational efficiency and superior optimization performance in complex and dynamic power system environments.

PE0123

An Improved Cloud Drift Optimization Based Two-Layer MPC for Economic Dispatch of Microgrids with Hybrid Energy Storage

Peixin He[1], **Chenyuhao Ma[1]**, Daming Zhou[1] and S. M. Muyeen[2]

1. Northwestern Polytechnical University, China

2. Qatar University, Qatar

Abstract-This paper proposes a two-layer Model Predictive Control (MPC) framework integrated with an Improved Cloud Drift Optimization (ICDO) algorithm to address the economic dispatch problem in renewable-energy-powered microgrids with hybrid energy storage systems (HESS). The upper-layer MPC performs long-term economic scheduling with battery degradation cost consideration, while the lower-layer MPC handles short-term power fluctuation suppression and prediction error compensation. To enhance the global optimization capability and computational efficiency of the non-convex upper-layer problem, an ICDO algorithm is introduced, incorporating sinusoidal chaotic mapping initialization, a ring topology strategy, and a multi-layer adaptive parameter mechanism. Simulation results under various electricity price and uncertainty scenarios demonstrate that the proposed method significantly reduces operating costs, mitigates battery degradation, and improves computational performance compared to conventional solvers and other swarm intelligence algorithms.

PE0131

Distributed Energy Dispatch for Energy Community Using Decision-oriented Net-load Prediction

Yibo Ding[1], Jian Zhao[2], Jiaqi Ruan[1] and Zhao Xu[1]
1. The Hong Kong Polytechnic University, Hong Kong, China
2. Shanghai University of Electric Power, China

Abstract-This paper focuses on distributed energy dispatch under uncertainties for an energy community. To effectively handle these uncertainties, a decision-oriented predict-then-optimize framework is employed, achieving statistically lower operation costs compared to traditional accuracy-oriented predict-then-optimize approaches. Furthermore, peer-to-peer energy sharing among agents is specially considered to promote renewable energy consumption. Dual consensus alternating direction method of multipliers is employed to solve the distributed energy dispatch problem. Simulation results over extensive scenarios have demonstrated the effectiveness of the proposed methodology.

PE2012

AC and DC Power Flow Calculation Method in Distribution Networks Based on Power Electronic Transformers

Zhen Zheng[1], Yinan Huang[1], Wenwen Chen[1], **Xiao Yang[2]** and Haijun Xing[2]
1. State Grid Shanghai Electric Power Company Qingpu Power Supply Company, China
2. Shanghai University of Electric Power, China

Abstract-To characterise the multi-port power coupling characteristics of power electronic transformers, this research proposes a method for calculating power flow in AC and DC distribution networks incorporating PETs. Firstly, by constructing a multi-port power flow decoupling model for PETs based on controlled source pairs, the power coupling characteristics of the power conversion elements under voltage control and power control modes are characterised. Secondly, an alternating iteration algorithm is employed to achieve efficient collaborative solution for AC and DC systems. Finally, power flow calculations for an enhanced 26-node AC and DC hybrid distribution network in a specific region demonstrate that the proposed method satisfies the requirements for power flow calculations in distribution networks incorporating PETs. The proposed PET power flow decoupling model accommodates multi-voltage level AC and DC buses. It accurately calculates both PET port power flows and internal power flow distributions under both voltage control and power control modes, whilst exhibiting a low number of iterations and rapid convergence.

PE2013

Grid Partitioning Method for Distribution Networks Considering the Clustering of Flexibility Resources

Yuanbing Xiao[1], Mingzhu Ren[1], Taotao Ma[1], Zhen Zheng[1], Duhong Wang[1], Yehui Ma[1], **Shijie Zhuang[2]** and Haijun Xing[2]
1. State Grid Shanghai Electric Power Company Qingpu Power Supply Company, China
2. Shanghai University of Electric Power, China

Abstract-To address the operational impacts arising from the large-scale integration of flexibility resources such as distributed photovoltaics, energy storage, and electric vehicles, and to overcome the limitations of existing grid partitioning methods in managing resource stochasticity and single-objective optimization, this paper proposes a

novel method for power distribution network partitioning that considers the cluster-based aggregation of flexibility resources. First, an improved K-means clustering algorithm, enhanced by the elbow method, is employed to perform a cluster analysis of flexibility resources. This approach dynamically determines the optimal number of clusters to generate representative operational scenarios. Subsequently, based on these clustering results, a distribution network partitioning optimization model is formulated with the objective of minimizing the weighted sum of total active power loss and load imbalance. This model is then transformed into a Mixed-Integer Second-Order Cone Programming (MISOCP) problem for efficient solution. Finally, the proposed method is validated through simulations on a 26-node distribution system.

ORAL SESSION 5 (ONLINE)

October 19th, 2025
Time Zone: GMT+8

Topic: Control Models, Parameter Optimization, and Performance Evaluation in Power Systems
Time: 13:30-14:45 (Duration for Each Presentation: 15 minutes)
Zoom Link: https://us02web.zoom.us/j/84535720120
Session Chair:

Online

PE0001

Performance Evaluation of Asymmetric Six-Phase Induction Motors Using an Improved DTC-SVPWM Technique

Kaniz Suburna, Shirazul Islam, Atif Iqbal and S. M. Muyeen
Qatar University, Qatar

Abstract-Multiphase induction motors play a crucial role in industrial applications, particularly in the mining sector, due to their superior reliability, fault tolerance, and efficiency. Despite these advantages, maintaining accurate torque and speed control while reducing power losses continues to be a major challenge. This study aims to enhance the operational performance of multiphase induction motors by implementing an advanced Direct Torque Control with Space Vector Pulse Width Modulation (DTC-SVPWM) technique. The proposed approach leverages sensor less DTC and the inherent capabilities of SVPWM to improve efficiency and accuracy while reducing power dissipation. The research specifically investigates the performance of a six-phase asymmetric induction motor operating under a variable-speed environment with a DTC-SVPWM strategy. To simplify control implementation and potentially minimize the required filter size, a fixed switching frequency is adopted, ensuring more stable and predictable operation. The study evaluates key performance metrics, including torque ripples, speed regulation, and overall dynamic response, to determine the effectiveness of the proposed method in enhancing efficiency and precision. The findings of this research contribute to enhancing multiphase motor control strategies for mining applications, where high performance and energy efficiency are critical.

PE0018

Electric Arc Simulation Validations and Switchgear Applications

Wenkai Shang[1], Shihu Ma[2], Meng Li[3], Oleg Chernukhin[4], Runan Mo[5], Somasekhar Machani[6], Chuan Lu[3], Yumin Xiao[3] and Isaac Liu[3]
1. ANSYS Germany GmbH, Otterfing, Germany
2. ANSYS, Inc, Boulder, CO, USA
3. ANSYS, Inc, Canonsburg, PA, USA
4. ANSYS, Inc, Waterloo, Canada
5. ANSYS, Inc, Canonsburg, CA, USA
6. ANSYS, Inc, Bengaluru, Indian

Abstract-In this paper, we focus on the validation of numerical simulation of electric arcs in gas. The core of the electric arc reaches a local thermal equilibrium (LTE) state, which primarily determines its behaviour. In contrast,

the regions near the anode and cathode and outside the arc core are in a non-LTE condition. This work mainly discusses the modelling of the near-anode and near-cathode regions and the arc core. We use a magnetostatic approach to calculate the Joule heating loss and the Lorentz force within the arc. To model the regions near the anode and cathode, we introduce nonlinear conductivity dependent on current density to simulate voltage drops near the electrodes. The anode and cathode surface losses are then determined based on these voltage drops. Computational fluid dynamics (CFD) simulations are used to calculate the electrical conductivity and temperature of the arc at each iteration. Multi-species models that incorporate local species concentrations are used to account for metal and insulation vapor. Various thermal radiation models can be applied to improve the accuracy of electric arc simulations. High-performance computing (HPC) is used to meet computational demands and reduce simulation time. To validate the proposed simulation workflow, we focus on two benchmark cases and compare the simulated results with the experimental results from literature. Switchgear electric arc simulation is a challenging topic, due to complex physics, examples are shown as application of the simulation workflow to understand the complex electric arc process.

PE0110

Design of Self-Powered Energy-Harvesting Power Supply for Three-Phase Cable Temperature Monitoring Device

Hong Lei, Zhaohong Wang, Lu Zeng, Jiale Chen and Sheng Li
Xiangtan University, China

Abstract-To address the power supply issue for temperature measurement devices on transmission line three-phase cables, this study investigates the magnetic field characteristics around three-phase cables and proposes a novel energy harvesting solution. This paper designs an energy harvesting current transformer (EHCT) suitable for extracting energy from the magnetic field around three-phase cables, along with subsequent rectification/filtering circuits and voltage stabilization circuits. An excessive power supply voltage ripple coefficient can severely affect the measurement accuracy of temperature monitoring devices. Therefore, this paper designs a high-gain, ultra-low-output-voltage-ripple DC-DC converter, which effectively solves the problems of low output voltage and excessive voltage ripple after the energy from the EHCT passes through the rectification/filtering circuits. To verify the accuracy of the proposed energy harvesting solution, a 3D simulation model of the EHCT was built using Ansys Electronics to validate its output performance, while a complete circuit simulation model of the energy harvesting system was constructed in Simulink. Simulation results show that the EHCT can achieve an output power of approximately 330 mW, and the final output voltage of the proposed energy harvesting circuit reaches about 5 V with a voltage ripple coefficient below 0.01%. This energy harvesting solution can provide a sufficiently high and stable output voltage, enabling reliable power supply for low-power cable temperature monitoring devices.

PE0120

Electromagnetic Simulation Model of Switching Power Supply

Wu Jianchao[1], Li Xinxin[1], Lv Hui[1], Liu Mi[1,2], Ji Zhipo[1] and Wan Chengan[1]
1. Dept. of Electronic Products Beijing Spacecraft, China
2. Harbin Institute of Technology, China

Abstract-Electromagnetic compatibility (EMC) of aerospace power modules is crucial for ensuring stable and reliable operation of the entire spacecraft. To meet the high power and high efficiency demands of aerospace

power supplies, GaN power devices with high switching frequency characteristics are gradually being incorporated into aerospace power supply designs. The high dv/dt and di/dt characteristics of GaN power devices have significant impacts on the parasitic parameters of sensitive circuits, such as driver circuits, posing a significant challenge to EMC design. In particular, in complex electromagnetic environments (such as external interference, power-on pulses, and capacitive loads), effective methods for quantitatively assessing interference in sensitive links are lacking. This paper develops an accurate high-frequency simulation model for a space-use buck power module. By extracting the parasitic parameters of key sensitive links (drive circuit and power circuit on the printed circuit board (PCB)) , core components and structural shells, a system-level simulation environment that can accurately reflect its high-frequency characteristics is constructed.This model enables quantitative analysis of the induced noise voltage/current caused by electromagnetic interference at any location along the sensitive link, transcending the limitations of traditional qualitative testing. Simulation and experimental results demonstrate that the model is highly accurate with a relative error of 10.3%. This research provides theoretical tools and engineering foundations for precis EMC design and fault prediction in aerospace power supplies, significantly improving the first-pass rate for EMC design of power supply products.

PE0053

Redefining Grid-Connected Control: A Polar-Coordinate Based Synchronized Virtual Oscillator Framework

Hoach The Nguyen, Ameena Saad Al-Sumaiti, Khalifa Al Hosani, Ahmed Al-Durra and Mohamed Shawky El-Moursi
Khalifa University, UAE

Abstract-This paper introduces a control framework for inverter-based resources using externally synchronized oscillators. Polar-coordinate control laws regulate phase, frequency, and magnitude without PLLs, dq-transforms, or trigonometric functions. Large-signal stability and convergence are proven via Lyapunov analysis. The framework supports direct power control, grid-forming features, and simple digital implementation. Simulations and experiments show fast synchronization, accurate regulation, and resilience in weak grids, unifying grid-following, grid-support, and grid-forming modes under one approach.

ORAL SESSION 6 (ONLINE)

October 19th, 2025
Time Zone: GMT+8

Topic: New Technologies for Integrated Energy Systems and Energy Storage
Time: 14:45-16:00 (Duration for Each Presentation: 15 minutes)
Zoom Link: https://us02web.zoom.us/j/84535720120
Session Chair:

Online

PE0061

Joint Estimation of State of Charge and State of Health for Lithium-Ion Batteries Based on Singular Value Decomposition and Multi-Innovation Adaptive Unscented Kalman Filter Algorithm

Tao Ren, Jin Jiang and Sheng Li
Xiangtan University, China

Abstract-Accurate state estimation of lithium-ion batteries faces fundamental challenges: integer-order models fail to capture diffusion dynamics effectively, Cholesky decomposition-based filtering algorithms suffer from numerical instability under strong noise interference, and strong SOC-SOH coupling leads to persistent error accumulation. This study establishes a second-order fractional equivalent circuit model employing Grünwald-Letnikov discretization to precisely characterize voltage relaxation processes. To address covariance matrix positive definiteness, we innovatively integrate singular value decomposition into the multi-innovation adaptive unscented Kalman filter framework, creating the SVD-FOAMIUKF algorithm that ensures filtering stability through singular vector matrix reconstruction of sigma points. For multimodal parameter identification, an enhanced firefly algorithm incorporating Cauchy mutation operators and adaptive step size mechanisms significantly improves global search efficiency. The proposed dual-timescale architecture (microscale SOC updates and macroscale SOH correction) achieves 0.07% RMSE under US06 dynamic profiles - a 3.8-fold accuracy improvement over conventional FOUKF. Experimental validation demonstrates <1% MAE robustness against 20% voltage measurement noise while maintaining merely 15% additional computational overhead, providing a pragmatic solution for high-precision battery management systems.

PE0067

Multiscale Modeling and Electrochemical Validation of PEM Electrolyzer-Coupled Hybrid Energy Storage Systems

Haotian Ma[1], Shangfeng Du[2] and Georgios Nikiforidis[1]
1. Institute for Materials Discovery, University College London, United Kingdom
2. Hydrogen & Fuel Cell Research Center, University of Birmingham, United Kingdom

Abstract-This paper presents a multiscale modeling and electrochemical validation framework for a decentralized hybrid energy storage system (HESS) integrating a proton exchange membrane (PEM) water electrolyzer, lithium-ion battery, supercapacitor, and photovoltaic (PV) generation. The proposed system enables autonomous energy management by dynamically coordinating short and long-term storage based on real-world environmental and load data.

At the component level, the PEM electrolyzer is modeled using thermodynamic and kinetic equations, capturing reversible electrochemical potential, activation, ohmic, and concentration losses under varying temperature and pressure. The lithiumion battery and supercapacitor are represented via dynamic and equivalent-circuit models, respectively, with hierarchical control logic ensuring fast transient response and long-term resilience.

One-year simulations at 15-minute resolution demonstrate the system achieves near-complete off-grid operation with grid interaction below 2%. The electrolyzer operates at 87% thermal efficiency at 2 A/cm² and maintains hydrogen purity above 99.2%. The supercapacitor absorbs 5 kW load transients within 50ms, preserving battery state-of-charge between 20% and 80% and preventing degradation. Control transitions remain stable with voltage overshoot below 3%.

Sensitivity analysis shows that a ±10° C stack temperature variation leads to only ±2.5% efficiency change, and moderate pressure increase improves hydrogen compression efficiency by 5% without electrical losses. These results validate the system's technical feasibility and operational robustness. Future work will incorporate degradation modeling, techno-economic analysis, and hardware-in-the-loop validation to support real-world deployment in residential microgrids and data centers.

PE0073

Medium-Long Term Balance Analysis Considering Extreme Scenarios at Multi-time Scales

Weijie Wu[1], Sui Peng[1], Zhengmin Zuo[1], Yixin Li[1], Shucan Zhou[1] and **Shijie Lin[2]**

1. Power Grid Planning Research Center, Guangdong Power Grid Co., Ltd, China

2. South China University of Technology, China

Abstract-Global climate change has exacerbated the frequency of extreme scenarios, leading to a higher risk of new power system balance. In order to solve this problem, this paper firstly proposes the extreme scenario timing operation constraints, considers the time-coupled constraints such as unit ramp-up and does not destroy the data characteristics of new energy output in extreme scenarios, and then nests them in the medium-long-term balance analysis model based on the approximate sustained load curve modeling, and then finally launches the case study based on the IEEERTS-1979 to demonstrate that the model can formulate a reasonable unit overhaul and standby It is demonstrated that the model can formulate reasonable unit maintenance and reservation allocation plans, effectively deal with the impact of extreme scenarios, and reduce the risk of system balance.

PE0078

An Electricity Price Forecasting Method Based on Multimodal Temporal Decomposition Framework Under the Mid-to-long-term Market Environment

Xiejun Du, Junjie Li, Kun Wang and Yan Shen

Economic and Technical Research Institute of State Grid Zhejiang Electric Power Co., Ltd., China

Abstract- Electricity price forecasting in the electricity market is a core component of power system dispatching, trading decision-making, and risk management, and its accuracy directly affects the economic benefits of market participants and system stability. This paper examines the forecasting of monthly time-of-use (TOU) electricity prices in the mid-to-long-term electricity market (MLTEM) for industrial and commercial (I&C) customers. Given the complex characteristics of electricity price fluctuations, which are influenced by a variety of factors such as load demand, fuel prices, renewable energy output, and policy adjustments, an innovative multimodal time-series decomposition framework (MM-TDF) is proposed. This framework enhances the signal-to-noise ratio of features through hybrid signal processing, dynamically integrates multi-source heterogeneous data such as electricity

prices and fuel prices by utilizing a conditional LSTM-Transformer interaction mechanism, and adopts a dynamic weight joint training strategy to optimize multi-task balance. Experiments show that in typical markets such as PJM and Nord Pool, MM-TDF achieves an accuracy rate improvement during peak hours improvement over LSTM, and exhibits strong robustness to data missingness. This research provides an interpretable and adaptive methodological breakthrough for high-precision electricity price forecasting in the electricity market.

PE0066

Peer-to-Peer Energy Trading and the Development of Grid-Blockchain Simulation Platform

Mohd Zamri Che Wanik Usman Zafar[1], Asrani Lit Nazreen Junaidi[2] and S. M. Muyeen[3]

1. Qatar Environment and Energy Research Institute, Hamad Bin Khalifa University, Qatar Foundation Education City, Qatar
2. Universiti Malaysia Sarawak, Malaysia
3. Qatar University, Qatar

Abstract-Peer-to-peer trading refers to the direct exchange without the involvement of intermediaries. This trading model is facilitated by advancements in distributed energy resources, digital technology, and supportive regulatory environments. The peer-to-peer (P2P) framework establishes an online platform where both prosumers and consumers can engage in electricity transactions at mutually agreed-upon prices, eliminating the need for a middleman. This paper provides a landscape brief of P2P and presents the simulation case studies of P2P trading for a few houses installed with PV and battery storage. The concept of P2P trading is explained first. Then the requirements for its implementation are described. A P2P trading co-simulation platform called P2PEnergyChain that combines blockchain technology with real-time grid monitoring to create a comprehensive energy marketplace is also presented. This platform will enable residential prosumers to trade excess energy directly with each other while maintaining grid stability and ensuring transparent, secure transactions through Hyperledger Fabric blockchain technology.

ORAL SESSION 7 (ONLINE)

October 20th, 2025
Time Zone: GMT+8

Topic: Application of Artificial Intelligence in Modern Power Electronics Systems and Optimized Scheduling
Time: 9:00-10:30 (Duration for Each Presentation: 15 minutes)
Zoom Link: https://us02web.zoom.us/j/84535720120
Session Chair:

Online

PE0046

Deployment of IoT Technologies for Phase Balancing in Low-Voltage Power Distribution

Aship Chaudhary[1], Samundra Gurung[2], **Rabindra Maharjan[1]**, Priyanshu Rouniyar[1], Sashank Shrestha[1] and Yubraj Chimoriya[2]
1. Equagen Engineers PLLC, Nepal
2. Kathmandu University, Nepal

Abstract-Voltage Unbalance (VU) is a significant power quality issue in low-voltage (LV) distribution feeders, particularly when voltage drops approach allowable limits and residential loads are unequally distributed across the three phases. The increasing penetration of single-phase rooftop solar photovoltaic (PV) systems further worsens this problem by introducing asymmetrical power injection, leading to greater per-phase loading variation and increased VU. High levels of VU can increase network losses and cause malfunctions or premature failure of three-phase equipment, such as induction motors. To mitigate this, a distributed intelligent load transfer scheme is proposed to dynamically reduce VU by redistributing residential loads among phases. A central controller installed at the distribution transformer monitors power consumption in each house using Internet of Things (IoT) technology and determines optimal load transfers. These transfers are executed via static transfer switches with a three-phase input and a single-phase output, installed at each residence to allow flexible phase reassignment. A short pi-model distribution line with unbalanced loading conditions is developed in MATLAB/Simulink to simulate the proposed scheme. The simulation results demonstrate the effectiveness of the approach in reducing voltage unbalance and improving the overall performance of the feeder.

PE0059

Research on Aerial Image Localization and Classification of Transmission Equipment Based on the C2f-CAA Mechanism

Weisong Liang, **Yonghua Wen**, Haimei Cen, Huiying You, Shaojun Qi, Xueying Huang, Yongqiu Liu and Huarong Wang
Guangdong University of Science and Technology, China

Abstract-Aiming at the problem of aerial image localisation classification of power transmission equipment, this study proposes a method for aerial image localisation classification of power transmission equipment based on the C2f-CAA mechanism. The method improves the residual convolutional neural network method by using the contextual anchor attention mechanism and the cross-stage partial double convolution module, so that the model is theoretically reduced in computational complexity. At the same time, the X-Small detection head and cross-

connection strategy are used to complete the feature extraction fusion process, and finally the bounding box regression module is completed based on the CIoU algorithm. The experimental results show that the accuracy and FPS of this model in insulator target localisation reaches 93% and 243 respectively, which indicates that this model has a positive effect in reducing computational complexity and small target detection.

PE0064

EV Charging Scheduling in Residential Areas: A Multi-Objective Approach Based on MOIPSO

Yuejun Li, Bin Duan and Yi Kuang
Xiangtan University, China

Abstract-To address the peak load overlapping phenomenon caused by the highly concentrated EV charging in residential areas, this study proposes an orderly charging strategy based on an improved multi-objective particle swarm optimization (MOIPSO) algorithm. A multi-objective optimization model is established to minimize the total system load variance, reduce user costs, and maximize charging volume, while considering EV battery aging costs and system power constraints. Simulation results demonstrate that, compared to the NSGA-II and MOPSO algorithms, the proposed algorithm significantly improves the diversity and convergence of the Pareto solutions through the introduction of dynamic inertia weights and elite crossover and mutation strategies. Moreover, compared to unordered charging, the proposed orderly strategy increases the average off-grid SOC by 3.3%, reduces the total cost by 29%, decreases the load peak by 28.4%, lowers the peak-valley difference rate by 39.3%, and reduces the load variance by 87.2%.

PE0065

An Optimal Scheduling Strategy for Virtual Power Plant Participating in Peak Regulation Considering Industrial Load Production Processes

Jin Mao[1], Liang Yin[2], Fang Wang[2] and Xiaoli Wang[2]
1. Wuhan University, China
2. Power Science Research Institute of State Grid Ningxia Electric Power Company, China

Abstract-High-energy-consuming industrial loads in multiprocess industries such as glass factories have considerable flexible adjustment potential, but their enthusiasm for participating in grid peak shaving is low due to production characteristics. As an aggregator of distributed resources, virtual power plant (VPP) can coordinate resources to participate in trading in energy and peak shaving markets. To address this, an optimal scheduling strategy for VPP peak shaving considering industrial load production processes is proposed: constructing a trading framework for VPP to participate in the two markets, establishing an energy-peak shaving response model for glass factory loads to tap adjustment potential, analyzing and modeling their typical production processes using the state-task network (STN) method, and then building an optimal VPP scheduling model to enhance loads' enthusiasm for demand response (DR) while ensuring normal production in glass factories. Case simulations show that the model can fully exploit load potential and actively participate in DR under the premise of ensuring safe production and plans of industrial enterprises, with VPP revenue increased by 8.16% and peak shaving and valley filling volume improved by 23.73%.

PE0068

Multi-objective optimization strategy of electric vehicle charging and discharging based on user demand response and Stackelberg game

Sheng Li[1], Yonghong Lan[1], Zhouzhou Xu[2] and Hong Lei[1]
1. Xiangtan University, China
2. Hunan Jiangye Electromechanical Technology Co., Ltd., China

Abstract-To address the issues of load overload and excessive peak-valley load difference caused by large-scale integration of electric vehicles (EV) into distribution networks and their interactions, this paper proposes a Stackelberg game-based EV charging-discharging strategy that considers both the charging-discharging storage facility operator (CDSFO) and users' elastic demand response. Unlike existing research, this study considers EV discharge and introduces virtual SOC to pre-calculate the optimization results, thereby reducing the user 's charging cost and whether to respond to the charging and discharging strategy. First, the load characteristics of residential communities and user travel behaviors are analyzed, and CDSFO scenarios are established. Then, a user charging-discharging demand response model is developed, and a multi-objective optimization scheduling model is constructed to maximize the respective benefits of CDSFO and EV users. Users can autonomously respond by selecting different weights based on demand response reference values to satisfy both travel needs and discharging requirements. Finally, simulations were conducted on a residential community distribution grid, verifying that the optimized scheme reduces charging costs and mitigates peak-valley load differences in the distribution network, while ensuring maximum benefits for both CDSFO and EVs users.

PE0071

Improving General-Purpose LLM Models for Power Cable Tasks Using Structured Context Engineering

Tong Wu
State Grid Xiamen Power Supply Company, China

Abstract-With the rapid development of large language models (LLMs), their performance on general tasks has approached human-level capabilities. However, challenges remain in applying these models to specific professional domains, such as insufficient domain knowledge and limited problem comprehension. This paper proposes a knowledge enhancement method based on context engineering. Using DeepSeek-R1-Distill-Qwen-32B as the experimental subject, the method embeds fault cases, textbook knowledge, and real-world problem descriptions from the field of power cables into the context in a structured manner. This significantly improves the model’s performance in the domain. Experimental results show that, compared with AI systems that do not employ context engineering, the proposed method achieves a notable increase in accuracy across multiple professional question sets. The study demonstrates that combining context engineering with high-quality data can rapidly and effectively enhance a general-purpose language model's domain knowledge and problem-solving capabilities without fine-tuning of the model.

ORAL SESSION 8 (ONLINE)

October 20th, 2025
Time Zone: GMT+8

Topic: Control Models, Parameter Optimization, and Performance Evaluation in Power Systems
Time: 10:30-11:45 (Duration for Each Presentation: 15 minutes)
Zoom Link: https://us02web.zoom.us/j/84535720120
Session Chair:

Online

PE0052

Research on the Evaluation of Autonomous Controllability of Power Grid Dispatching Technical Support Systems

Li Zhao[1], **Bijing Liu[1]**, Xiaosong Zhu[1], JianCheng Guo[2] and Yong Yang[1]
1. State Grid Electric Power Research Institute, State Grid Electric Power Research Institute, China
2, State Grid Dispatch Center, State Grid Dispatch Center, China

Abstract-The power grid dispatching technical support system holds a significant position in power systems. To enhance its level of autonomous controllability, the primary task is to establish a scientific evaluation framework and quantitative assessment methods. This paper investigates evaluation methods for the autonomous controllability of power grid dispatching technical support systems, proposing an integrated approach that combines the Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation (FCE) for quantitative analysis. This evaluation method provides a theoretical basis and decision-making reference for system optimization, contributing to the advancement of power systems toward greater security, efficiency, and autonomy.

PE0063

KG-SA-GNN: Knowledge-Guided Self-Attention Graph Networks for Imbalanced Fault Detection in Smart Grids

Yi Guo, Yi Kuang, Bin Duan and Sheng Li
Xiangtan University, China

Abstract-Detecting low-frequency faults in smart grids is challenging due to the class imbalance in fault data and dynamic changes in grid topology. To address these issues, this paper proposes a knowledge-guided self-attention graph neural network (KG-SA-GNN). First, a domain-specific knowledge graph is constructed by integrating equipment topological constraints, historical fault co-occurrence patterns, and maintenance rules, which enhances the modeling of physical relationships in the power grid. Second, a dynamic self-attention mechanism is introduced that incorporates relationship weights and fault frequency priors to adaptively focus on critical propagation paths and improve classification performance. Experimental results on the IEEE 39-node system show that the proposed method achieves a recall rate of 78.6% for cascading faults, outperforming SMOTE-GNN by 14.9%. The false alarm rate is reduced by 9.5%, and the macro-average F1-score reaches 87.1%. The results demonstrate that KG-SA-GNN provides an effective solution for imbalanced fault diagnosis in smart grids.

PE2010

A trading settlement analysis model for the southern regional electricity market based on big data intelligent computing

Zhang Ge, Ding Junce, He Shiyang and Wen Qingyang
GuangZhou Power Exchange Center, China

Abstract-In response to the challenges such as massive data processing, complex business rules and real-time requirements faced in the trading and settlement of the southern regional electricity market, this paper proposes an intelligent analysis system framework based on big data technology. By constructing a multi-level data model, designing an intelligent contract execution mechanism, and developing a visual monitoring platform, precise analysis and settlement optimization of the entire power trading process have been achieved. The system performed outstandingly in the pilot application of the electricity spot market in the southern region of China, effectively enhancing the operational efficiency and risk control capabilities of the market.

PE0081

Power System and Reliability Analysis of Geothermal and Hydrogen Storage-Orientated Grid-Connected Smart Grid for Mining and Agricultural Application: A Global Perspective

Md. Nimul Hasan[1], Sk. A. Shezan[2], Md. Fatin Ishraque[1,3], SM Muyeen[4] and Innocent Kamwa[3]
1. Pabna University of Science and Technology, Bangladesh
2. Northern Border University, Saudi Arabia
3. Laval University, Canada
4. Qatar University, Qatar

Abstract-This paper demonstrates a detailed analysis of the behaviour of a hybrid smart grid system that combines with geothermal power and hydrogen energy storage for reliable and sustainable energy supply in the mining and agricultural sectors. When implemented and compared to another existing control strategy called Constant Cosphi Controller, the study reveals that Voltage IQ Droop Controller not only reduces the fault recovery time by around 30% but also stabilizes the system faster. The findings suggest that integrating with a hybrid system leads to both greater energy stability and significant emissions and cost savings. Additionally, integration of renewable sources with smart grid architecture represents a scalable and affordable solution which in turn would mitigate energy challenges specific to industrial sectors. Our findings highlight the demonstrable ability of hybrid renewable energy systems to contribute to sustainable energy generation in industrial and rural settings, providing a basis for evolving from centralised and fickle electricity production towards decentralised, efficient and environmentally benign energy infrastructure.

PE0103

Distribution Network Power Quality and Potential Impact on Electric Vehicle Charging

Mohd Zamri Che Wanik, Muneera Al-Qahtani, Abdullah Abdul Jabbar and Mohamed Khalid Gad
Qatar Environment and Energy Research Institute, Hamad Bin Khalifa University, Qatar

Abstract-This paper investigates power quality (PQ) issues in a residential distribution network in Doha and evaluates their implications for charging electric vehicles (EVs). EV chargers, being power electronic-based devices, are highly sensitive to PQ disturbances such as voltage dips, voltage swells, and voltage unbalances. Using one year of historical data collected from a phasor measurement unit (PMU) monitoring system, the study

identifies and classifies PQ events, including 154 voltage limit violations, 122 voltage unbalance events, 12 voltage dips, and 2 voltage swells. These disturbances frequently exceed the tolerance limits of Level 1 and Level 2 chargers, posing risks of charging interruptions, reduced efficiency, and potential equipment damage. The findings underscore the need for systematic PQ assessments before charger deployment, with corrective actions such as voltage regulation or smart charging strategies recommended to mitigate adverse impacts. This study provides the first Qatar-specific evidence linking existing PQ conditions to EV charging reliability, supporting grid operators and policymakers in planning robust charging infrastructure.

NOTES