5th REPE 2022

Conference Program

2022 5th International Conference on Renewable Energy and Power Engineering

2022年第5届可再生能源和电力工程国际会议

September 28-30, 2022 | VIRTUAL

GMT+8

Co-sponsored by

清华大学 Tsinghua University

IEEE

IEEE PES Power & Energy Society

Hosted by

清华大学 电机工程与应用电子技术系 Department of Electrical Engineering Tsinghua University

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☆ **Virtual Background.jpg** (click)

☆ **Electronic Banner.jpg** (click)

Welcome Address

Dear All,

Welcome to attend the 2022 5th International Conference on Renewable Energy and Power Engineering!

Due to COVID-19 is a worldwide pandemic, we have made a difficult decision to convert REPE 2022 to fully virtual conference again after considering the safety and well-being of our participants is of paramount importance to us. We were looking forward to seeing everyone face to face, but we are excited for the opportunity to innovate by creating an engaging virtual conference that will be rewarding for both presenters and attendees.

The objective of the conference is to provide a premium platform to bring together researchers, scientists, engineers, academics and graduate students to share up-to-date research results. We are confident that during this time you will get the theoretical grounding, practical knowledge, and personal contacts that will help you build a long term, profitable and sustainable communication among researchers and practitioners in the related scientific areas.

We would like to express our gratitude to our distinguished speakers: Prof. Loi Lei Lai, from Guangdong University of Technology, China; Prof. Jizhong Zhu, from South China University of Technology, China; Prof. Chunzhi Zhang, from Beijing Institute of Electrical Safety, China and Prof. Fei Teng, from Imperial College London, UK and other distinguished scholars for sharing their deep insights on future challenges and trends in the conferences.

Special thanks to our committee members, all the reviewers, researchers and students who participate in the conference.

Hope you could enjoy the conference and have an unforgettable experience!

Conference Organizing Committees

VooV Meeting(腾讯会议) Guidance-1

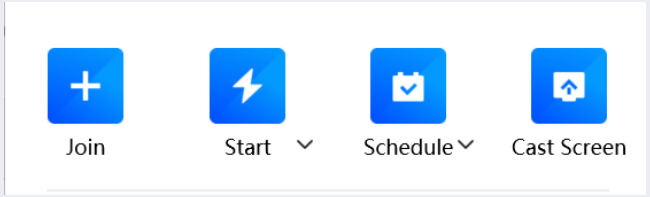
Download

No Sign-in

You can join the meeting without sign-in process.
Just put the meeting ID and join us.

Download

URL (For Foreigner Delegates) :
https://voovmeeting.com/
URL (For Chinese Delegates):
https://meeting.tencent.com/download

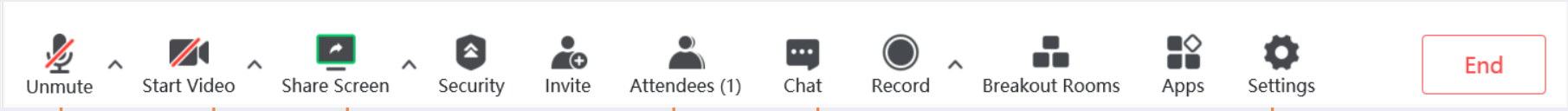


Join a Meeting

Each meeting has a unique **9, 10, or 11-digit** number called a **meeting ID** that will be required to join a VooV Meeting(腾讯会议).

Assistant

For any questions on the meeting day, you can text privately to “Assistant” for help.



Audio muted and video off (both indicated by a red slash).

To share screen or contents.

To see all participants.

Click to open the Chat box.

To set “General” or “Background”.

VooV Meeting(腾讯会议) Guidance-2

Room ID

MI: 752 5636 7809 (Room A)
MI: 527 2797 5015 (Room B)
MI: 657 3929 8689 (Room C)

Room will be open 30 mins in advance.

01

Rename ID

Keynote Speaker: Keynote-Full Name
Committee: Position-Full Name
Author: Paper ID-Full Name
Listener: Listener-Full Name

02

Test Time

Check details of your testing time **September 28, 2022 (GMT+8)**, and please make sure to show up on time.

03

Time Zone

GMT+8
Please be aware of time difference between this and your region/country.

04

Presentation Tips

Conference room will be available 30 mins before the conference scheduled time. Please enter the meeting room 10-15 minutes earlier.

A best presentation selected by session chair for each session will be given a certificate for his/her excellent work.
Each presentation will be given a ceritificate after conference by email.

Please unmute audio and start video during your presentation. There will be different meeting ID for system test and technical sessions, please check your allocated system VooV Meeting(腾讯会议) ID carefully.

Each paper will be presented by the author making a 15-minute presentation within the virtual conference. Authors will also be required to be available for a Q&A section on their paper. Authors that do not meet both these requirements will be considered "no-shows."

VooV Meeting System Test Timetable GMT+8, Sep. 28

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

10:00-10:50	10:50-11:40	13:30-14:20	14:20-15:10
EP021	EP006	EP033	EP063
EP023	EP067	EP018	EP012
EP015	EP034	EP035	EP027
EP088	EP042	EP005	EP038&EP040
EP095	EP058	EP029	EP048
EP046	EP061	EP071	EP064&EP065
EP070	EP062	EP1011	EP074
EP078	EP085	EP093	EP1009
EP086	EP041	EP092	EP053&EP054
EP036	EP025	EP094	EP1004

Note

a) **15:10-16:00** alternative time for participants who are unavailable at allocated time

b) We will test control panel including screen sharing, audio, video and “Raise Hand” function, etc. Please get your presentation slides and computer equipment prepared beforehand.

c) All the presenters are required to join the test on **September 28, 2022**, to ensure the next two-day meeting runs smoothly.

VooV Meeting System Test Timetable GMT+8, Sep. 28

Meeting ID (Room B): 527 2797 5015
Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7

10:00-10:50	10:50-11:40	13:30-14:20	14:20-15:10
EP037	EP026	EP013	EP1008-A
EP097	EP030	EP008	EP052
EP049	EP1005-A	EP069	EP080
EP045	EP089	EP084	EP082
EP091	EP043	EP1003	EP011
EP051	EP032	EP019	EP031
EP047	EP039	EP056	EP044
EP068	EP057	EP079	EP060
EP1002	EP007	EP096	EP081
EP028	EP024	/	/

Note

a) **15:10-16:00** alternative time for participants who are unavailable at allocated time

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c) All the presenters are required to join the test on **September 28, 2022**, to ensure the next two-day meeting runs smoothly.

Meeting Agenda GMT+8 Sep. 29

Keynote Session

Meeting ID (Room A): 752 5636 7809 Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Time	Activity	Speaker
Chairman: **Assoc. Prof. Qingguang Yu**, Tsinghua University, China (**Local Organizing Chair**)		
08:50-09:00	**Opening Remarks**	**Prof. Qinglai Guo** IET Fellow / IEEE senior member / CIGRE member Tsinghua University, China
09:00-09:45	**Speech I + Q&A** Smart Energy and Standards Development	**Prof. Loi Lei Lai** IEEE Life Fellow / IET Fellow, Guangdong University of Technology, China
09:45-10:30	**Speech II + Q&A** New-type Power System Operation under the Dual Carbon Target	**Prof. Jizhong Zhu** IEEE Fellow, South China University of Technology, China
10:30-11:00	**Break & Group Photo**	
11:00-11:45	**Speech III + Q&A** Research on Application of Cable Fault Intelligent Monitoring and Protection Technology	**Prof. Chunzhi Zhang** Beijing Institute of Electrical Safety, China
11:45-14:00	**Lunch Break**	
14:00-14:45	**Speech IV + Q&A** Operation of Power Systems with High Penetration of IBRs towards Carbon-Neutrality: A Stability-constrained Optimization Approach	**Prof. Fei Teng** Imperial College London, UK
14:45-15:00	**Break Time**	

Meeting Agenda GMT+8 Sep. 29

Oral Sessions

Time	Activity (Each talk including 2-3mins for Q&A)	Meeting ID
15:00-17:15	**Session 1: Load Prediction Model and Calculation in New Power System** EP021, EP023, EP015, EP088, EP095, EP046, EP070, EP078, EP086	**Meeting ID (Room A): 752 5636 7809** Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2
15:00-17:30	**Session 2: Power System Operation and Condition Monitoring** EP036, EP006, EP067, EP034, EP042, EP058, EP061, EP062, EP085, EP041	**Meeting ID (Room B): 527 2797 5015** Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7

Meeting Agenda GMT+8 Sep. 30

Oral Sessions

Time	Activity (Each talk including 2-3mins for Q&A)	Meeting ID
09:00-11:45	**Session 3: Wind Forecasting and Wind Power Generation** EP025, EP033, EP018, EP035, EP005, EP029, EP071, EP1011, EP093, EP092, EP094	**Meeting ID (Room A): 752 5636 7809** Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2
09:00-11:45	**Session 4: Fault Diagnosis and Safety in Power System** EP063, EP012, EP027, EP038, EP048, EP064, EP074, EP065, EP1009, EP053, EP1004	**Meeting ID (Room B): 527 2797 5015** Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7
09:00-11:45	**Session 5: Modern Power Electronic Technology and Application** EP037, EP097, EP049, EP045, EP091, EP051, EP047, EP068, EP1002, EP028, EP026	**Meeting ID (Room C): 657 3929 8689** Meeting Link: https://meeting.tencent.com/dm/slgEQI5FTOBI
11:45-13:00	**Lunch Break**	
13:00-15:30	**Session 6: Mechatronics and New Energy Drive Technology** EP030, EP1005-A, EP089, EP043, EP032, EP039, EP057, EP007, EP040, EP024	**Meeting ID (Room A): 752 5636 7809** Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2
13:00-15:15	**Session 7: Distribution Network Operation and Grid Dispatch** EP054, EP013, EP008, EP069, EP084, EP1003, EP019, EP056, EP079	**Meeting ID (Room B): 527 2797 5015** Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7
13:00-15:30	**Session 8: Integrated Energy Systems and Management** EP096, EP1008-A, EP052, EP080, EP082, EP011, EP031, EP044, EP060, EP081	**Meeting ID (Room C): 657 3929 8689** Meeting Link: https://meeting.tencent.com/dm/slgEQI5FTOBI

Opening Speech GMT+8 Sep. 29

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Speech Time
08:50-09:00

IET Fellow / IEEE senior member / CIGRE member
Prof. Qinglai Guo, Tsinghua University, China

Bio: Dr. Qinglai Guo（B.Sc. '00, Ph.D. '05, both from Tsinghua University, Beijing, China）is currently a professor in Dept. of E.E., Tsinghua University. In 2015, he was awarded the National Science Fund for Excellent Young Scholars. In 2016, he was awarded the Mao Yisheng Beijing Youth Technology Award. In 2017, he was awarded the Yangtze River Young Scholar. In 2018, he was awarded the Beijing Science Fund for Distinguished Young Scholars. In 2020, he was awarded the Special Prize of China Science & Technology Award for Young Scholars (only 10 winners every two years in China). His research interests include Energy Management System, Voltage Stability and Control, and Cyber-Physical System.

He is now an IET Fellow, IEEE senior member and a CIGRE member, and is involved in 5 workgroups of these two organizations. Now he is TCPC of Energy Internet Coordinating Committee of IEEE PES, the co-chair of IEEE PES Work Group on “Energy Internet”, IEEE PES Task Force on “Cyber-Physical Interdependence for Power System Operation and Control”, and IEEE PES Task Force on “Voltage Control for Smart Grid”. He is an editorial member of “IEEE Transactions on Power Systems”, “Renewable & Sustainable Energy Reviews”, “IEEE Transactions on Smart Grid”, and other 5 international journals.

Keynote Speech **GMT+8 Sep. 29**

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Speech Time
9:00-09:45

IEEE Life Fellow / IET Fellow
Prof. Loi Lei Lai, Guangdong University of Technology, China

Speech Title: Smart Energy and Standards Development

Abstract: In this talk, smart energy will be defined and how this can contribute to carbon neutral and living standards will be looked at. The opportunities and challenges will be investigated and standards development to promote smart energy will be reviewed. Some real-life examples in clean energy, transportation, health, and wireless communication will be used to demonstrate the requirements needed.

Bio: Loi Lei Lai received the B.Sc. (First Class Hons.), Ph.D., and D.Sc. degrees in electrical and electronic engineering from the University of Aston, Birmingham, UK, and City, University of London, London, UK, in 1980, 1984, and 2005, respectively.
Professor Lai is currently a University Distinguished Professor with Guangdong University of Technology, Guangzhou, China. He was a Pao Yue Kong Chair Professor with Zhejiang University, Hangzhou, China, and the Professor and Chair of Electrical Engineering with City, University of London. His current research areas are in smart cities and smart grid. Professor Lai was awarded an IEEE Third Millennium Medal, the IEEE Power and Energy Society (IEEE/PES) UKRI Power Chapter Outstanding Engineer Award in 2000, a special award from City, University of London in 2005 and is its honorary graduate, the IEEE/PES Energy Development and Power Generation Committee Prize Paper in 2006 and 2009, the IEEE/SMCS Outstanding Contribution Award in 2013 and 2014, the Most Active Technical Committee Award in 2016, and his research team received a Best Paper Award in the IEEE International Smart Cities Conference in October 2020.
Professor Lai is an Associate Editor of the IEEE Transactions on Systems, Man, and Cybernetics: Systems, Editor-in-Chief of the IEEE Smart Cities Newsletter, a member of the IEEE Smart Cities Steering Committee and the Chair of the IEEE Systems, Man, and Cybernetics Society (IEEE/SMCS) Standards Committee. He was a member of the IEEE Smart Grid Steering Committee; the Director of Research and Development Center, State Grid Energy Research Institute, China; a Vice President for Membership and Student Activities with IEEE/SMCS; and a Fellow Committee Evaluator for the IEEE Industrial Electronics Society. He is a Fellow of IET and Life Fellow of the IEEE.

Keynote Speech **GMT+8 Sep. 29**

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Speech Time
09:45-10:30

IEEE Fellow
Prof. Jizhong Zhu, South China University of Technology, China

Speech Title: New-type Power System Operation under the Dual Carbon Target

Abstract: In general, the research and construction of new type power system is an inevitable choice under the background of increasingly prominent energy and environmental issues. Because the traditional power systems cannot cope with the three new challenges of “multi-energy flow, multi-scale, multi-agent”, theoretical breakthroughs are urgently needed for new type power system. Building a new type power system can help break barriers between traditional power systems, address new challenges, and increase the accommodation of renewable energy.

Bio: Jizhong Zhu is a Professor of South China University of Technology, and National Distinguished Expert. He is an IEEE Fellow, IET Fellow, CSEE Fellow, Chair of IEEE Standard IEEE P2781 WG and P2783 WG, Chair of IEEE PCCC SBLC Technical Committee, IEEE SMC Intelligent Power and Energy Systems Technical Committee member. He has been an Expert of IEEE 2030.9 Standard WG on Micro-grids, Expert of International Electrotechnical Commission WGs IEC SEG6, IEC TC22 AHG1, IEC TC22 AHG2, respectively, and Chair of IEEE SBLC Load Subcommittee as well as Chair of IEEE SBLC Asia-Pacific Working Group. Dr. Zhu has worked at ALSTOM Grid Inc. in Washington State, Howard University in Washington, D.C., the National University of Singapore, Brunel University in England, and Chongqing University and CSG in China. He was a Senior Principal Engineer as well as a Fellow with ALSTOM Grid Inc., and an honorable advisory professor of Chongqing University. He has published six books as an author and co-author, as well as about three hundred papers in the international journals and conferences. His research interest is in the analysis, operation, planning and control of power systems, smart grid, power markets as well as applications of renewable energy.

Keynote Speech **GMT+8 Sep. 29**

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Speech Time
11:00-11:45

Prof. Chunzhi Zhang, Beijing Institute of Electrical Safety, China

Speech Title: Research on Application of Cable Fault Intelligent Monitoring and Protection Technology

Abstract: As the main carrier of power transmission, cable plays an important role in the safe and stable operation of power system. At present, there is a lack of effective monitoring means for cables in the distribution network, and daily maintenance is also difficult to achieve timely and efficient, leading to electrical safety accidents caused by cable hazards from time to time. In view of the problems that it is difficult to find cable aging, damage and other faults, and the poor protection effect of traditional automatic fire extinguishing system against cable fire, this research proposes to combine the automatic electrical fire extinguishing system, Internet of Things technology and cable fault location technology based on frequency domain reflection method to build a new intelligent cable fault monitoring and protection system, which realizes cable hidden danger early warning, real-time data monitoring, rapid fire response and Fire-fighting zoning control.

Bio: Chunzhi Zhang received the Ph.D. degrees from the China University of Mining and Technology (Beijing). Professor Zhang is currently the director of Beijing Institute of Electrical Safety, a leading talent in Beijing's high-tech innovation plan, and a famous teacher in Beijing's colleges and universities. Her research focuses on key technologies in electrical safety and electromechanical field. Professor Zhang has successively developed more than 10 new products for the enterprise, published more than 30 papers. She hold 22 patents of China.

Keynote Speech **GMT+8 Sep. 29**

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Speech Time
14:00-14:45

Prof. Fei Teng, Imperial College London, UK

Speech Title: Operation of Power Systems with High Penetration of IBRs towards Carbon-Neutrality: A Stability-constrained Optimization Approach

Abstract: Power systems are facing new challenges in system operation, security and stability towards Carbon-Neutrality, due to the large-scale integration of Inverter-Based Resources (IBRs). In this talk, I will present a new generation of optimal system operation strategies to maintain the security and stability of the grid at a minimum cost. On one hand, the dynamics-based stability constraints are derived and incorporated into the system scheduling model. On the other hand, the fast and accurate control capabilities of the IBRs are modelled in the optimization problem, which connects the device-level control and system-level optimization to maximize the overall economic benefit. Specifically, I will focus on the challenges in different areas ranging from frequency and low inertia issues to short circuit current shortage and voltage problems in high IBG-penetrated systems. The impacts of different stability constraints on system operating conditions and operational cost as well as their interactions are also investigated.

Bio: Dr Fei Teng received BEng from Beihang University (BUAA), China in 2009 and PhD from Imperial College London in 2015. He is currently the Director of Education in Energy Futures Lab, a panuniversity hub promoting inter-disciplinary research in energy, and a Senior Lecturer in the Department of Electrical and Electronic Engineering, Imperial College London. He also holds visiting positions at MINES ParisTech, France and PolyU, Hong Kong. His research focuses on the power system operation with high penetration of Inverter-Based Resources (IBRs) and the Cyber-resilient and Privacy-preserving cyber-physical power grid. He is the editor of several international journals published by IEEE, IET, Elsevier and Springer, including the IEEE Transactions of Power Systems and IEEE Open Access Journal of Power and Energy. He has authored more than 80 scientific publications in leading power system journals and conferences. His research has been funded by EPSRC, ESRC, Innovate UK, Research England, Royal Society, EDF Energy, Hitachi, and National Grid ESO.

Oral Session 1 GMT+8 Sep. 29

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Topic: Load Prediction Model and Calculation in New Power System
Time: 15:00-17:15

Session Chair
Dr. Rui Xie, Tsinghua University, China

Time	Paper ID	Presentation
15:00-15:15	**EP021**	Load balance and recovery optimization of distribution network based on binary particle swarm optimization algorithm **Yuhui Ma, Nanjing Haoqing Information Technology Co., Ltd, China** Abstract— With the rapid increase of electricity load, the distribution network is prone to line load imbalance or even power outage faults caused by line damage during operation, so it is extremely important to optimize the load balance of the distribution network and ensure the stable operation of the power grid. Firstly, in this paper, when the load is unbalanced, a line load balancing strategy for the reconstruction of the distribution network with network loss and load balance index as the optimization goals is proposed to maintain the line load balance while ensuring the economy. Further, considering the power failure caused by line damage, a node load recovery strategy for the reconstruction of the distribution network with additional consideration of node voltage drop and minimization of power loss load is proposed to ensure the balance of line load and the improvement of power quality while maximizing the recovery load. Finally, the above optimization model is solved by using the binary particle swarm optimization algorithm based on split-loop substitution, and the simulation is verified on the IEEE-33 node model, which shows that the proposed algorithm can balance the line load well, and in the event of power failure, the lost power load can be restored to the greatest extent, which greatly improves the operational toughness of the power grid. This work was financially supported by the State Grid Shanghai Electric Company(52094021N002).

Time	Paper ID	Presentation
15:15-15:30	**EP023**	Research on the identification method of vulnerable lines along the CZ railway considering the uncertainty of traction load **Yuze Tong, Southwest Jiaotong University, China** Abstract— Aiming at the extremely weak power grid along the CZ railway and the uncertainty of forward and reverse traction loads, a method for identifying vulnerable lines of power system considering the uncertainty of traction loads is proposed. Firstly, the probabilistic power flow section of the system is calculated using the simulated high-speed railway load curve. Then, a high-risk power flow section discrimination algorithm is constructed using random matrix theory to extract high-risk power flow sections. Immediately after that, the correlation network of the power grid is established by using the dual graph under the high-risk section, and then the weighted z-index is proposed, which is applied to the correlation network to identify the vulnerable lines. Finally, the accuracy and effectiveness of the proposed method are verified in the simulation of the power grid along the CZ railway.
15:30-15:45	**EP015**	Short-Term Load Forecasting Model Based on Multi-Feature Fusion of Long Short-Term Memory Network **Chao Jin, Hohai University, China** Abstract— With the continuous development of China's economy and the popularity of Internet of Things and intelligence, the use of power load forecasting in production an life has deepened in proportion. In this paper, multiple influencing factors of electric load are considered, and in terms of model selection, a multivariate Long Short-Term Memory (LSTM) model considering external multi-feature factors is adopted based on the LSTM network model in deep learning in order to avoid phenomena such as long-term dependence on the network and gradient disappearance. By adding a fully connected layer, it is made to analyze all external feature factors in a weighted manner and fuse the whole features through the connected layer before output to achieve the optimal output. To verify the accuracy and improvement advantages of the model, historical electricity load data of a region in 2012 are used for training forecasts. A comparison test is set up to predict the load of the last month in the sample by the improved model and the LSTM model respectively, and the results show that the former has better prediction accuracy with a MAPE value of 4.94%.

Time	Paper ID	Presentation
15:45-16:00	**EP088**	Short-term load forecasting method of TPA-LSTNet model based on time series clustering **Zhuyun Li, China Southern Power Grid Technology Co., Ltd., China; Waseda University, Japan** Abstract— To provide a stronger guarantee for the power system's stable operation, improving the accuracy of short-term load peak prediction is necessary. This paper proposes a short-term load prediction model TPA-LSTNet that combines TPA (Temporal Pattern Attention) and LSTNet and combines the K-Shape time series clustering method. First, collect external information on the corresponding date of the data, such as daily temperature, humidity, wind direction, whether it is a holiday, Etc. Firstly, using the characteristics of high precision and high efficiency of the K-Shape algorithm, cluster analysis is carried out on the electricity load data in the station area. Then combine the data with external information and input it into the TPA-LSTNet model to extract time series features and train the model. Finally, the prediction of short-term power load is realized using the trained model. The predicted results on an existing urban distribution network verify the prediction accuracy of the method.
16:00-16:15	**EP095**	A transferable load management contract model based on mechanism design theory **Liaoyi Ning, Anshan Power Supply Company of State Grid Liaoning Electric Power Co. LTD, China** Abstract— In the electricity market environment, the information asymmetry between power grid companies and users may lead to the inefficient planning and implementation of demand response (DR) projects. Therefore, this paper proposes a transferable load management contract model based on mechanism design theory to improve the flexibility and operability of users with transferable load to participate in day-ahead scheduling of power system. In this model, the user type parameter is introduced to describe the user's willingness to participate in the transferable load management contract, the rational behavior of the user participating in the contract transaction is reflected by the personal rational constraint, and the incentive compatibility constraint is used to urge the user to report the real type parameter in the transaction process. Under this mechanism, according to the type of users reported by the users, the power grid company uses the incentive mechanism to encourage users to actively participate in load transfer, and restricts the response behavior of users through the form of contract, which can reduce the uncertainty of the implementation of demand response and improve the economy and environmental protection of the power grid operation. In this paper, through the analysis of a numerical example, it is verified that the mechanism can effectively stimulate the potential of user transfer load, realize the optimal allocation of transferable load, which is beneficial to reduce the economic cost of the system, reduce carbon emissions, and improve the overall social benefits.

Time	Paper ID	Presentation
16:15-16:30	**EP046**	Optimal Allocation of Electrochemical Energy Storage of Source-Grid-Load Sides in Power System Considering Social Benefit **Miao Yu, North China Electric Power University, China** Abstract— To improve the comprehensive utilization of three-side electrochemical energy storage (EES) allocation and the toughness of power grid, an EES optimization model considering macro social benefits and three-side collaborative planning is put forward. Firstly, according to the principle that conventional units and energy storage help absorb new energy output fluctuation, the EES operation mode is determined. Secondly, a comprehensive economic model is established considering the social benefit of EES, covering energy saving and emission reduction on the power generation side, reduction of power grid line loss and power outage loss on the grid side, and delay of equipment loss and backup configuration on the user side. The overall goal of model is to maximize the macro social benefit. Finally, the Nondominated Sorting Genetic Algorithm with Elitist Strategy (NSGA-II) is applied for the multi-objective majorization model, and an example is analyzed based on the improved IEEE 30-node network, providing a reference for the allocation of EES in electric system.
16:30-16:45	**EP070**	Non-intrusive Load Monitoring based on Multiple Feature Optimization and Genetic Algorithm **Lei Lu, State Grid Hebei Electric Power Co., Ltd. Shijiazhuang Power Supply Branch, China** Abstract— Load monitoring is an important part of smart utilization. To address the problem of low accuracy of current non-intrusive load monitoring methods in identifying multi-state loads and loads with similar power, this paper proposes a multi-feature genetic optimization method considering state probability factors. The algorithm selects the active power and the amplitude of the third harmonic current as the research characteristics, and uses clustering by fast search and find of density peaks (CFSFDP) clustering algorithm to construct the load characteristic template. Based on the traditional genetic optimization objective algorithm, the state probability factor is added as an auxiliary feature to further improve the identification degree of similar loads. The performance of the algorithm is evaluated on The Reference Energy Disaggregation Data Set (REDD). The simulation results show that the above method can effectively improve the accuracy and outperform existing algorithms.

Time	Paper ID	Presentation
16:45-17:00	**EP078**	A Hierarchical Classification method for Type II Appliance Recognition in NILM **Zhaoqing Zhang, Shandong University, China** Abstract— Complex load patterns of multi-state appliances, also known as type II appliances, make trouble for appliance recognition by non-intrusive load monitoring (NILM). We solve this problem by decreasing the impact of intra-class variety (IACV) and inter-class similarity (IECS) caused by type II appliances. In this paper, an agglomerative hierarchical clustering (AHC) method is used to overcome the IACV while a comprehensive feature set is used to overcome the IECS. Considering the impact of IACV and IECS together, a hierarchical classifier is introduced to improve performance on appliance identification. The experimental results on public NILM datasets validate the effectiveness of the proposed method.
17:00-17:15	**EP086**	Data-driven turbine modeling and load rejection analysis **Xuan Liu, China University of Mining and Technology (Beijing), China** Abstract— The full characteristic model of hydraulic turbine must be considered in the research of control and transition process calculation of hydraulic turbine generator unit. In order to obtain the full characteristic model of hydraulic turbine, it is indispensable to reasonably extend the high-efficiency working condition characteristic area to the low-efficiency area according to the comprehensive characteristic curve. In this paper, BP(back propagation) neural network is used to process the comprehensive characteristic curve of hydraulic turbine to obtain the full characteristic model. In view of the defects of traditional BP neural network, such as slow convergence speed, long training time and easy oscillation in the learning process, BP neural network is improved. The improved BP neural network is used to train the model of flow and torque characteristics, and then the full characteristic model of hydraulic turbine is trained by using the value point to extend the flow and torque characteristic data. Experiments demonstrate that the full characteristic model established by the improved BP neural network algorithm has higher accuracy. Finally, the full characteristic model is used to calculate the load rejection transition process. The results demonstrate that the full characteristic model is suitable for the calculation of hydraulic turbine transition process and meets the requirements of engineering application.

Oral Session 2 GMT+8 Sep. 29

Meeting ID (Room B): 527 2797 5015
Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7

Topic: Power System Operation and Condition Monitoring
Time: 15:00-17:30

Session Chair
Dr. Zhanpeng Xu, Huadong Engineering Corporation Limited, China

Time	Paper ID	Presentation
15:00-15:15	**EP036**	The influence of carbon price on the transmission cost of UHV power system **Caixing Liu, Beijing Jiaotong University, China** Abstract— The carbon peaking and carbon neutrality goals in China will further promote the collecting of carbon emission tax. This change of carbon emission policy will have an important impact on the economy of UHV power system. Due to the carbon price influence the economy of different transmission lines, we construct a economic evaluation model of UHV power system including carbon price to analysis the cost of per kilowatt hour of transmission. This model is based on the life-cycle cost theory（LCC）. From the aspects of cost and revenue, we construct the comparative evaluation models are adopted to evaluate the economy and cost per kilowatt hour of UHV power system. One model is considering the carbon emission quota and the other isn't consider the quota. These models providing theoretical basis for the planning and construction of UHV power system. Finally, we use case study to analyze electricity cost per kilowatt hour of UHV power transmission under different carbon prices. The case verified the influence of carbon price on the economics of UHV power system.

Time	Paper ID	Presentation
15:15-15:30	**EP006**	HR Control Strategy Based on Phase Compensation for LCL Grid-Connected Inverters in Weak Grid **Zhihang Luo, Harbin Institute of Techonlogy, China** Abstract— With the large-scale development of renewable energy, distributed power generation represented by voltage source type grid-connected converters with inductor–capacitor–inductor (LCL) filter is increasingly used in power systems. Aiming at the problem that the increase of grid impedance in the weak grid reduces the system bandwidth, which leads to the instability of multiple harmonic resonant (HR) control, this paper proposes an improved HR current control strategy for LCL grid-connected inverters. The traditional HR control is improved by phase compensation to avoid the -π line crossing caused by the sudden phase change. The weak grid adaptability of traditional and phase-compensated HR control is analyzed and simulated respectively. And the results shows that the current THD is only 1.57% with improved HR control when the weak grid inductance is 3mH, which can effectively improve the system stability and robust performance under weak grid conditions.
15:30-15:45	**EP067**	Improved Finite-Control-Set Model Predictive Control of BLDC Motors Driven by Three-Phase-Four-Leg Inverters **Tianhao Zhang, Shenzhen University, China** Abstract— This paper presents an improved finite-control-set model predictive control （FCS-MPC） of brushless DC (BLDC) motors driven by three-phase-four-leg inverters. In the conventional MPC of BLDC motors based on three-phase-four-leg drivers, more harmonic currents can be introduced which will deteriorate the steady-state performance of the system. In this paper the concept of duty cycle control is employed to MPC for motor drives. This novel method allocates an active voltage vector in a fraction of one control period and a null vector in the rest of the period, the duration of the active voltage vector is determined by minimizing the cost function to optimize the current flowing into the motor. In addition, the fixed switching frequency of the inverter can be realized by appropriately inserting the action time of zero vector in one cycle through vector modulation. Compared with the conventional method, the simulation results show that the proposed method can further reduce the steady-state torque and reactive power ripples.

Time	Paper ID	Presentation
15:45-16:00	**EP034**	Decoupled Piecewise Linear Relaxation for the AC Optimal Power Flow Problem **Zhe Lv, Tsinghua University, China** Abstract— Power system are witnessing fundamental changes with increasing renewable power generation. It is necessary to further consider voltage and reactive power in the optimal power flow (OPF) problem. OPF based on linear power flow models is efficient and reliable. However, conventional linear OPF methods cannot ensure high solution accuracy especially for reactive power and voltage. Hence, this paper proposes a decoupled piecewise linear relaxation method for the OPF problem. The cosine terms are retained and piecewise relaxed. The results show the proposed method improves the approximation accuracy of reactive power and voltage while the computation burden is still acceptable.
16:00-16:15	**EP042**	A bi-level electricity flow planning model for new power system **Yiding Sun, North China Electric Power University, China** Abstract— With the introduction of the “Double Carbon” strategy, the installed capacity of renewable energy generation in the power grid is increasing day by day, and the traditional power system planning methods are no longer applicable to this new power system with a high proportion of renewable energy access. However, combining the background of the “Double Carbon” strategy and making reasonable planning for the new power system from multiple dimensions is an important issue to be solved. In this paper, based on the scenario analysis method, we generate a set of scenarios in different horizontal years, which are based on the uncertainty of load growth rate and the uncertainty of thermal power unit decommissioning in the context of “Double Carbon”. By analyzing the upper-level objectives and the lower-level objectives, we construct the bi-level electricity flow planning model of the new power system, which is based on the hierarchical sequence method. Among the bi-level model, the upper-level objectives are based on the characteristics of the traditional power system, and the lower-level objectives are based on the characteristics of new energy generation. Finally, the paper uses the improved Garver 6-bus system as an example to evaluate the planning of the new power system from a diversified perspective to verify the feasibility and correctness of the model.

Time	Paper ID	Presentation
16:15-16:30	**EP058**	A Blockchain based Federal Abnormal Detection Method for Power Dispatching Systems **Dongdong Huo, Institute of Information Engineering, CAS, China** Abstract— With the improvement of the network technology, power dispatching systems (PDS) are increasingly attacked from the Internet. Due to the limitations and regulations in laws and local management requirements, it is difficult for such systems to form a joint force to detect the security status while ensuring the privacy of each system's data. Aiming at this issue, this paper proposes a blockchain based federal abnormal detection method for power dispatching systems. The method provides a tree based federal-privacy-training scheme to aggregate data from various power scheduling systems, and generates a model with higher detection accuracy on the basis of not leaking the plaintext of these data. Moreover, the blockchain is used to connect dispatching systems across areas to enable the secure transfer of data between these systems. The experimental results show that this method not only improves the accuracy for detecting attacks, but also ensures the privacy of the data among PDSs.
16:30-16:45	**EP061**	Modeling of medium and long-term transaction behavior of generators based on Bayesian network **Chuhao Wang, Nanjing Normal University, China** Abstract— With the advance of the new electricity reform, the annual planned electricity quantity of China's electric power system is gradually replaced by medium and long term transaction electricity quantity. Regardless of the electricity market participants of the medium and long term trading the imbalance of the uncertainty of market behavior, capacity, or trading results randomness factors such as power grid operation mode of the unexpected, results in uneven distribution of tidal current and power grid operation safety margin decline, increased the complexity of the system operation arrangement, may lead to serious power system security. Therefore, based on the Dynamic Simulation Platform for Macro-energy Systems, this paper develops the application of electricity market transaction Simulation based on the hybrid Simulation method of combining computer agent model and experimental economics. Combined with statistical analysis, causality analysis and behavior analysis three research paradigms to analyze the medium and long term trading behavior of power producers. Firstly, the key driving factors of power producers' trading behaviors in the electricity market are explored by combining expert knowledge, prior knowledge and relevant literature. Based on this, a proxy model of trading behaviors with the same distribution characteristics as real participants' trading behaviors is established by using Bayesian network model, and its validity is verified.

Time	Paper ID	Presentation
16:45-17:00	**EP062**	Design and Implementation of the Substation Intelligent Auxiliary Control System Based on OPC UA **Xiaoyu Zhao, Fudan University, China** Abstract— At present, the traditional substation auxiliary control system is faced with the following four problems: poor real-time capability to abnormal response, high dependence on people when solving malfunctions, the communication, deployment and expansion of different underlying devices, and the lack of security mechanism. To solve these problems or optimize the functions, an intelligent substation auxiliary control system is proposed. The system innovatively applies OPC UA to the construction of the auxiliary control system. First, through the use of OPC UA's unique object-oriented modeling method as well as the joint specification modeling of OPC UA and IEC61850, to solve the data communication problems caused by heterogeneous devices. Second, applying the Client/Server mode to realize the remote access from authorized mobile clients and give instructions, to cope with abnormal conditions , which reduces the dependency on people . Clients of other authorized enterprises are allowed to access the working data of the devices they are interested in, makes full use of massive data and ensures the information security of the system. Third, Pub/Sub mode is applied to enable the underlying devices to communicate directly with each other through the middleware, which reduces the response time of equipment joint debugging and improve the real-time performance. In addition, through OPC UA, the industrial data of the system can be transmitted over the Internet, realizing the combination of the Internet of Things and the Internet, which is an idea of the combination of the two in the future.
17:00-17:15	**EP085**	Design of Energy Supply Device for Online Monitoring Equipment of Power Transformer **Zihan Zhang, China University of Geosciences, Wuhan, China** Abstract— During the routine inspection of devices in the existing power system, a series of parameters such as temperature, pressure, flow, and magnetic field must be obtained in time to ensure the security and stability of the system. Therefore, the stable operation of monitored devices in the system must be ensured. However, one of the key problems of the monitoring equipment in the system is the power supply problem, so this paper proposes a design method of the power supply device for the online monitoring equipment of the power transformer. The device is based on the law of electromagnetic induction, by cutting the magnetic induction line, the coil generates induced electromotive force; At the same time, the three-dimensional model of structural mechanics and two-dimensional axisymmetric model of magnetic field of the device were established by using simulation software. Finally, the effective value of the output voltage of the device is 3.9V and the output power is 14.45mW. The device has the advantages of simple structure, small size, simplicity and universality, which is conducive to the development of intelligent integrated monitoring system of transformer operation status, and improves the operation level of transformer to a certain extent.

Time	Paper ID	Presentation
17:15-17:30	**EP041**	Research on new power system planning based on improved particle group algorithm **Zhanpeng Xu, Huadong Engineering Corporation Limited, China** Abstract— In the traditional sense, the dispatching objective function of power system can control the total fuel cost at the lowest level, but it does not consider the pollution substances composed of fossil fuels and their cost. Therefore, in the case of an increasingly strong demand for ecological and environmental protection, in view of the new energy planning and construction of power system scheduling scheme, emissions are regarded as the constraint condition of scheduling function, and a better variable search radius optimization multi-objective particle swarm optimization system model is constructed, and simulation analysis is conducted based on the new energy power system in a certain region. The final results show that the improved PSO is more effective than the traditional PSO.

Oral Session 3 GMT+8 Sep.30

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Topic: Wind Forecasting and Wind Power Generation
Time: 09:00-11:45

Session Chair
Assoc. Prof. Hamed Badihi, Nanjing University of Aeronautics and Astronautics, China

Time	Paper ID	Presentation
09:00-09:15	**EP025**	High-proportion Wind Power System Risk Scheduling Considering Peak Regulation and Frequency Safety **Huicong Zheng, Dalian University of Technology, China** Abstract— With the development of the novel power system under the “carbon peaking and carbon neutrality” goal, the problem of frequency regulation and peak regulation caused by the fluctuation characteristics of wind power is highlighted. It is necessary to fully consider the influence of wind load fluctuation on reserve optimization and verify the frequency stability of the system under the disturbance of power shortage when formulating the day-ahead unit commitment scheme. In view of this, the virtual inertia control and load shedding control of wind power are added to the frequency analytic expression. The linearized frequency nadir is added in unit commitment optimization model. Based on the conditional risk value theory, the risk scenarios of wind power and load uncertainty are considered to the optimization of spinning reserve, the unit commitment scheme meeting the demand of risk peak regulation and frequency safety is obtained.

Time	Paper ID	Presentation
09:15-09:30	**EP033**	Variation Rule of Wind Speed and Its Influence on the Fast Frequency Response of Wind Turbine Generator **Ping Liu, Hohai University, China** Abstract— The equivalent inertia of the power system has been significantly reduced with the massive adoption of new energy generation and equipment with power electronic interfaces. Many countries require wind power generation to be capable of offering a fast frequency response (FFR) when deviations in power system frequency occur. Because the FFR covers a short duration, the wind speed variation during this period has been largely ignored in previous studies. In this paper, we paid attention to the wind speed variation rule within a 15 s time frame. By analyzing the measured data of a wind farm, we found that the wind speed variation rule within 15 s can be clustered into six categories, among which the probabilities of continuously rising wind speed and continuously falling wind speed are the two with the largest values, 37.68%, and 37.49%, respectively. The change of wind power in the 15 s time range usually does not exceed 40%. Subsequently, we analyzed how the various wind speeds affect the FFR of the wind turbine generator (WTG) with combined virtual inertia and droop control. The simulation results suggest that there is little difference in the WTG response within the first 3 s of the FFR whether the wind speed change is considered or not. However, there is a significant difference in the response of the WTG with or without considering the wind speed variation in the subsequent time. Therefore, to study the FFR control of the WTG or to accurately evaluate the effect of the FFR, the wind speed variation should be considered.
09:30-09:45	**EP018**	Wind Power Forecast Based on Dimensionality Reduction using Ridge Regression **Shu Xin Sun, Tsinghua University, China** Abstract— In order to reduce the randomness and fluctuation of wind power, numerical weather prediction is usually used to forecast power generation. Due to the redundancy of numerical weather prediction factors, dimensionality reduction is carried out to improve the effectiveness of data processing and reduce the complexity of algorithm. In this paper, the multicollinearity diagnosis is carried out to show the existence of multicollinearity among numerical weather prediction variables. The ridge regression method is adopted to screen variables, so as to reduce the dimension of numerical weather prediction data, which are trained later by back propagation neural network or convolutional neural network to fit corresponding power data. In comparison with results using training data without preprocessing, dimensionality reduction can improve predicting effect in most cases and reduce the error caused by improper selection of neural network.

Time	Paper ID	Presentation
09:45-10:00	**EP035**	Rolling Prediction Method of Input Wind Power of Wind Turbine Generators in Wind Farm **Xinyi Shen, Hohai University, China** Abstract— The power system's inertia and capability of frequency regulation decrease as the proportion of renewable energy generation in the system rises. The current system includes a significant amount of wind power generation, and the contribution of wind power to frequency control has a significant impact on the frequency stability of the power grid. The ability of wind turbine generators to regulate frequency is significantly impacted by variations in wind speed. To accurately evaluate the frequency response capability of wind power generation, it is necessary to predict the change in wind speed or wind power after the wind turbine generator starts the frequency response. Because the wind speed measured by the wind turbine generator is not accurate, this paper uses accurate power measurement data to represent the change in wind power. In this paper, a rolling prediction method for the power of downwind turbines in a wind farm is proposed using spatial correlation. The future power curves of the downwind turbines are obtained by weighting and summing the power curves of several upwind turbines while taking into account time lags. The validity of the method is verified using measured data from an actual wind farm. The prediction results of the power of wind turbine generators can provide a basis for rolling evaluation of the wind farm's frequency response capability at different moments.
10:00-10:15	**EP005**	Terminal Sliding-Mode Control of Grid-Side Converter of Wind Energy Conversion Systems in Unbalanced Grid **Tianyu Liu, Harbin Institute of Techonlogy, China** Abstract— Firstly, a mathematical model of grid-side converter of PMSG is established when the power grid voltage imbalance fault occurs. According to the characteristics of its mathematical model, a full-order sliding mode controller is applied to current inner loop. The controller has non-singular and chattering characteristics. On the basis of the traditional PI regulator, the power feed-forward is added in the voltage loop，which optimizes DC bus voltage stability. The design of the control system does not require rotation transformation, PLL, decoupling and separation of current sequence. Under the condition of unbalanced power grid, different control objectives can be achieved according to the design requirements.

Time	Paper ID	Presentation
10:15-10:30	**EP029**	N − 1 Contingency Constrained Transmission Expansion Planning with Offshore Wind Farm Integration **Mingxuan Li, Tsinghua University, China** Abstract— Offshore wind farm (OWF) has been developed rapidly worldwide as one of the promising renewable energy technologies. Transmission expansion and flexibility reformation of thermal power units may be necessary to accommodate wind power and maintain operational security. This paper proposes an optimization approach to jointly optimize the sites of OWF integration, the transmission expansion, and the flexibility reformation of thermal power units. In the planning model, the total investment cost is minimized under the requirements of wind power utilization and N-1 security. The problem is decomposed and solved by an iterative algorithm, which comes down to solving mixed-integer linear programming problems repeatedly with modified constraints. The case study based on the IEEE-30 bus system demonstrates the effectiveness of the proposed method.
10:30-10:45	**EP071**	A Hybrid Model based on Deep Learning and Cross-attention for Short-term Wind Power Prediction **Yiqin Zhang, University of Shanghai for Science and Technology, China** Abstract— New energy is a substitute for traditional energy in the coming decades, but its stability is poor. Power generation forecasting is an effective way to mitigate its negative effects. This paper proposed a wind power generation prediction model algorithm independent of meteorological data and propose a new way to build the cross-attention mechanism and perform a better result. We introduce a three-year wind farm dataset and apply out model to it, which facilitate feasibility analysis.

Time	Paper ID	Presentation
10:45-11:00	**EP1011**	Research on dynamic operating point coordination optimization algorithm of wind farms **Xiaoyu Li, Tsinghua University, China** Abstract— In the content of carbon peaking and carbon neutrality, the development and utilization of renewable energy have become major initiatives in China's energy development strategy. Wind power is one of the most valuable renewable energy sources. As the total installed capacity of wind power continues to increase and the proportion of wind power in the national energy generation continues to rise, the volatility and uncertainty of its power generation also bring new challenges to the power system. In this paper, we consider the optimization of wind power generation control strategy and parameters to improve the stability of the power grid and new energy consumption capacity. This paper proposes a genetic algorithm-based wind farm dynamic operating point coordination optimization algorithm to make the wind turbine operate at the operating point with minimum load, minimum operating cost, and maximum total power generation under normal external conditions, and also proposes a control strategy framework for wind farms under emergency/fast active command. In this paper, a wind farm with 16 wind turbines is built on MATLAB/Simulink to verify the feasibility of the algorithm verified by this model.
11:00-11:15	**EP093**	Analysis of the Three-dimensional Temperature Distribution and Ampacity of Forced Ventilation Multi-loop Cable Tunnel By Finite Element Method **Jing Wang, Zhejiang University, China** Abstract— Cable tunnel in a multi-loop laying arrangement can improve the space utilization. Forced ventilation is an effective measure to increase the ampacity of the cables in such application, ensuring the safe and reliable operation of the cable. However, the commonly used IEC-60287 standard for ampacity computation is an analytical method based on ideal models and simplified conditions without considering the three-dimensional distribution of a physical field. In this respect, this paper establishes a three-dimensional coupled multi-physics field model, and solves the distributions, of the temperature field and fluid field in the long-distance cable tunnel based on the finite element method. Also, the paper studies the variation law of the cable temperature field under the forced ventilation and its influence on the ampacity. The results show that in the forced ventilation, the air velocity and temperature are the key factors affecting the ampacity. Higher air velocity is conducive to heat dissipation in the tunnel, effectively increasing the ampacity. The higher the air temperature is, the less heat is dissipated in the tunnel, and the more decreased corresponding ampacity.

Time	Paper ID	Presentation
11:15-11:30	**EP092**	An Improved Chance-Constrained Method for Unit Commitment in Multi-regional Power Systems Considering Wind Power Uncertainties **Yan Chen, Electric Power Research Institute of China Southern Power Grid Company Limited, China** Abstract— With the increasing proportion of wind power in the power system, it brings a new challenge to solve the unit commitment problem for power system considering wind power uncertainties accurately and quickly. An improved chance-constrained method for unit commitment in multi-regional power systems considering wind power uncertainties is proposed in this paper. The spinning reserve constraints in all areas are formulated as chance constraints. The bundle method is used as the transformation strategy of chance constraints. The proposed method in this paper is verified by a power system with 3 areas. The results show that the proposed method can greatly shorten the calculation time and improve the calculation efficiency while ensuring the reliability and economy of scheduling results.
11:30-11:45	**EP094**	Small Disturbance Stability Analysis of Weak-Grid-Connected DFIG-Based Wind Power System **Haoyuan Jin, Zhejiang University, China** Abstract— This paper is focused on the small disturbance stability of weak-grid-connected DFIG-based wind power systems. Firstly, the theory and structure of the system are expounded, and the complete mathematical model is deduced. Secondly, a reduced-order small signal model that disregards the mechanical component is created using the eigenvalue analysis approach as a foundation. The eigenvalues and correlation factors are then used to derive a categorical definition of the system oscillation modes. The eigenvalues and correlation factors are then used to derive a categorical definition of the system oscillation modes. Following that, based on the eigenvalue trajectory analysis, preliminary conclusions on the influence of the control parameters of the phase-locked loop (PLL), rotor-side converter (RSC), grid-side converter (GSC), and grid strength are obtained. Finally, the corresponding time-domain simulation model is created in MATLAB/Simulink. Finally, analyzing the active power waveform changes after disturbance confirms the correctness and accuracy of the theoretical conclusion.

Oral Session 4 GMT+8 Sep.30

Meeting ID (Room B): 527 2797 5015
Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7

Topic: Fault Diagnosis and Safety in Power System
Time: 09:00-11:45

Session Chair
Assoc. Prof. Shaowei Huang, Tsinghua University, China

Time	Paper ID	Presentation
09:00-09:15	**EP063**	Diagnosing Malfunctions in Grid-Connected Photovoltaic Single-Phase Fly-back Inverters **Jin Li, Concordia University, Canada** Abstract— A new defect diagnostic method is predicted based on the features of staggered flyback photovoltaic grid-connected inverter topologies. Because it operates in interleaved continuous mode, the micro-inverter is a single-inverse device. Work and rest take turns in the alternating intermittent mode of operation. All inverter power levels may be controlled with the same method. And since the quality of the grid-connected current is dependent on the inverter's performance, this might boost its effectiveness across the board. An expression for the relationship between the reference current and grid-connected current is generated.

Time	Paper ID	Presentation
09:15-09:30	**EP012**	Research on the neutral point operation mode and fault line selection strategy ofnuclear power plants **Wang Xiaobin, Shandong University, China** Abstract— The auxiliary power of Chinese nuclear power plants is a medium-voltage system, and large cross-section cables are commonly used. Because of the high capacitance current, it is difficult to extinguish the arc when a single-phase ground fault occurs. The neutral point using resonant grounding method can inhibit arc reignition. The actual field operation shows that the arc suppression device has a long response time and the problem of difficult fault line selection. Firstly, this paper investigates the transient process of single-phase ground fault in auxiliary power systems. It is proposed to use delayed removal of series damping resistance to speed up the response speed. Secondly, this paper investigates the fault selection technology of the parallel resistance of the arc suppression device. It is proposed that reasonable selection of the resistance value of the parallel resistance can improve the fault line selection accuracy and suppress the residual fault current. Finally, the effectiveness and reliability of the above solution measures are verified by PSCAD simulation.
09:30-09:45	**EP027**	Fault Diagnosis analysis of distribution network based on Compound Statistics of Residual and Score **Junwen He, China University of Geosciences (Wuhan), China** Abstract— It is a key tool for reducing distribution network failure loss by identifying the fault cause promptly and correctly and eliminating the fault quickly. By examining whether the Q and T2 statistics exceed the control limit, the fault diagnostic method based on Principal Component Analysis (PCA) may determine whether a fault occurs and the source of the fault by using the contribution value of Q and T2. However, the outcome of this procedure is ambiguous, resulting in low diagnostic accuracy. To simplify diagnosis chores and enhance diagnosis accuracy, this research suggested a PCA fault diagnosis approach based on Compound Statistics of Residual and Score (CRS), which uses Q and T2 Statistics to produce CRS Statistics and CRS contribution value. Finally, an IEEE33 node distribution network model is created for simulation verification, and the results validate the PCA approach for defect identification based on CRS data.

Time	Paper ID	Presentation
09:45-10:00	**EP038**	Full Bridge Modular Multilevel Converter AC Grid Voltage Unbalance Analysis and Fault Ride Through Method Research **Jinke Li, Jiangsu Power Design Insititute Corporation China Energy Engineering Group, China** Abstract— At present, the Half Bridge Modular Multilevel Converter (HBMMC) has been studied and applied most frequently because of low cost and simple control. However, due to the topological structure, the half-bridge sub-module carried by HBMMC does not have the ability of DC short circuit fault clearing. Therefore, this paper takes Full Bridge Modular Multilevel Converter (FBMMC) with DC short-circuit fault ride through capability as the research object, and carries out the research around the topology, equivalent mathematical model, operation characteristics and system control framework of FBMMC under grid voltage unbalance. Finally, the correctness of the analysis and the effectiveness of the proposed method are verified in Matlab/Simulink simulation and the experimental platform.
10:00-10:15	**EP048**	Research on Coordinated Adjustment Method of System Protection and Communication System under the Typical Fault Scenarios **Su Ruihao, Tsinghua University, China** Abstract— With the rapid development of ultra-high voltage (UHV) inter-regional interconnected power grid and the wide application of a large number of power electronic devices, the security and stability characteristic of power grid is becoming more and more complex, and the risk of safe operation is increasing day by day. To further adapt to the power grid situation, in recent years, the State Grid Corporation of China has put forward the requirement of building a comprehensive security defense system for the large power grid, namely "system protection". System protection is an emergency control system based on wide area information collection, rapid fault diagnosis and isolation, multi-resource collaboration, and other functions. It covers many sites and the coupling relationship between device strategies is complex. At the same time, due to the limitation of control resources, the cross configuration between strategies is gradually increasing, and the influence range of local system anomalies is becoming larger and larger. Its complexity and hidden dangers lead to a significant increase in the risk of power grid operation. At present, there is little literature on how to reduce the risk of power grid safe and stable operation caused by the failure of the system protection itself through effective coordinated adjustment. In this paper, a coordinated adjustment method based on typical expected fault scenarios of system protection is proposed. For typical expected fault scenarios of system protection with unacceptable risks, certain measures are taken in advance to reduce the possible risks to the power system.

Time	Paper ID	Presentation
10:15-10:30	**EP064**	Weak feature fault identification and location of distribution network based on multi-task learning **Boyang Shang, Beijing Jiaotong University, China** Abstract— The field of distribution network has entered the era of “big data”, and deep learning with strong adaptive feature extraction, classification and prediction ability has also achieved fruitful results in the distribution network data processing. However, most of these studies were all performed under a single label system to achieve a single task objective. In the context of big data, single label system not only cuts off the connection between multi-tasks in fault identification of distribution network, but also can’t completely describe various state information such as fault type and segment location of distribution network from fault data. Aiming at the above problems, a method of weak feature fault identification of distribution network based on multi-task learning is proposed. Its advantage lies in that it adaptively extracted the features of different target tasks from the same distribution network fault data and discriminated the types through the shared network with global feature pooling. The experimental results show that the proposed method can’t only realize the classification of weak feature faults in distribution network and locate the faults in and out of sections, but also has high accuracy and calculation efficiency.
10:30-10:45	**EP074**	Wind Turbine Rotor Fault Prediction Based on Convolutional Neural Network **Yingjun Shen, Nanjing University, China** Abstract— Condition monitoring and early deterioration trend prediction are important to reduce downtime and economic loss. In this paper, the status of wind turbine before downtime are classified into Normal, Risky and High-risk based on the time to the moment of failure. Vibration signal analysis techniques are applied in de-noising and feature engineering, suitable feature combination is selected for prediction models. We visualize the selected features as two-dimensional line charts, and the convolutional neural network (CNN) algorithm is used to predictive modeling. To verify the effectiveness of proposed method, the prediction scores of several classical machine learning algorithms are compared with the prediction scores of CNN. At the same time, considering that most evaluation indexes are static, which ignore the dynamic of online prediction. In this study, a time-series prediction ability evaluation index (TPAEI) is proposed to select a prediction model with small prediction error and good consistency. The effectiveness of the proposed method is verified by wind turbine rotor data sets.

Time	Paper ID	Presentation
10:45-11:00	**EP065**	Fault location method of distribution network based on phasor feature **Boyang Shang, Beijing Jiaotong University, China** Abstract— A fault location method of distribution network based on stacked denoised auto-encoder (SDAE) is proposed. The method integrates the practicability of single-end ranging and the nonlinear fitting characteristics of artificial intelligence to achieve an accurate range of distribution network lines when faults occur. The improved topology based on actual distribution lines verifies the validity of the SDAE model. The hardware closed-loop verification is carried out at the end of the study. Simulation results show that SDAE is superior to other machine learning methods in fault diagnosis and has high fault location accuracy. In addition, this method is robust to measurement noise and data loss error, which can provide an auxiliary decision for existing fault location methods.
11:00-11:15	**EP1009**	Research of a foreign objects detection fusion algorithm using video and LIDAR in FAO system **Ashton Yuxuan Tan, Tsinghua University, China** Abstract— This paper aims to research a fusion algorithm for subway screen doors to make future fully automatic operation (FAO) systems safer and more efficient. This paper adopts video with light detection and ranging (LIDAR) fusion algorithm technology, and proposes a dual-criteria artificial intelligence (AI) strategy using video image recognition and radar point cloud fusion to detect foreign objects in the gap between subway platform doors. A novel approach of cross-stacking and layered installation of sensors is innovatively proposed to realize the function of redundant detection of foreign objects in the gap. Cross-checking improves the reliability of the detection device while 2D sensors are used to achieve 3D detection effects. The developed system provides safety interlocking signals for the subway signal system, delivering alarm information to the integrated monitoring system, then pushes the smart hand ring alarm information to the on-site operators.

Time	Paper ID	Presentation
11:15-11:30	**EP053**	Design of Comprehensive Defense System for UHV AC and DC Power Grids Security **Yafei Ding, China Electric Power Research Institute, China** Abstract— In today's China, UHV AC and DC hybrid power grid has the new feature of "strong HVDC and weak AC system" and power electronization. Response to this new situation, in order to effectively reduce the risk of large-scale power outages in power grid, it is necessary to build a secure and reliable comprehensive defense system for power grid security to ensure secure and stable operation of China's power system. Based on the current three defense lines in China, this paper argues the goals and design principles of the UHV AC and DC power grid security defense system that adapt to the new characteristics of China's power grid, and designs the overall structure of the UHV AC/DC power grid security defense system, main functions and specific configuration schemes.
11:30-11:45	**EP1004**	Anomaly Detection Method of Unknown Protocol in Power Industrial Control System Based on RNN **Wenbo Wang, Hunan University, China** Abstract— The power industrial control system contains a large number of communication protocols. These protocols lack security consideration at the beginning of the design, which makes them face the risk of cyber attacks. Therefore, the anomaly detection of protocols plays an important role in improving the active defense capability of the power industrial control system. With the increasing number of private protocols, traditional methods based on protocol depth parsing cannot perform anomaly detection for unknown protocols. In this paper, we propose an anomaly detection method for unknown protocol in power industrial control system based on Recurrent Neural Network (RNN). Firstly, extract the payload of power industrial control traffic in application layer, and preprocess each field of the payload; Secondly, input the preprocessed field values as the feature quality to the built RNN model for training; Lastly, use the trained model for unknown protocol anomaly detection. The traffic data collected by the real substation is used for simulation. The experimental results show that the method in this paper can effectively detect the abnormality of unknown protocols, and has high accuracy and low false alarm rate. At the same time, it has significant advantages when compared with traditional machine algorithms.

Oral Session 5 GMT+8 Sep.30

Meeting ID(Room C): 657 3929 8689
Meeting Link: https://meeting.tencent.com/dm/slgEQI5FTOBI

Topic: Modern Power Electronic Technology and Application
Time: 09:00-11:45

Session Chairs

Prof. Donghui Zhang, Tsinghua University, China

Dr. Saman A. Gorji, Queensland University of Technology, Australia & Deakin University, Australia

Time	Paper ID	Presentation
09:00-09:15	**EP037**	Research on Bidirectional DC/DC for DC Power Flow Controller **Qiyuan Liu, Beijing Jiaotong University, China** Abstract— In this paper, the principle of line power flow control in DC power grid is given first, and the influence of DC voltage and line equivalent resistance on DC power flow is analyzed based on this. Under the application background of flexible DC transmission system, a partial-power line power flow controller based on phase-shifted full-bridge topology is proposed. The proposed power flow controller has a single-stage structure, which can realize bidirectional control of DC line power without additional external power supply. The designed active clamp circuit can reduce the voltage stress caused by the leakage inductance of the transformer to the switches under reverse working conditions, and can realize the soft switching of all the switches on the secondary side through the clamp circuit. The soft-switching characteristics of the proposed topology in bidirectional operation are verified by simulation.

Time	Paper ID	Presentation
09:15-09:30	**EP097**	A Modified Positive Output Super-Lift Luo DC-DC Converter with Improved Voltage Boost Ability **Saman A. Gorji, Queensland University of Technology, Australia; Deakin University, Australia** Abstract— An improved topology of the positive output super_x005flift Luo converter is proposed. The continuity of the input current waveform in the original topology is maintained while the voltage boost ability has been improved. Indeed, the voltage-lift technique has been applied twice, which leads to a voltage gain ratio higher than of the original super-lift topology. Some comparisons were made that indicated the topology is of great benefit, where a high voltage gain is required within the duty cycles lower than 50 percent, i.e. the proposed topology outperforms the quadratic boost converter both in voltage gain and efficiency, albeit within the specified operating range. The claims and calculations have been validated through experimental results.
09:30-09:45	**EP049**	Improved Impedance Stability Analysis of Power Electronic System ConsideringHarmonic Source **Yuke Gui, Tsinghua University, China** Abstract— With the rapid growing of the power electronic devices in the distributed grid, the impedance stability analysis has been paid more attentions, which is the main method of analyzing the oscillation stability of the power electronic system. The harmonic source, which comes from these power electronic devices, will influence the impedance measurement when the same frequency disturbance is injected. An improved impedance stability analysis method of the DC power electronic system considering the influence of power side harmonics is proposed in the paper. This method eliminates the impact of the harmonics by considering the initial inherent background harmonics of source side. The simulation results show the accuracy of impedance stability analysis criterion can be improved with the proposed method. And the stability misjudgment caused by inaccurate impedance characteristics, impacted by the harmonics, could be avoided.

Time	Paper ID	Presentation
09:45-10:00	**EP045**	Finite Element Model Modification Method of Transmission Tower Based on StaticTest Result **Qingbiao Xiao, North China Electric Power University (Baoding), China** Abstract— The results of finite element model of transmission tower are inconsistent with those of test. In order to better reflect the actual mechanical properties of transmission towers, it is necessary to modify its finite element model. Compared with the dynamic modification method, the statics modification method has higher accuracy, but it is seldom studied because of the difficulty of obtaining experimental data. Based on static test of tower, this paper considers the influence of bolt connection slip on the axial stiffness of rods of tower, and proposes a static finite element model modification method based on BP neural network. According to the input parameters of the model, three different modified models are constructed. The results show that the model of taking displacement and strain as the input parameter, the difference between the results of the modified finite element model and the experimental measurement values are the smallest, and the correction effect is the best. And then the influence of different loading conditions on the model modification effect is analyzed. After a comprehensive analysis and discussion of the results, the model structure and model input parameters with the best modification effect are given. The modified finite element model can provide important reference for health monitoring and damage identification of transmission tower.
10:00-10:15	**EP091**	Research on the Reconstruction Design of Ground Wire Fittings on Transmission Line about Three-span **Qian Zhang, State Nuclear Electric Power Planning Design & Research Institute Co., LtD, Beijing, China** Abstract— State Grid related standardized design atlas are not satisfied with the current "three-span" requirements, previous literatures were only analyse the "three-span" fitting strings of the transmission line from the aspect of the natural environment and the material of the fittings. In order to ensure the safe and reliable operation of transmission line span high-speed railways, expressways and important high-voltage transmission lines, this paper demonstrates the essential safety of the fittings of the ground wire on the transmission line, and proposes the actual string type to improve the safety redundant.

Time	Paper ID	Presentation
10:15-10:30	**EP051**	A Flexible Loss Calculation Method Based on Finite Sampling for MMC HVDC System **Zhidi Huang, Maintenance & Test Center. EHV Power Transmission Company of China Southern Power Grid Co., Ltd., China** Abstract— During the last decade, an increasing number of Modular Multilevel Converter (MMC) based HVDC projects have been operated, while the overall loss rate increased compared with the Line Commutated Converter (LCC) based HVDC system. Accurate and efficient loss calculation and analysis of HVDC systems are the key steps of studying the loss composition and loss reduction measurements. Since the losses can hardly be accurately measured for the HVDC system, the losses are often obtained by either simulation or analytical calculation, with the disadvantages of time-consuming and low accuracy, respectively. In this work, an efficient and flexible loss calculation method based on finite sampling for the MMC HVDC system is proposed, which can be used for long time-period power loss calculation utilizing the manufacturer's datasheet with device-level characteristics of power electronics switches. This method can flexibly use the finite current samples and switching pulse samples from simulation, field measurement, or calculated from power measurement as the calculation inputs. The accuracy of the algorithm is verified by comparing with the measured data of a practical hybrid HVDC project with both MMC and LCC.
10:30-10:45	**EP047**	Generalized Short Circuit Ratio Calculation Based on Thevenin Equivalent Parameters Identified through Transient Simulation **Ruipeng Sun, Zhejiang University, China** Abstract— Generalized short circuit ratio (gSCR) can be used to efficiently measure the strength of receiving end AC system, which is the foundation of secure operation of HVDC. A gSCR calculation method based on Thevenin equivalent parameters identified through transient simulation is proposed, which simplifies the receiving end AC system with multi-port Thevenin equivalent model, identifies the equivalent parameters through transient simulation data after fault clearance, and calculates the gSCR based on the identified parameters. The proposed method has the advantage of considering the effect of generator transient reactance, and hence improves the accuracy of the gSCR calculation. Case studies from single-infeed and four-infeed HVDC system show that the proposed method is feasible and effective with good accuracy and robustness.

Time	Paper ID	Presentation
10:45-11:00	**EP068**	A Coordinated Control Strategy for Flywheel Energy Storage Matrix System Based on Consensus Algorithm **Jingjing Wang, Wuhan University, China** Abstract— The randomness and fluctuation of renewable energy bring significant difficulties for operation and control of power grids. The flywheel energy storage system (FESS) provides a new solution in dealing with high frequency power fluctuation of renewable energy generation, due to its unique characteristics of fast dynamic response, long service life, unlimited charge/discharge times, and high power density. To consider the capacity requirement for power grid control in practical application scenarios, multiple flywheel energy storage units are usually integrated in parallel into the power grid, and the flywheel energy storage matrix system (FESMS) is therefore formed. In order increase the controllability of the FESMS integrated into the wind farm for practical application, this paper proposed a coordinated control strategy of the FESMS based on a consensus algorithm. By taking charge/discharge ratio of each flywheel energy storage unit as the consensus index and also coordinating the operation power of each unit in the FESMS by a distribution algorithm, the power fluctuation of the wind farm is smoothed. Finally, the effectiveness of the proposed control method is verified by simulation.
11:00-11:15	**EP1002**	Optimization Model and Calculation Method for Thermal Stability Limit of Transmission Sections **Xi Ye, State Grid Sichuan Electric Power Company, China** Abstract— In China, the monitoring regarding power grid dispatch usually adopts section monitoring rather than real-time static safety analysis. The manual calculation process is so complicated that it is necessary to calculate the thermal stability limit of the transmission section through optimization. In this paper, the active power flow of the section after the expected disconnection is expressed as a linear function of the initial active power flow of the section, with the aid of the concept of transfer ratio. The constraints on the initial active power flow of the sections are determined according to the current carrying capacity. The maximization of the minimum ratio between the sectional thermal stability limit and the initial active power flow is taken as the basic principle. The optimization model of the sectional thermal stability limit is proposed and is solved with simplex algorithm from linear programming. The correctness of the model and the effectiveness of the calculation method are verified with the case study of an actual provincial power grid.

Time	Paper ID	Presentation
11:15-11:30	**EP028**	Defect identification of power line insulator based on an improved yolov4-tinyalgorithm **Weidong Zan, Inner Mongolia University of Technology, China** Abstract— With the rapid development of artificial intelligence technology, the collection of power line images through unmanned aerial vehicles (UAV) and the further use of deep learning algorithms to automatically detect power insulator defects is gradually replacing the traditional manual inspection and identification methods. The image capture and machine recognition and learning has gradually become a kind of emerging automatic inspection methods of power line insulators. Aiming at the problems of small target size, complex background, and low defect recognition rate of insulator defects, this paper proposes an insulator defect detection method based on an improved yolov4-tiny deep learning algorithm (IYTDLA). Compared to the traditional yolov4-tiny deep learning algorithm (TYTDLA), the key improvement lies that a coordinate attention (CA) module is introduced after the major feature extraction network to enhance the network feature representation ability. First, based on the original UAV-collected image data sets, the improved algorithm is used to randomly scale captured images, and Gaussian noise is mixed to further enhance the data sets. Then, IYTDLA is applied to discern the two different defects “missing” and “broken” from the power line insulator images captured by UAVs. The experimental results show that the IYTDLA has a higher recognition accuracy than the TYTDLA. Compared to the mAP of TYTDLA, the mean average precision (mAP) of IYTDLA is increased by 0.94%, the average precision (AP) of missing insulator defects of IYTDLA is increased by 1.19%, the AP of insulator damage defects of IYTDLA is increased by 2.99%. At the same time, the performances of IYTDLA are also higher than those of traditional faster-rcnn (FRCNN) and efficientdet (EDET) in terms of recognition accuracy and processing speed. However, IYTDLA also has a processing speed comparable to the TYTDLA. That verifies that both of IYTDLA and TYTDLA are suitable for the deploy applications on mobile devices or embedded devices to implement device-side edge computing.
11:30-11:45	**EP026**	Communication Scheduling Strategy for the Power Distribution and Consumption **Wei Wang, South China University of Technology, China** Abstract— Massive access of the Power Distribution and Consumption Internet of Things(PD-IoT) application data to the edge IoT gateway will cause the accumulation and loss of application data packets, which will affect the normal operation of the power system. In this regard, this paper proposes a dynamic priority-based communication scheduling strategy for the PD-IoT to meet the communication needs of different applications. Firstly, a multi-priority application queuing model is established based on the application communication value, and the average queuing time of the edge IoT gateway for processing and forwarding the PD-IoT application data is calculated to provide a theoretical basis for application scheduling. Then, a communication scheduling strategy based on dynamic priority is proposed. A dynamic priority factor is introduced based on the application remaining value density and the urgency of execution, added by a preemption threshold set under the application preemption mechanism. Finally, it is verified through OPNET simulation that the communication scheduling strategy proposed in this paper can not only take into account the communication needs of different PD-IoT applications, reduce the processing delay of information collection applications, but also improve the overall reliability and efficiency of communication when massive application data is accessed.

Oral Session 6 GMT+8 Sep, 30

Meeting ID (Room A): 752 5636 7809
Meeting Link: https://meeting.tencent.com/dm/wurHiC4sxwj2

Topic: Mechatronics and New Energy Drive Technology
Time: 13:00-15:30

Session Chair
Assoc. Prof. Jian Yin, Shenzhen University, China

Time	Paper ID	Presentation
13:00-13:15	**EP030**	Investigation on thermal balance capability of FCV under extreme operating conditions **Shiyu Wu, China automotive technology research center Co., Ltd, China** Abstract— In the research and development process of fuel cell electric vehicle (FCEV), the test and research on vehicle thermal balance ability is of great significance. In this paper, the characteristics of typical fuel cell electric vehicle thermal management system is summarized, and the test requirements of fuel cell electric vehicle in thermal balance test is analyzed. What is more, the design of FCEV thermal balance test is completed. Based on this, an experimental study on the thermal balance capability of a FCEV is carried out, and the thermal balance capability of the whole vehicle under high-speed driving conditions and high-speed climbing conditions is analyzed.

Time	Paper ID	Presentation
13:15-13:30	**EP1005-A**	New approaches for ORC turbine serialization design and ORC system optimization **Wenyu Li, Nanjing Tech University, China** Abstract— The organic Rankine cycle (ORC) has been proven to be an effective method to convert low_x005fgrade heat sources into electrical power which is a crucial approach to improving the utilization efficiency of energy. Therefore, for the past few years, the studies of applying the ORC system to renewable energy and industrial waste heat recovery attracting more and more researchers' attention. As the crucial component of the ORC system, the turbine not only directly influences the system's thermodynamic performance but also dominates the investment cost of the ORC device. Therefore, making the ORC turbine serialization is a promising way to reduce the ORC device investment costs and promote its application. However, currently, very few studies have paid attention to this. To give a feasible solution approach for designing the serialized ORC turbine and even ORC device, the authors have conducted several investigations. And the main achievements include: 1. A novel radial inflow turbine preliminary design framework has been constructed, which is based on the geometric parameters; 2. A novel ORC system optimization analysis framework has been constructed, which is based on the turbine database. These researches give new analysis ideas for the ORC system, which contributes to promoting its application and improving the utilization efficiency of energy.
13:30-13:45	**EP089**	Study on Primary Frequency Regulation Capability and System Stability of Hydropower Units **Xiangyang Yu, Xi'an University of Technology, China** Abstract— As an important frequency regulation unit, the hydropower unit plays an important role in the stable operation of the power grid. At present, most of the hydropower units pursue the primary frequency regulation (PFR) assessment index, ignoring the system stability. This could lead to ultra-low frequency oscillation in a high proportion hydropower area, such as the Yunnan power grid. Therefore, this paper studies the relationship between the PFR and the stability of the system. Firstly, the mathematical model of the hydropower unit is established, and the judgment criteria for satisfying the PFR assessment and system stability are obtained through theoretical analysis, indicating that the PFR capability of the unit is related to the control parameter KI. Then, according to the judgment criteria of system stability, the functional relationship between the system parameters Ta and Tw of different types of hydropower units and the maximum value of the control parameter KI is obtained by fitting, and the judgment criteria that the unit can satisfy both the PFR assessment and system stability is obtained by using the judgment criteria of PFR assessment. At the same time, it shows that most of the Francis and Kaplan units and all the tubular units cannot satisfy the PFR assessment and system stability at the same time. Finally, on the premise of considering a 20% regulation margin, combined with the fitting function, the PFR assessment formula that satisfies the system stability in a high proportion hydropower area is proposed.

Time	Paper ID	Presentation
13:45-14:00	**EP043**	Shape Optimization of a Horizontal Axis Tidal Turbine (HATT) Blade using Neural Networks for Response Surface Methodology **Mark Anthony Rotor, State University of New York, South Korea** Abstract— Ocean energy is gaining popularity with tidal energy being the most mature technology. Presently, most of the tidal energy research is being focused on tidal stream turbines because it is cheaper and less environmentally invasive. However, this technology is currently considered highly site-specific due to the current tidal turbines being designed for high flow velocity areas. Countries in the tropical region (e.g., the Philippines) are characterized as having low-velocity tidal currents. To efficiently exploit the energy from the ocean tides for relatively low velocity flows, a site-specific Horizontal Axis Tidal Turbine (HATT) blade must be designed and optimized. In this study, a novel robust design optimization framework is used to optimize the blade. This study uses Artificial Neural Networks (ANN) for response surface methodology to generate a surrogate model while using Particle Swarm Optimization (PSO) as the meta-heuristic algorithm to find the optimized blade. The results indicate that the optimized blade increases the turbine's maximum power coefficient and Annual Energy Production (AEP) while limiting the bending stress and cavitation number. The maximum power coefficient of the blade is increased by 30.30%. The maximum bending stress of the blade is decreased by 6.62% while remaining cavitation_x005ffree. One key feature of this method is its robustness as it can be applied to any site located within the design space of interest. Overall, this could be viable for a more computationally efficient method to optimize the performance of HATTs for any set of conditions.
14:00-14:15	**EP032**	A Method for Modeling the Output Power of Photovoltaic Power Supplies Based on Non-parametric Kernel Density Estimation **Zhigao Meng, Chengdu Power Supply Company, State Grid Sichuan Electric Power Company, China** Abstract— To address the shortcomings of the traditional PV power output model, which requires the assumption of parameter distribution and cannot fully consider the influence of various random factors, this paper adopts the k-nearest neighbor estimation method and the kernel density estimation method based on the non-parametric estimation theory to describe the PV power output respectively, and proposes an improved optimal bandwidth calculation model without reference to the overall distribution for the kernel density bandwidth selection problem, and selects the actual measured data of a large PV power supply in a certain region for simulation and comparison analysis to verify the correctness, validity, and adaptability of the proposed kernel density estimation probability model to the random characteristics of different PV power supplies.

Time	Paper ID	Presentation
14:15-14:30	**EP039**	A Node-Level Distributed Power Flow Based on Newton-Raphson Method **Sikai Tan, Shenzhen University, China** Abstract— In the future power system, it is necessary to develop a power flow method that can protect the privacy information of generators and electricity purchasers, and alleviate the calculation pressure of the central calculator. In this paper, a node-level distributed power flow method based on the Newton-Raphson method is established. First, the method regards a single node in the power network as an agent (capable of independent computing devices), and then constructs a single node power balance equation. Taking the voltage of the neighbor node as a known invariant and using the first-order Taylor approximation, the iterative formula of the node voltage is derived. This method disperses the computational load confronted in the central processor by constructing an iterative formula for a single node. In addition, each node only needs the voltage value of its neighboring nodes for computation. Hence, this method can well protect the privacy information of generators and electricity purchasers. By simulating several IEEE systems, the results show that the distributed method and the centralized method get the same answer, which means that the distributed method is effective.
14:30-14:45	**EP057**	Controllable synthesis of hierarchical porous carbon with ultra-high specific surface area from Milkvetch Root residue for supercapacitor application **Dongjun Lei, South China University of Technology, China** Abstract— Ultra-high specific surface area porous carbons with micropores and narrow mesopores are preferred candidates for catalysis, pollution remediation, and energy storage. In this work, porous carbon materials derived from Milkvetch Root residue with specific surface area exceeding 3300 m2 g-1 was synthesized by controlled variable strategy. As electrode materials, the prepared ultra-high specific surface area porous carbon provides a specific capacitance up to 274.8 F g-1 at the current density of 1 A g-1 and maintains 224.5 F g-1 at 50 A g-1. Moreover, the effects of activation conditions on the surface area, pore structure and electrochemical performance of the porous carbon materials were clarified. This work provides the direction for the design and construction of ultra-high surface area porous carbon with hierarchical structures for supercapacitor application.

Time	Paper ID	Presentation
14:45-15:00	**EP007**	Optimization of PSS4B based on hybrid particle swarm optimization **Yongshuai Cui, Harbin Institute of Techonlogy, China** Abstract— With the rapid development of power system, the power grid becomes more and more complex, which makes the system often appear low frequency oscillation. PSS is the most important measure to suppress low-frequency oscillations, but the single-branch PSS is difficult to meet the requirements of the current power system, most of the applications of PSS4B with superior performance to suppress low-frequency oscillations. In this paper, the mechanism of low frequency oscillation and common PSS model are introduced. Secondly, the hybrid particle swarm optimization algorithm with higher convergence accuracy is improved based on the basic particle swarm optimization algorithm. Finally, based on the infinite motor system, the simulation results of three systems without PSS, with PSS4B and optimized PSS4B were compared by setting different disturbances. The simulation results show that PSS4B parameter simulation optimized by hybrid particle swarm optimization algorithm can suppress the oscillation faster and enhance the stability of the system.
15:00-15:15	**EP040**	Investigation on the Discontinuous Modulation Method of Full-bridge Modular Multilevel Converters **Jinke Li, Jiangsu Power Design Insititute Corporation China Energy Engineering Group, China** Abstract— As a new type of multilevel converter topology, the Modular Multilevel Converter (MMC) has the advantages of high equivalent switching frequency, strong scalability and flexible control in recent years, thus has attracted more and more attention. This paper mainly studies the discontinuous modulation method of full-bridge MMC and proposes an implementation method of discontinuous modulation strategy for full-bridge MMC with a mathematical model established based on segmental function, taking advantage of the segmental characteristics of modulated wave of MMC under discontinuous modulation. Discontinuous Pulse Width Modulation (DPWM) makes the switches remain inactive in a specific modulation period, which can improve the equivalent switching frequency, optimize harmonic characteristics and reduce switching loss. The effects of discontinuous modulation strategy on device power losses and modular capacitor voltage is analyzed on the basis of the mathematical model. Then, the effects of discontinuous circulation on device power losses and modular voltage is analyzed by combing the discontinuous modulation strategy and circulation injection strategy. Simulation is conducted and verified that the MMC loss and modular voltage fluctuation can be reduced by the circulation injection strategy under discontinuous modulation.

Time	Paper ID	Presentation
15:15-15:30	**EP024**	Health Performance Interval Prediction of Pumped Storage Unit Based on Multi-Objective Optimization **Yahui Shan, Wuhan Second Ship Design and Research Institute, China** Abstract— The health performance of pumped storage unit (PSU) affects the stable and safe operation of pumped storage station and even the power system. Thus, it is essential to predict the health tendency accurately and helpful to achieve predictive maintenance as well. An interval prediction model based on information fusing and multi-objective optimization is proposed to describe the randomness and uncertainty of the health performance. To effectively obtain the operating characteristic of PSU, the health state model is developed based on Gaussian process regression (GPR) and the monitoring data. Then, to comprehensively quantify the health degree, an integrate health index (IHI) is developed with entropy weight to fuse the healthy information of different objects. Taken the prediction interval coverage probability (PICP) and prediction interval normalized average width (PINAW) as objective constraints, the global optimization strategy is proposed based on kernel extreme learning machine (KELM) and multi-objective particle swarm optimization (MOPSO). In the final, the comparative experiments are conducted with the data collected from a PSU in China. The results show that the proposed model can deduce the health interval with reliability and accuracy.

Oral Session 7 GMT+8 Sep, 30

Meeting ID (Room B): 527 2797 5015
Meeting Link: https://meeting.tencent.com/dm/HX54hyrStEZ7

Topic: Distribution Network Operation and Grid Dispatch
Time: 13:00-15:15

Session Chair
Assoc. Prof. Zheng Qi, North China Electric Power University, China

Time	Paper ID	Presentation
13:00-13:15	**EP054**	Stability Mechanism Analysis and Improvement Measures for Sending End Near Area Power Grid with UHVDC Transmission System **Yafei Ding, China Electric Power Research Institute, China** Abstract— In hybrid power grid, mutual support, coupling and influence exist between AC and HVDC. Unbalanced development situation of the two transmission modes will profoundly change operating of hybrid power grid. In today's China, power system has entered a new era of "large-scale hybrid UHV AC/DC power grids" pattern. Within this paper, the main hazards to sending end power grid with UHVDC are proposed based on reviewing development history of the hybrid power grid. Besides, take a typical sending end near area power grid with UHVDC as an example, to analyze stability characteristics and mechanism for sending end power grid with UHVDC, some security and stability control measures are put forward to enhance stability of sending end near area power grid with UHVDC.

Time	Paper ID	Presentation
13:15-13:30	**EP013**	Optical storage multi-objective programming based on the third generation non dominated sorting genetic algorithm **Zihang Chen, Hohai University, China** Abstract— The article focuses on the problem that the multi-objective optimal allocation work of optical storage is not considered in the traditional distribution network (TDN), and establishes a multi-objective planning model for optical storage with the objectives of annual comprehensive cost, annual active network loss and minimum average voltage offset in TDN, taking into account the economics of distribution network operation and power quality. This model proposes a TDN optical storage multi-objective planning process based on the third-generation non-dominated ranking genetic algorithm, which effectively solves the multi-objective planning problem of optical storage in TDN. Finally, the simulation analysis is carried out by IEEE-33 node active distribution system to verify the effectiveness of the proposed model and hybrid solution strategy, and to analyze the important role played by multi-objective optimal allocation to improve the operation quality and economic efficiency of the distribution network.
13:30-13:45	**EP008**	Day-ahead Reactive Power Optimization for Active Distribution Network Considering Flexible Loads **Huang Hao, Hangzhou Worui Power Technology Co., Ltd, China** Abstract— As a response to environmental issues related to climate change, renewable distributed generations (DGs) are getting more and more integrated into active distribution network (ADN) in recent decade, which can result in certain difficulty in voltage control. This difficulty can usually be tackled by reactive power optimization (RPO) considering DGs and traditional voltage control measures, but sometimes needs more efforts to overcome. In this paper, flexible loads (FLs) are utilized in ADN voltage control. A day-ahead RPO model considering FLs is proposed to relief voltage over-limit caused by massive DG integration, which considers the constraints from FLs besides DGs and ADN, and is solved by General Algebraic Modeling System (GAMS). The effectiveness of the proposed method is verified by the case studies of the modified IEEE 33-bus system.

Time	Paper ID	Presentation
13:45-14:00	**EP069**	An Efficient Sparse Matrix Technique for Closed Loop Current Analysis in Distribution Network **Tao Zeng, Hangzhou Worui Electric Power Technology Co., LTD, China** Abstract— In order to improve the power supply reliability in distribution network, the closed loop operation is used to achieve the purpose of transferring power loads without outage. In this paper, the closed loop current is calculated by power flow method. Firstly, the three electrical islands which are affected most by closed loop operation are spliced together. At the same time, this paper expands the voltage constraints and the power change constraints of boundary nodes. Then, the sparse matrix technique is used to process the Jacobian matrix to quickly calculate the power flow. Finally, the rapidity and accuracy of the proposed method are verified by the calculation result of closed loop current of a regional power system.
14:00-14:15	**EP084**	An Evaluation Index System suitable for operation and management of distribution network automation system **Yan Zhang, Department of Strategic Planning Guizhou Power Grid Co., Ltd. Guiyang, China** Abstract— Conducting the evaluation of distribution automation operation status is an important link to promote the construction of distribution automation and the coordinated development of distribution networks. In order to accurately evaluate the business level of distribution automation, this paper proposes a preliminary set of index system for evaluating the operation status of distribution network automation. Firstly, the framework of distribution automation operation status evaluation system is determined from the construction principles. Secondly, the evaluation system of distribution automation operation status is constructed from four aspects: strategic objectives, key indicators, statistical indicators and analysis indicators. Further, the weight values of each index are determined based on the hierarchical analysis method. Finally, the proposed evaluation index system is verified to be scientific, objective, and easy to operate with simplified calculation examples.

Time	Paper ID	Presentation
14:15-14:30	**EP1003**	Research on path connectivity optimization model for active distribution network reconfiguration **Chen Feng, Electric Power Research Institute of State Grid Zhejiang Electric Power Co., Ltd, China** Abstract— According to the “closed-loop design and open-loop operation” structural characteristics of the distribution network, an undirected graph method is used in this paper to describe the radial structure constraints. The operation state of the nodes should be consistent before and after the optimal reconfiguration of the active distribution network. In this paper, the concept of “virtual demand” is defined to establish the mathematical model of the connectivity between the charged nodes and substation power supply nodes. Along with the equality that the number of closed branches is equal to the total number of nodes minus the number of substation power supply nodes, a mathematical model of path connectivity in the strict sense is built, which ensures the radial structure of the distribution network. On this basis, the optimal reconfiguration model of the distribution network is established with the objective of minimizing the active power loss, and is solved with mathematical programming. The PG&E 69-bus distribution system is used to verify the effectiveness of the proposed method.
14:30-14:45	**EP019**	Influence of Grid Structure Change on Resonance Frequency of DistributedPhotovoltaic Cluster Grid-Connected System **Jing Gao, State Grid Jibei Electric Power Co. Ltd. Research Institute (North China Electric Power Research Institute Co., Ltd.), China** Abstract— As the number of distributed photovoltaics in the power grid continues to increase, the inherent resonance points of distributed photovoltaic cluster grid-connected systems become more complex. This paper firstly analyzes the grid structure of the distributed photovoltaic cluster grid-connected system. Then, the grid structure and resonance coupling relationship of single inverter, and the grid structure and resonance coupling relationship of cluster grid-connected inverters are analyzed. Based on the above analysis, the resonant frequency distribution of the distributed photovoltaic cluster grid-connected system is obtained. Then, the influence mechanism of the grid structure on the resonance is analyzed. Finally, it is verified by simulation that the change of the grid structure will cause the change of the resonant frequency distribution of the distributed photovoltaic cluster grid-connected system.

Time	Paper ID	Presentation
14:45-15:00	**EP056**	A DFIG Based Stepwise Inertia Control Method for Fast Frequency Response Considering Secondary Frequency Drop **Zhang Wen, Wuhan University, China** Abstract— Doubly-fed induction generators (DFIGs) can participate in power grid frequency regulation utilizing stepwise inertia control (SIC) by releasing the kinetic energy stored in the rotational masses. Nevertheless, a secondary frequency drop (SFD) of the power grid may occur during the rotor speed recovery stage of conventional SIC in DFIGs, which will further worsen the system unbalance and cause a second frequency nadir. To address this issue, this paper proposes an improved SIC considering SFD. In particular, the stored kinetic energy of DFIGs is quantified under various wind speeds. Further, the proposed SIC is divided into the overproduction stage and rotor speed recovery stage, with appropriately designed shaping parameters for each stage to strike a balance between the SFD prevention and the recovery speed. The performance of the proposed SIC is compared with conventional SIC and frequency-based inertia control (FBIC) through explicit simulation analysis. The results verify that the proposed control strategy can effectively offset the SFD while improving the frequency nadir and the rate of change of frequency (RoCoF) in any wind conditions, as well as contribute to reliable operation during an unexpected second cascade event.
15:00-15:15	**EP079**	Research on Dynamic Pricing Scheme and Compensation Mechanism of 5G EnergyStorage Participating in Power Grid Collaborative Dispatching **Cheng Xin, State Grid Economic and Technological Research Institute Co., LTD, China** Abstract— This study focuses on the dynamic pricing strategy design of 5G energy storage system participating in the interaction of power grid system. First, the incremental cost of 5G energy storage system participating in power grid cooperative dispatching is analysed, and the comprehensive benefits of 5G energy storage system participating in power grid cooperative dispatching are obtained by comparing the cost changes in independent and collaborative modes. Second, build G base stations grid energy storage system to participate in cooperative cost-benefit model of power grid company, from the perspective of the power grid companies, 5G base stations grid energy storage system to participate in cooperative expected earnings, combined with the incremental cost analysis, using the method of game equilibrium, research covers the grid, and the 5G operators of various main dynamic pricing model and revenue sharing model, Build a sustainable capacity in multi-agent dynamic pricing scheme and compensation mechanism, through the example analysis of 5G storage by participating in the interactive operation, to some extent, can reduce the operation cost of 5G base stations, at the same time reduce the grid peak valley, flexible given to promote renewable energy, has good comprehensive benefits.

Oral Session 8 GMT+8 Sep, 30

Meeting ID(Room C): 657 3929 8689
Meeting Link: https://meeting.tencent.com/dm/slgEQI5FTOBI

Topic: Integrated Energy Systems and Management
Time: 13:00-15:30

Session Chair
Dr. Xingshuo Li, Nanjing Normal University, China

Time	Paper ID	Presentation
13:00-13:15	**EP096**	Photovoltaic System to Cover Energy Demand for Tourist Activities in an Artisanal Fishing **Juan Carlos Zuñiga Torres, Universidad Tecnológica del Perú (UTP), Peru** Abstract— Artisanal fishing is socially and economically important for coastal communities. However, the environmental crisis, pollution of the seas, and the depredation of marine resources have significantly decreased the productive capacity and profitability of artisanal fishermen. Therefore, new economic opportunities are beginning to be explored based on tourism, specifically fishing tourism, which revalues and explores artisanal fishermen's culture and knowledge. The present research performs the design, installation, and evaluation of a system of photovoltaic panels on an artisanal fishing boat as part of the adaptation that allows the development of tourist activities, which require the supply of electrical energy so that various equipment can function and effectively offer communication services, entertainment, food, comfort, and safety. The tests at sea demonstrate that it is possible to supply the new energy demand generated by tourist activities. The tests were carried out in winter (pessimistic conditions), and even so, it is possible to satisfy a demand for four tours, one of them at night.

Time	Paper ID	Presentation
13:15-13:30	**EP1008-A**	Photocatalytic conversion of lignin into high-value chemicals **Xintie Wang, Southeast University, China** Abstract— Photocatalysis has become a promising technology in solar energy engineering. Recently, the application of photocatalytic technology to biomass energy conversion becomes increasingly popular due to higher reaction controllability than traditional thermal conversion. In biomass energy, lignin represents the most abundant and sustainable aromatic resource to produce value-added aromatics. However, it remains challenging to efficient and selective cleavage of recalcitrant C-C bonds in lignin at mild conditions. In this work, under visible light, we report efficient and selective C-C bond cleavage in β-O-4 lignin model at room temperature using polyimide as a photocatalyst. The lignin model was converted into aromatic products with >99% substrate conversion and >99% C-C bond cleavage selectivity, which are superior to previously reported photocatalytic systems. Experimental investigations together with theoretical calculations indicated that the superior performance of polyimide photocatalyst was attributed to its strong photooxidation capability and efficient charge carrier separation efficiency. Mechanism studies revealed that the dehydrogenation of lignin model driven by photogenerated holes was the rate-determined step. This work provides useful guidance for the design of high performance photocatalyst for selective C-C bond cleavage of lignin.
13:30-13:45	**EP052**	Analysis of subsynchronous oscillation mechanism and its influencing factors in large-scale photovoltaic series compensation system **Rui Peng, Tsinghua University, China** Abstract— With the rapid development of new energy power generation, the installed capacity of photovoltaic power generation continues to increase in the proportion of power supply in the power system. In order to realize large-scale long-distance transmission of photovoltaic power generation, it is planned to adopt series compensation capacitor (hereinafter referred to as "series compensation") transmission technology to transmit large-scale photovoltaic power generation to the load center. However, there is a risk of inducing subsynchronous oscillation in the dynamic interaction between series compensation line and photovoltaic grid connected inverter. The specific mechanism of subsynchronous oscillation in the interaction between series compensation line and photovoltaic grid connected inverter has not been clear. In order to ensure the stable operation of large-scale photovoltaic power generation bases, it is urgent to reveal the specific mechanism of subsynchronous oscillation of the interaction between large-scale photovoltaic power generation and series compensation lines. In view of the above problems, this paper applies the small signal analysis method and time-domain simulation analysis method to study the mechanism of subsynchronous oscillation of large-scale photovoltaic and series compensation lines, and carries out simulation verification. Finally, the equivalent model of photovoltaic power station is built in PSCAD/EMTDC platform, and its accuracy is verified by simulation.

Time	Paper ID	Presentation
13:45-14:00	**EP080**	Performance optimization of air cooling battery thermal management system based on structure design **Xinyue Zhang, Soochow University, China** Abstract— The battery thermal management system (BTMS) is critical to the battery pack of an electric vehicle, and it significantly affects the battery life and performance. According to the actual application situation, this paper considers the heat dissipation of the battery pack with air flowing in from the bottom and flowing out from the side. Under the premise of maintaining the uniformity of the cell spacing, the effects of the cell spacing, the outlet width, the outermost spacing and the width of the baffle on the cooling performance of the BTMS are studied. The results show that the optimization strategy proposed in this paper is an effective method to improve the cooling performance of the system.
14:00-14:15	**EP082**	Optimization of System Configuration and Production Simulation for On-grid Green Hydrogen Projects **Siyu Zhang, State Grid Energy Research Institute, China** Abstract— Green hydrogen produced from renewable energy through electrolysis is regarded as complementary to electricity, which could help decarbonize sectors that are hard to electrify. Besides, electrolytic hydrogen can serve as an interface and build synergy between different sectors and energy networks. Recently, many demonstration projects, which are normally composed of power generation units, energy storage units and electrolysers, are in the phase of planning and construction. Optimization of the system configuration and the power supply plan are essential elements to reduce the cost of green hydrogen and increase its economic competitiveness. In this paper, an optimization planning model for on-grid green hydrogen projects embedded with the function of production simulation is presented. Then, two case studies are carried out based on the proposed model. One represents green hydrogen projects in the northwestern area with plentiful renewable resources, relatively lower electricity prices and smaller price differences between peak and valley period. The other represents the ones in the southeastern area with relatively higher electricity prices and bigger peak-valley price differences. In each case study, the system configuration is optimized considering the photovoltaic (short as PV) and wind power output characteristics in the local area. Furthermore, the power supply plan, including when to use self-built power plants and when to use power from the grid is also optimized and analyzed. At last, specific suggestions are summarized and proposed for green hydrogen demonstration projects, which could provide important references for the future planning.

Time	Paper ID	Presentation
14:15-14:30	**EP011**	Research on Internationalization Path of Integrated Energy Service Standards **Chengying Xu, Wuhan University, China** Abstract— Under the background of energy structure reform and the Belt and Road Initiative, integrated energy service industry in China is booming and seeks to develop overseas markets, and the internationalization of its standards is one of the key steps. This paper first analyzes the current situation of internationalization of integrated energy service standards at home and abroad, and obtains the factors that hinder the internationalization. Secondly, using the theory of innovation ecosystem, this paper compares the environment of integrated energy service industry with the ecosystem of biology, and points out the three-stage evolution path of internationalization process in China. Finally, the internationalization road-map is formulated from two levels and four time periods, and constructive suggestions are put forward.
14:30-14:45	**EP031**	Robust Resilience-oriented Management Model of Integrated Energy Systems with Random Outages **Yanqiu Hou, Zhejiang University City College, China** Abstract— This paper proposes a robust resilience-enhancing optimization framework of the integrated energy system considering random outages of power lines and pipelines with multi-energy demand responses. First, a two-stage robust optimization framework is devised to accommodate stochastic failures of power lines and pipelines. Secondly, multi-energy demand responses, including electricity and gas demand response are embedded into the proposed framework to provide more flexibility for system operation. To achieve effective solving of the proposed framework, column and constraints generation algorithm(C&CG) is employed. Finally, numerical experiments are conducted to verify the effectiveness of the proposed method.
14:45-15:00	**EP044**	Joint Planning of Electric Vehicle Charging Swapping Station and Energy Hub **Chenke He, South China University of Technology, China** Abstract— This paper proposes a joint planning model of electric vehicle (EV) charging swapping station (CSS) and energy hub (EH) in an integrated energy system (IES). Firstly, via the load analysis of endurance mileage and driving battery level for the of plug-in EVs (PEVs) and swapping taxies (STs), the EV load of CSS is obtained. Then, based on the CSS's internal structure and operating characteristics, the operating and configuring models of CSS are built. After that, we propose configuring models of various energy supply and storage equipment (ESSE) of EH, which fully considers the coupling between planning and operating of ESSEs. And then, the planning comprehensive cost is regarded as the objective, and a joint planning model of CSS and EH is developed. Afterwards, the joint planning model is solved by the CPLEX in this paper. Finally, and the feasibility and effectiveness of the proposed method are verified.

Time	Paper ID	Presentation
15:00-15:15	**EP060**	Research on energy storage scheduling strategy considering high proportion of new energy uncertainty **Chuhao Wang, Nanjing Normal University, China** Abstract— With the continuous improvement of the permeability of new energy, how to deal with the inherent randomness and volatility of wind and solar power generation, evaluate and guarantee the security and economy of system output has become an important issue to ensure the utilization of new energy. Energy storage can determine the timing and scale of energy replenishment or release depending on the amount of generating capacity available to the system. Energy storage has become an important factor to promote the absorption of new energy and ensure the economic security of the power system. Based on the high-proportion new energy output and energy storage system, this paper establishes the collaborative model of fire, light, storage and charge, defines the power generation cost function, and introduces the risk assessment of wind abandoning cost and power outage cost in addition to the cost of coal burning. In addition, the generation of energy storage path in operation is simulated. Finally, the optimal scheme is obtained through the method of linear programming. The optimized path can effectively reduce the power generation cost of the system and promote the absorption of new energy. The final results verify the validity of the model and algorithm.
15:15-15:30	**EP081**	Appliance Scheduling Optimisation Method Using Historical Data in Households with RES Generation and Battery Storage Systems **Martha Correa-Delval, Durham University, UK** Abstract— In recent years, the importance of reducing car_x005f bon dioxide (CO2) emissions has increased. With the use of technologies such as artificial intelligence, we can improve the way households manage their energy use to decrease cost and carbon emissions. In this paper, we use the Spectral Entropya and Instantaneous Frequency-based Bidirectional Long Short Term Memory (SE-IF BiLSTM) method so the Home Energy Management System (HEMS) can learn from historical use data of energy, as well as the preferred consumption patterns for the user. With this data, a multi-objective optimisation problem (MOP) that considers cost, CO2 emissions and discomfort is generated to schedule appliances in different simulation scenarios. These scenarios include households with Battery Storage Systems and with or without Renewable Energy Sources (RES). We compare the results by using Multi-objective Immune Algorithm (MOIA) where we find a 10.06% reduction in cost and 20.56% reduction in CO2 emissions when scheduling the appliances while minimising user discomfort.

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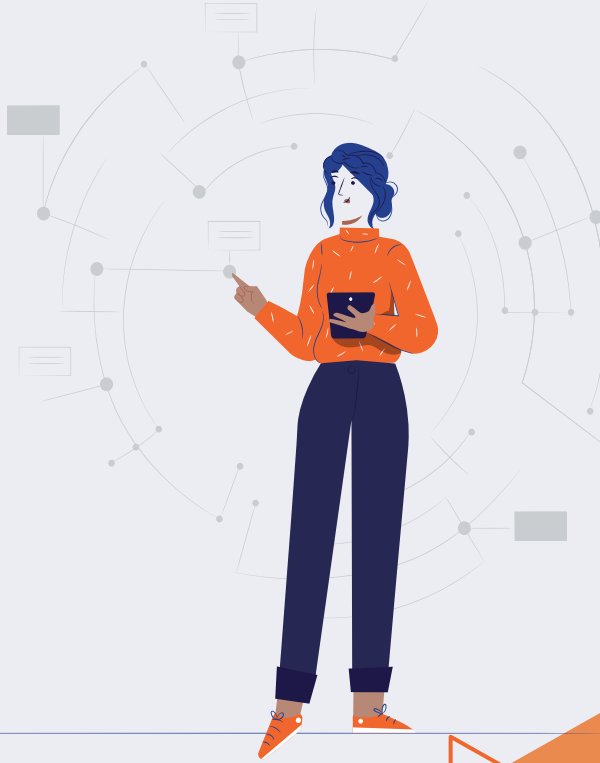

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