CONFERENCE ABSTRACT

CEEGE 2021

June 10-13

CEEGE 2021

THE 4TH INTERNATIONAL CONFERENCE ON ELECTRICAL ENGINEERING AND GREEN ENERGY

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About CEEGE

The 4th International Conference on Electrical Engineering and Green Energy (CEEGE) will take place virtually from June 10-13, 2021.

The clean technologies are now making progress and hence the conference will focus on providing an opportunity to technologists, scientists, industrialists, environmentalists, and experts to showcase their novel energy efficient technologies. The goal of the conference is to address energy and environment related challenges, especially those facing the developing world by providing networking opportunities for global collaborations for developing suitable solutions for diverse applications and user groups. The scientific program will include overviews, state of the art lectures and controversial debates, interactive education sessions, featured symposia, breakout sessions and oral presentation sessions for abstracts. We sincerely hope that the blend of pleasant weather, warm hospitality and revitalizing social evenings will make the scientific environment richer.

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Welcome Address

It gives us immense pleasure to invite you to attend The 4th International Conference on Electrical Engineering and Green Energy (CEEGE 2021), will take place during June 10-13, 2021. The conference focuses on the trending, highly popular, but exciting and extremely challenging areas from our keynote speakers of leading scientists and a variety of authors around the world. The outcome of our deliberations will play a crucial role in progress achieved in these areas. The conference was scheduled in Munich, Germany this year. Unfortunately, it transferred to online due to travel restrictions.

The conference brings together researchers looking for opportunities for conversations that cross the traditional discipline boundaries and allows them to resolve multidisciplinary challenging problems. It is the clear intent of the conference to offer excellent mentoring opportunities to participants. Although we cannot meet each other physically, through this online platform, we trust that you still will be able to share the state-of-the-art developments and the cutting-edge technologies in these broad areas.

We have an exciting four days planned and conference is highlighted with 2 keynote speakers, 3 invited speeches, half-day Symposium as well as 13 parallel sessions. The whole conference is held with two time zones: Germany (GMT+2) and Beijing (GMT+8), because conference attracts around 100 participants from all around the word.

Special thanks are extended to our colleagues in program committee for their thorough review of all the submissions, which is vital to the success of the conference, and also to the members in the organizing committee and the volunteers who had dedicated their time and efforts in planning, promoting, organizing and helping the conference. Last but not least, our special thanks go to speakers as well as all the authors for contributing their latest researches to the conference.

In closing, we thank you for participating in CEEGE 2021 and we hope you enjoy the next four days.

CEEGE 2021 Conference

June 10-13, 2021

www.ceege.org

Conference Schedule

10 JUNE | GMT+8	11 JUNE | GMT+2	12 JUNE | GMT+2	13 JUNE | GMT+8
9:30-10:30 Test Session 1 & 2	9:00–9:05 Opening Remarks & Host **Prof. Hassan Bevrani**	9:00-9:05 Symposium Opening **Prof. Dr. J. A. Paixão**	10:00-12:00 Session 5, 6, 7
	9:05–9:45 Keynote Speech I **Prof. Zhe Chen**	9:05-9:30 Symposium Speaker **Prof. Dr. M. Aziz**	
	9:45–10:25 Keynote Speech II **Prof. Alberto Borghetti**	9:30-10:00 G137, G093	
10:30-11:00 | Break	10:25-10:35 | Break	10:00-10:20 | Break	
11:00-12:00 Test Session 3 & 4	10:35-11:00 Invited Speech I **Prof. Reiner Johannes Schütt**	10:20-10:45 Symposium Speaker **Prof. Dra. M.H. Braga**	
	11:00-11:25 Invited Speech II **Prof. Eduard Siemens**	10:45-11:15 G085, G091	
	11:25-11:50 Invited Speech III **A/Prof. Amjad Anvari-Moghaddam**	11:15-11:20 Symposium Closing **Prof. Dr. M. Aziz**	
	11:50-12:15 Invited Speech IV **A/Prof. Farhad Shahnia**		
12:00-13:30 | Break	12:15-13:30 | Break	11:20-13:30 | Break	11:45-13:30 | Break
13:30-14:30 Test Session 5 & 6	13:30–15:15 Session 1 & 2	13:30–15:30 Session 3 & 4	13:30-15:15 Session 8 ,9, 10
14:30-15:00 | Break			15:15-15:45 | Break
15:00-16:00 Test Session 7 & 8			15:45-17:45 Session 11, 12, 13

Link: https://zoom.com.cn/j/99207634433
Keynote & Invited Speeches, Symposium

Session 1 | Link: https://zoom.com.cn/j/99207634433
Techno-economics of Sustainable Electrical Energy System

Session 2 | Link: https://zoom.com.cn/j/91210761834
Power and Energy Engineering

Session 3 | Link: https://zoom.com.cn/j/99207634433
Smart Grid and Micro Grid

Session 4 | Link: https://zoom.com.cn/j/91210761834
Power Electronics and Transmission Technology

Session 5 | Link: https://zoom.com.cn/j/99207634433
Battery Technology and Electric Vehicles

Session 6 | Link: https://zoom.com.cn/j/91210761834
Fault Diagnosis and Maintenance

Session 7 | Link: https://zoom.com.cn/j/92266961196
Advanced Electronic Technology and Engineering

Session 8 | Link: https://zoom.com.cn/j/99207634433
Voltage and Current Control

Session 9 | Link: https://zoom.com.cn/j/91210761834
Converter Design and Test

Session 10 | Link: https://zoom.com.cn/j/92266961196
Electrical Engineering and Automation

Session 11 | Link: https://zoom.com.cn/j/99207634433
Wind Energy Utilization and Power Generation Technology

Session 12 | Link: https://zoom.com.cn/j/91210761834
Renewable Energy and Clean Energy

Session 13 | Link: https://zoom.com.cn/j/92266961196
Power System Safety and Reliability

Test Schedule

June 10 | GMT+8

Time	Session	Paper ID	ZOOM Link
9:30-10:30	1	G051, G071, G053, G072, G118, G116, G148, G143, G173, G4002, G129, G146	https://zoom.com.cn/j/99207634433
	2	G061, G020, G140, G077, G040, G094, G187, G192, G190, G182, G008, G170	https://zoom.com.cn/j/91210761834
11:00-12:00	3	G134, G145, G046, G175, G012, G111, G080, G038, G166, G147, G110, G092	https://zoom.com.cn/j/99207634433
	4	G033, G132, G006, G117, G135, G101, G093, G084, G115, G158, G098, G180	https://zoom.com.cn/j/91210761834
13:30-14:30	5	G005, G100, G183, G106, G103, G022, G124, G136, G088, G168, G131, G179	https://zoom.com.cn/j/99207634433
	6	G130, G086, G085, G032, G112, G089, G155, G120, G185, G044, G160, G042	https://zoom.com.cn/j/91210761834
15:00-16:00	7	G063, G107, G138, G4001, G144, G097, G109, G152, G174, G056, G025, G4003	https://zoom.com.cn/j/99207634433
	8	Keynote & Invited Speech, Symposium	https://zoom.com.cn/j/91210761834

Test before Formal Meeting

Date: June 10, 2021

Before the formal meeting, presenters shall join the test room to ensure everything is good.

Time Zone

Beijing Time (GMT+8)

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

Equipment Needed

- A laptop with great network and camera
- Headphones

Environment Needed

- A quiet place
- Stable internet connection
- Proper lighting and background

Platform

ZOOM Download link:

- https://zoom.us/download
- https://zoom.com.cn/download (for Chinese authors)

Video Tutorials:

https://support.zoom.us/hc/en-us/articles/206018765-Zoom-Video-Tutorials

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Opening Remarks

CONFERENCE CHAIR

Prof. Hassan Bevrani

University of Kurdistan, Iran

ZOOM Link: https://zoom.com.cn/j/99207634433

Time: 9:00-9:05, June 11 (GMT+2)

Hassan Bevrani received PhD degree in electrical engineering from Osaka University in 2004. He is a full professor and the Program Leader of Micro/Smart Grids Research Center (SMGRC) at the University of Kurdistan. Over the years, he has worked with Osaka University, Kumamoto University (Japan), Queensland University of Technology (Australia), Kyushu Institute of Technology, Centrale Lille (France), and Technical University of Berlin (Germany). Currently, he is a visiting professor at the Osaka University and experienced research fellow of AvH foundation. He is the author of 6 international books, 15 book chapters, and more than 300 journal/conference papers. He has been the gust editor of 4 volumes of Elsevier Energy Procedia and Energy Reports journals. His current research interests include Smart grid operation and control, power system stability, Microgrid dynamics and control, and Intelligent/robust control applications in power electric industry.

Keynote Speech I

Prof. Zhe Chen
Aalborg University, Denmark
Leader of Wind Power Research Program (Fellow of IET, IEEE)
Speech Title: Power and Energy Systems in Green Transition
ZOOM Link: https://zoom.com.cn/j/99207634433
Time: 9:05-9:45, June 11 (GMT+2)

Dr. Chen received his Ph.D. degree in Power and Control, from University of Durham, England, he has been a full Professor with the Department of Energy Technology, Aalborg University, Denmark since 2002.

Professor Chen is the Danish Principle Investigator for *Wind Energy* of *Sino-Danish Centre for Education and Research (SDC)*, the leader of Wind Power System Research program at the Department of Energy Technology, Aalborg University. His main current research interests are wind energy, power electronics, power system and modern energy systems. In these areas, he has led many international and national research projects and has supervised many PhD, Postdoctoral researchers and visiting scholars, has more than 800 technical publications. He is a panel member and a review expert for many international funding organizations.

Dr Chen is a member of editor boards of many international journals, including Associate Editor of the IEEE Transactions on Power Electronics, Subject Editor (wind turbine control) of IET Renewable Power Generation, etc. He is a Fellow of IET, a Chartered Engineer in the U.K., a Fellow of IEEE, a member of European Academy of Sciences and Arts, and a member of the Danish Academy of Technical Sciences.

Abstract: Power and Energy is an important part of Green Transition. Various energy technologies have been developed and utilised to enable the green transition of energy systems, from the sources to conversion and applications, including solar, wind, biomass, and power to x, smart houses etc.

The speech will brief the development of new renewable energy based technologies, discuss the challenges and possible solutions, including some developments in Denmark and recent research results.

Keynote Speech II

Prof. Alberto Borghetti
University of Bologna, Italy (Fellow of IEEE)

Speech Title: Modeling of Renewable Energy Communities and Neighborhood Energy Trading Schemes

ZOOM Link: https://zoom.com.cn/j/99207634433

Time: 9:45-10:25, June 11 (GMT+2)

Alberto Borghetti graduated in electrical engineering from the University of Bologna, Italy, in 1992. Since then he has been working with the power system group of the same University, where is now a Professor of Electrical Power Systems. His research and teaching activities are in the areas of power system analysis, power system restoration after blackout, electromagnetic transients, optimal generation scheduling, and distribution system operation. He is the author or coauthor of over 150 scientific papers published in peer-reviewed journals or presented at international conferences. He has served as Technical Program Committee chairperson of the 2010 30th Int. Conf. on Lightning Protection (ICLP), chair of the 2016 Bologna CIGRE Colloquium on Lightning and Power systems, and as a special reporter for CIGRE 2018. IEEE Fellow (class 2015) for contributions to modeling of power distribution systems under transient conditions, he received the ICLP Scientific Committee Award in 2016 and the 2018 CIGRE Technical Council Award for Study Committee C4. From 2010 to 2017 he served as an editor of IEEE Transactions on Smart Grid. Currently he is a member of the editorial board of IEEE Transactions on Power Systems and of Journal of Modern Power Systems and Clean Energy. Since the beginning of 2019, he serves as editor in chief of Electrical Engineering – Archiv fur Elektrotechnik.

Abstract: Citizens are expected to have a great role in the future global energy transition and assigning them the role of prosumers in the new energy market seems necessary by exploiting the presence of photovoltaic units and other energy resources within users' properties. The creation of energy communities can engage citizens providing flexibility and ancillary services, reducing losses and curtailments in the grid. It also brings environmental and social benefits, activating virtuous circles in the local economy. In this framework, recent electricity regulation in several countries is opening the possibility for electricity end-users to establish direct transactions with their neighbors. The establishment of renewable energy communities equipped with both distributed generation and storage units will increase the local balance between production and consumption during the day, with the expected advantages of improved efficiency and reduced use of the grid. This presentation is aimed at illustrating some models for the analysis of the expected impact on the operation of distribution networks where the use of energy trading between neighbors will become significant. The impact on the operation of the distribution network is mainly associated with the optimal scheduling of the generation and storage units available inside the local energy communities. The presentation is mainly based on the following papers: Lilla S.; Orozco C, Borghetti A., Napolitano F. Tossani F., (2020). “Day-ahead scheduling of a local energy community: an alternating direction method of multipliers approach”, IEEE Transactions on Power Systems, 35(2), 1132 – 1142 and Orozco C, Borghetti A., Napolitano F. Tossani F., (2020). “Multistage day-ahead scheduling of the distributed energy sources in a local energy community”. Proc. Of 2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe).

Prof. Reiner Johannes Schütt

West Coast University of Applied Sciences, Germany

Speech Title: Properties and Approaches for the Use of Power Electronic Equipment to Transform the Energy System

ZOOM Link: https://zoom.com.cn/j/99207634433

Time: 10:35-11:00, June 11 (GMT+2)

Prof. Dr. Reiner Johannes Schütt is the coordinator of focus area “automation of sustainable energy systems” in the “Competence Centre Renewable Energies and Climate Protection Schleswig-Holstein” and member of the “Institute for the Transformation of Energy Systems”. Prof. Schütt received the Diploma degree in Electrical Engineering from the Universtity of Hannover in 1987. Prof. Schütt started his professional career as an R&D engineer in the department of power electronics at the University of Hannover and worked for several years as a technical director at ENERCON Nord Electronic GmbH. In 1998 he joined the West Coast University of Applied Scienes in Schleswig-Holstein as a Professor for Electrical Drives and Control with focus on applications in decentralized sustainable energy systems. He published numerous technical journals and conference proceedings especially in the field of control and automation of decentralized electrical generators. In 2010 he published the “Innovation Study Pellworm”, where he described how to build up a smart grid on a German island. Prof. Schütt is co-author of the book “Understanding Wind Power Technology”, 2014 John Wiley & Sons, Ltd.

Abstract: Power generation, transmission and distribution are in a profound change process. In many regions all over the world, the annual generation of electrical energy from renewable sources is higher than consumption what makes it necessary to renew, to expand and to redesign the electrical distribution grids. It is well known, that power electronic equipment like smart transformers in different application-oriented configurations and MV-DC- or HV-DC-short coupling systems increase the flexibility of electricity distribution grids but there are few holistic approaches to the characterization and evaluation with regard to the transformation of the energy system. This presentation describes selected power electronic equipment and topologies and first applications in Northern Germany to show which properties are decisive for use. It is obvious that electrical characteristics and requirements on the primary and secondary side of the grid connection including the loads and generators have to be considered. Each application offers possibilities to integrate an increased number of decentralized and renewable energy sources as well as new loads.

In case of a smart transformer on the primary side there are mainly the requirements from the grid on the higher voltage level which determines the necessity. On the secondary side the connected loads and generators as well as the possibility of using DC distribution to connect these units determine if the use of a smart transformer is beneficial. In case of a MV-DC- or HV-DC-short coupling system two possible use cases for the back-to-back converter are presented. On the one hand it is used to improve the power quality with the help of phase shifting operation. On the other hand, a bidirectional power flow between different areas at the lower voltage level even with different frequencies, unmatching phase angles or vector groups as well as grounding schemes is possible to relieve the infrastructure at the higher voltage level. Additional functionalities like black-start of a sub-network, island operation, grid-forming capabilities, inertia support and avoidance of fault or harmonic propagation between different sub-networks are possible.

With the help of the applications it is demonstrated that beside these electrical properties other non-electrical criteria such as environmental conditions at the expected site, noise level, life time, carbon footprint and economic criteria are decisive. This presentation makes a first attempt for a guidance to evaluate when and under what preconditions the use of these devices is beneficial or not.

Invited Speech II

Prof. Eduard Siemens
Anhalt University of Applied Sciences, Germany

Speech Title: Energy-Autarkic Systems for Rural Areas – Use of IOT for Deployment of Economically Feasible and Environment-Friendly Energy Islands

ZOOM Link: https://zoom.com.cn/j/99207634433

Time: 11:00-11:25, June 11 (GMT+2)

Prof. Dr. Eduard Siemens is head of the Future Internet Lab Anhalt and manages a research group of about 15 PhD students. He is conducting research in applied sciences on the topic of Industrial IoT, M2M communications, of efficient and fast data transport and Big Data infrastructures. The main application of IoT is the use of communication technologies for raising efficiency of energy systems. In this field he has implemented several field setups of energy systems in countries of Central Asia as well as in South-East Asia.

Prof. Siemens is author of more than 80 patents and author of about 100 peer-reviewed publications. He is also chair of the International Conference of Applied Innovations in IT and takes over over reviews for several technical journals.

Besides his full professorship position at University of Applied Sciences Anhalt he is also visiting professor position at National Research Tomsk Polytechnic University. In this role he coordinates several double degree programs with Universities of South-Easts Europe, Central Asia and Russa.

He is founder of several tech start-ups in the field of energy efficiency and also in Big Data – e.g. SmartLighting, Dexor, Tixel with several technology and start-up awards.

Abstract: Prof. Dr. Eduard Siemens is head of the Future Internet Lab Anhalt and manages a research group of about 15 PhD students. He is conducting research in applied sciences on the topic of Industrial IoT, M2M communications, of efficient and fast data transport and Big Data infrastructures. The main application of IoT is the use of communication technologies for raising efficiency of energy systems. In this field he has implemented several field setups of energy systems in countries of Central Asia as well as in South-East Asia.
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Invited Speech III

A/Professor Amjad Anvari-Moghaddam

Aalborg University, Denmark

Speech Title: Green Energy Transition – Opportunities and Challenges

ZOOM Link: https://zoom.com.cn/j/99207634433

Time: 11:25-11:50, June 11 (GMT+2)

Amjad Anvari-Moghaddam received the Ph.D. degree (Hons.) from University of Tehran in 2015 in Power Systems Engineering. From 2015 until 2019 he was a Postdoctoral Research Fellow at Aalborg University. Currently, he is an Associate Professor at the Department of Energy Technology, Aalborg University where he is the coordinator and responsible for the Integrated Energy Systems Laboratory (IES-Lab). His research interests include planning, control and operation management of microgrids, renewable/hybrid power systems and integrated energy systems with appropriate market mechanisms. He has (co)authored more than 200 technical articles, four books and eight book chapters in the field. Dr. Anvari-Moghaddam serves as the Associate Editor of the IEEE TRANSACTIONS ON POWER SYSTEMS, IEEE ACCESS, IEEE SYSTEMS JOURNAL, IEEE OPEN ACCESS JOURNAL OF POWER AND ENERGY, and IEEE POWER ENGINEERING LETTERS. He is the Vice-Chair of IEEE-PES Danish Chapter and serves as a Technical Committee Member of several IEEE PES/IES/PEL and CIGRE working groups. He was the recipient of 2020 DUO – India Fellowship Award, DANIDA Research Fellowship grant from the Ministry of Foreign Affairs of Denmark in 2018, IEEE-CS Outstanding Leadership Award 2018 (Halifax, Nova Scotia, Canada), and the 2017 IEEE-CS Outstanding Service Award (Exeter-UK).

Abstract: With the 2015 Paris Agreement, the world is on a new trajectory towards sustainable development and a low-carbon economy. Delivering on the promise of Paris requires countries to urgently scale up renewable energy and to use energy more efficiently. At the same time, the energy landscape is changing rapidly with far-reaching implications for the global energy industry and actors. While the transformation of the energy system is rapid in certain regions of the world-such as Europe (through leveraging formation technology, smart technology, policy frameworks and market instruments), the speed of the global energy transition remains highly uncertain and there exist a number of socio-technical challenges yet to be solved. Harvesting renewable energies implies decentralization, where many consumers also become producers, who at times export electricity to the grid. To accommodate large numbers of renewable resources, energy distribution and transmission networks need to be adapted and expanded to avoid network congestion and failures. Flexibility options and services have to be also enabled not only at the supply side but also through responsive loads and suitable means of energy storage to maximize the security of supply and the quality of service in the most efficient way. Accelerating the energy transition also requires a rethinking of electricity markets in many aspects, a key one being the adaptation of their design and operation to support higher shares of variable renewables as well as distributed power generation. This talk covers the aforementioned promising areas in green energy transition and discusses the current and future opportunities and challenges exist in this context.

Invited Speech IV

A/Prof. Farhad Shahnia

Murdoch University, Australia

Speech Title: Recent and Future Research on Microgrid Clusters

ZOOM Link: https://zoom.com.cn/j/99207634433

Time: 11:50-12:15, June 11 (GMT+2)

A/Professor Farhad Shahnia received his PhD in Electrical Engineering from Queensland University of Technology (QUT), Brisbane, in 2012. He is currently an A/Professor at Murdoch University. Before that, he was a Lecturer at Curtin University (2012-15), a research scholar at QUT (2008-11), and an R&D engineer at the Eastern Azarbayjan Electric Power Distribution Company, Iran (2005-08). He is currently a Fellow member of Engineers Australia, Senior Member of IEEE, and member of the Australasian Association for Engineering Education. Farhad's research falls under Distribution networks, Microgrid and Smart grid concepts. He has authored one book and 11 book chapters and 100+ peer-reviewed scholarly articles in international conferences and journals, as well as being an editor of 6 books. Farhad has won 5 Best Paper Awards in various conferences and has also received the IET Premium Award for the Best Paper published in the IET Generation, Transmission & Distribution journal in 2015. One of his articles was listed under the top-25 most cited articles in the Electric Power System Research Journal in 2015 while one of his 2015 journal articles has been listed under the top-5 most read articles of the Australian Journal of Electrical and Electronics Engineering. He was the recipient of the Postgraduate Research Supervisor Award from Curtin University in 2015 and the Australia-China Young Scientist Exchange Award from the Australian Academy of Technology and Engineering in 2016. Farhad is currently a Subject Editor, Deputy Subject Editor, and Associate Editor of several journals including IEEE Access, IET Generation, Transmission & Distribution, IET Renewable Power Generation, IET Smart Grid, IET Energy Conversion and Economics, and International Transaction on Electrical Energy Systems and has served 35+ conferences in various roles such as General, Technical, Program, Publication, Publicity, Award, Sponsorship, and Special Session Chairs. Farhad is currently the Chair of the IEEE Western Australia Section and a member of IEEE's Industrial Electronics Society (IES)'s Technical Committees of Smart Grid and Energy Storage.

Abstract: Electricity systems around the world are experiencing a radical transition as the consequence of replacing fossil fuels, used for electricity production, by sustainable and cleaner energies. The growing penetration of renewable energies requires smarter techniques capable of handling the uncertainties of these intermittent sources. Along with this change, traditionally centralised power systems are also converting into distributed self-sufficient systems, often referred to as microgrids, that can operate independently. This talk will focus on remote area microgrids as a hot research topic in Australia and Southeast Asia that have hundreds of remote and off-grid towns and communities, and islands. It is expected that remote area microgrids will strongly benefit these remote locations in the forthcoming years. This talk will briefly introduce the progress of research in this field around the world and Australia, and will also discuss some of the technical challenges associated with interconnection of neighbouring microgrids as a key step to improve their survivability in the course of unexpected imbalances between the demand and the available generation from intermittent renewable resources.

Mini Symposium

Topic: Modeling and Experimental Characterization of Advanced Materials and Systems for Energy Applications
ZOOM Link: https://zoom.com.cn/j/99207634433
Time: 9:00-11:20, June 12 (GMT+2)

Symposium Chair
Prof. Dr. J. A. Paixão
The University of Coimbra, Portugal

Symposium Co-Chair & Speaker
Prof. Dr. M. Aziz
The University of Tokyo, Japan

Symposium Coordinator
Dr. S.A.M. Elmoselhy
The University of Coimbra, Portugal

Symposium Speaker
Prof. M.H. Braga
The University of Porto, Portugal

Abstract: The present symposium addresses recent advances in modeling, experimental characterization and instrumentation for green energy applications. The symposium covers modeling topics that include: First-principle calculations, Density-functional theory, Atomic and molecular-scale simulations, Empirical / Semi-empirical methods, and Multi-scale modeling. Also, the symposium covers topics of experimental characterization of Advanced Materials as well as instrumentation systems including: (1) Characterization and evaluation of mechanical, electrical, magnetic, optical, chemical or thermal properties; (2) X-ray-based techniques; (3) Chromatography and mass spectrometry; (4) Analog / digital instrumentation and electronics. The symposium is dedicated to modeling and experimental research work in physics of advanced materials, green energy and applied physics. The relevant topics and applications include: Electrical engineering, Power & energy, Electronics & control, Communications & Digital signal processing, Sustainable energy, Nanomaterials, Nanotechnology, Modelling, Instruments to support science/technology, Computational methods, Experimental characterization and Optimization. Such applications help in realizing highly efficient and green energy systems that are developed toward the realization of a sustainable society.

Keywords: Green energy, Power & energy, Electronics & control, Communications & Digital signal processing, Electrical engineering, Nanomaterials, Nanotechnology, Modelling, Instruments and characterization

Presentation Guideline

Time Zone

- June 10: Beijing Time (GMT+8)
- June 11: Germany Time (GMT+2)
- June 12: Germany Time (GMT+2)
- June 13: Beijing Time (GMT+8)

Voice Control Rules

- The host will mute all participants while entering the meeting.
- The host will unmute the speakers' microphone when it is turn for his or her presentation.
- Q&A goes after each speaker, the participant can raise hand for questions, the host will unmute the questioner.
- After Q&A, the host will mute all participants and welcome next speaker.

Oral Presentation

- Timing: a maximum of **15 minutes** in total, including 3 minutes for Q&A. Please make sure your presentation is well timed.
- It is suggested that the presenter email a copy of his/her video presentation to the conference email box as a backup in case any technical problem occurs.

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* The recording will be used for conference program and paper publication requirements. The video recording will be destroyed after the conference and it cannot be distributed to or shared with anyone else, and it shall not be used for commercial nor illegal purpose. It will only be recorded by the staff and presenters have no rights to record.

Parallel Sessions Glance

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2	13:30-15:15	G143, G173, G4002, G129, G146, G082, G061	https://zoom.com.cn/j/91210761834	P21
June 12, 2021 | GMT+2				
Symposium	9:00-11:00	M. Aziz, G137, G093, M.H. Braga, G085, G091	https://zoom.com.cn/j/99207634433	P24
3	13:30-15:15	G020, G030, G052, G140, G077, G174, G120, G197	https://zoom.com.cn/j/99207634433	P27
4	13:30-15:15	G040, G156, G094, G192, G190, G182 G187, G198	https://zoom.com.cn/j/91210761834	P31
June 13, 2021 | GMT+8				
5	10:00-12:00	G008, G170, G134, G145, G046, G175, G012, G195	https://zoom.com.cn/j/99207634433	P34
6	10:00-11:45	G111, G080, G086, G166, G038, G147, G110	https://zoom.com.cn/j/91210761834	P37
7	10:00-12:00	G092, G033, G132, G006, G117, G135, G101, G196	https://zoom.com.cn/j/92266961196	P41
8	13:30-15:15	G121, G084, G115, G158, G098, G180, G133	https://zoom.com.cn/j/99207634433	P45
9	13:30-15:15	G005, G100, G183, G142, G106, G103, G022	https://zoom.com.cn/j/91210761834	P48
10	13:30-15:15	G124, G136, G088, G168, G131, G179, G130	https://zoom.com.cn/j/92266961196	P51
11	15:45-17:45	G018, G032, G112, G089, G155, G185, G071, G194	https://zoom.com.cn/j/99207634433	P54
12	15:45-17:30	G044, G160, G042, G063, G053, G107, G036	https://zoom.com.cn/j/91210761834	P57
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Session 1- Techno-economics of Sustainable Electrical Energy System

Chair: Prof. Mohan Kolhe, University of Agder, Norway

13:30-15:15, June 11 (GMT+2)

Zoom Link: https://zoom.com.cn/j/99207634433

G051
13:30-13:45

Energy Storage Analysis and Flow Rate Optimization Research of Vanadium Redox Flow Battery

Dr. Zebo Huang, Anle Mu, Fuxiang Hao, Hang Wang, Jianxiang Yang
Xi'an University of Technology, China

Abstract: Vanadium redox flow batteries (VRFBs) have become the best choice for large-scale stationary energy storage technology due to their outstanding advantages such as flexible design, good safety, long life, no ion cross-contamination, and environmental friendliness. The random and intermittent nature of renewable energy has accelerated the promotion and application of VRFBs, which is a promising new energy storage technology. This article briefly discusses the current status and demand of renewable energy power generation, the analysis of the current status of energy storage technology led by VRFBs, the working principle and technical bottlenecks of VRFBs. The focus is on the optimization and design of the flow field structure to improve the distribution characteristics of the electrolyte solution and improve the battery performance. The simulation structure shows that designing a reasonable flow channel size can optimize the electrolyte flow rate and improve performance.

G072
13:45-14:00

Research of Renewable Energy Penetration Rate in Integrated Energy Stations

Prof. Guangqing Yu, Zhicheng Jiang, Yuming Liu, Yingke Zhang
Tsinghua University, China

Abstract: At present, multi-station fusion forms a variety of modes based on various combinations of substation, data center, energy storage station and charging station. In this paper, an integrated energy system was designed, using existing substation resources, construction of data fusion center stations, energy storage station, 5 g base stations, photovoltaic power station, wind power station, gas turbine station etc., realizing the sharing of resource integration, to support smart grid, to develop into a comprehensive energy services as a typical application scenario. The simulation was created to focus on evaluating the reliability of the system and penetration of the renewable power. Results of the structural optimization model simulation show that the designed integrated control strategy of multi-energy fusion energy station has high performance and comprehensive energy efficiency.

G025
14:00-14:15

Investigating the Potential of Solar Trackers in Renewable Energy Integration to Grid

Oladimeji Joseph Ayamolowo, **Dr. Patrick Tendayi Manditereza,** K. Kusakana
Central University of Technology, South Africa

Abstract: Over the years, there has been a continued effort aimed at enhancing the energy output of PV panels. One of such innovations is in the use of solar trackers to improve the overall performance and efficiency of solar systems. This paper presents a critical review of various types of solar tracking systems, highlighting their key characteristics, merit, and demerits. In addition, a prototype double axis solar tracker

was developed and tested. The results show the power output of the prototype double axis solar tracker to be 30.5% higher than that of a fixed PV system, also an increase in efficiency from 35.91% to 45.45% was observed. Finally, the research reveals that a double-axis solar tracked PV system in Nigeria will deliver an estimated 823,150,000Wh more energy than PV system without the use of solar tracker in the long term, which further justifies the importance of solar trackers in renewable energy integration to grid.

G116
14:15-14:30

Weekly Bidding Strategy and Selling Price Determination for A Energy Internet Zone
Dr. Yangyang Liu, Jiangxin Zhou, Renjie Dai, Qian Lou, Yu feng
Nantong University, China

Abstract: Energy internet zones, which supply and manage multiple energy kinds to customers simultaneously, attract more and more attentions for its high energy efficiency. This paper discussed the optimal weekly bidding strategy for a energy internet zone in midterm timescale. The optimal amount of bilateral contract and selling prices of multiple energy kinds can be obtained for expected profit maximization. Stochastic optimization is adopted to manage the uncertainties of electricity market prices and load demands. A energy internet zone in shanghai, China is adopted to illustrate the proposed model. The result shows that the energy internet zones prefer to supply the base load by signing bilateral contracts. The signed contracts increase with the decrease of contract prices and local photovoltaic system's installed capacity.

G013
14:30-14:45

Optimal Design and Techno Economic Analysis of Wood Based Biogas Hydro Solar Hybrid System for A Remote Pond
Milan Tomović, Miroljub Jevtić,' **Mr. Dardan Klimenta**, Jordan Radosavljević
University of Priština in Kosovska Mitrovica, Serbia

Abstract: This paper deals with the design and optimization of an autonomous system consisting of a hydropower plant, photovoltaic system, biogas-fuelled generator, and battery storage. As a case study, the trout pond of Jablanica at the foot of the mountain of Juzni Kucaj in eastern Serbia is taken. Because the presence of a significant amount of wood biomass, optimization of the system was carried out for the following three cases: (1) when using diesel fuel (2) when using biogas produced from pure beech wood and (3) when using biogas produced from waste wood. The system configuration was optimized with respect to the total system costs, electricity generation costs and greenhouse gas emissions. Moreover, a sensitivity analysis was performed using different values of the mean annual flow of the river supplying the pond and hydro turbine with water, solar irradiance and daily amount of wood biomass. The optimization and sensitivity analysis of the given system was performed using the HOMER software.

G118
14:45-15:00

Risk Assessment of Park-level Integrated Energy System Planning Considering Uncertainty and Dynamic Correlation of Natural Gas Price and Electricity Price
Mr. Yan Cao, Congshan Wang, Yunfei Mu, Hongjie Jia, Kuihua Wu, Kai Hou
Tianjin University, China

Abstract: The planning of the park-level integrated energy system (PIES) is a long-term process, it faces risk caused by the volatility of energy prices including the natural gas price (NGP) and the electricity price (EP). The uncertainties of them are complex and have time-varying correlation, which influence the results of risk losses evaluation. To resist the future risk and guide the planning of PIES, a risk assessment method considering the uncertainty and dynamic correlation of energy prices is proposed in this paper.

Considering the heteroscedasticity effect of NGP and EP, the time-varying marginal distribution models of them are established using the generalized autoregressive conditional heteroscedasticity (GARCH) model. Subsequently, resorting to the dynamic Copula function and dynamic conditional correlation (DCC) model, the dynamic joint distribution of NGP and EP is established, which describes the dynamic correlation of NGP and EP. On this basis, the Monte Carlo method is adopted to generate scenarios of NGP and EP to simulate possible situations. Then the conditional value at risk (CVaR) is introduced as the risk measure to quantify the risk losses for the PIES planning schemes. Simulation results verified the effectiveness of the proposed method, which can present different correlation features of energy prices in different time periods and beneficial to evaluate the risk losses. And the utilization of multi-energy complementary supply and distributed renewable resources can improve the risk-resistant ability of the PIES.

G148
15:00-15:15

Research on Local Consumption Method of Distributed Photovoltaic Generation for Benefits of Multi Parties Based on Blockchain

Mr. Tao Zhang, Jianhua Yang, Jiabin Li, Zhijie Yang, Kaiyuan Jin
China Agricultural University, China

Abstract: With the continuous growth in the proportion of distributed photovoltaic generation installed in rural distribution networks, some problems such as abandoning solar energy and increasing voltage fluctuation have become more and more prominent. In order to increase the local electricity consumption of the photovoltaic generation, the incentive mechanism using an optimal internal electricity price is proposed with blockchain technology. Some information is collected and stored in the blockchain network as scoring indicators. A comprehensive scoring strategy for photovoltaic generation companies to consumers is established. The optimal internal electricity price is set by maximizing comprehensive revenue of the companies and the consumers. The time-shiftable load plan can be made for the consumers based on the price and actual load constraints. The simulation result shows that the comprehensive revenue is increased, and the local electricity consumption rate of distributed photovoltaic generation is significantly raised after the incentive mechanism is implemented with the internal electricity price, and the feasibility of the blockchain technology is verified for the mechanism.

Session 2-Power and Energy Engineering

Chair: Prof. Eduard Siemens, Anhalt University of Applied Sciences, Germany

13:30-15:15, June 11 (GMT+2)

Zoom Link: https://zoom.com.cn/j/91210761834

G143
13:30-13:45

Temporal Feature Adaptive Non-Intrusive Load Monitoring Via Unsupervised Probability Density Evolution

Dr. Yu Liu, Tiancheng E. Song, Xiaolong Sun, Shan Gao, Xueliang Huang
Southeast university, China

Abstract: Toward the smart power and energy consumption, non-intrusive load monitoring is emerging as the promising technical assistance of intelligent energy user. The load behaviors of individual power users are distinct, that is potential to enhance the monitoring performance if effectively addressed. In this paper, the customized temporal behaviors are thoroughly investigated and utilized for load disaggregation from the view of time characteristics. At the first stage, the temporal features of appliance usage are formularized via customized time of use probability, and the model is adaptive for the specific user habit via unsupervised probability density evolution method. Then, a generic two-stage load disaggregation framework is proposed, where the primary stage is formulized by dictionary learning and for basic load disaggregation, and the secondary stage is integrated with probabilistic temporal weights and for optimal disaggregation decision. Lastly, the sparse coding principle and risk analysis theory are employed for the robust problem solution. By comprehensive verifications on low voltage networks simulator, it is demonstrated that the proposed approach is effective in temporal load feature modelling, and thereby achieving the higher accuracy and flexibility for the non-intrusive load monitoring problem.

G173
13:45-14:00

Energy Storage Configuration of An Integrated Energy System Considering the Response of Air-Conditioning Load and The Uncertainty of Source-Load

Mr. Hongye Zhang, Li Kang, Jiinwen Yang, Jinjian Cai, Ruidong Wang, Zhihong Cai, Guoxin Liu
Dongguan University of Technology, China

Abstract. The integrated energy system is developing rapidly because of its good energy efficiency. With the development of the integrated energy system, how to reduce the operating cost of the system and improve the utilization rate of new energy in the system has become the focus of today. This paper considers the response of air-conditioning load, and establishes a two-stage robust configuration model to integrate the energy storage of the energy system. The model aims at the lowest comprehensive annual cost, which includes the investment cost of energy storage, the compensation cost after the air-conditioning load response, the maintenance cost of the equipment, the cost of electricity purchase, the cost of natural gas, and the income from electricity sales. The results of the calculation example show that, compared with the case where the response of the air conditioning load is not considered and the energy storage is not configured, the energy storage configuration in the integrated energy system that considers the response of the air conditioning load can effectively cope with the uncertainty of the source load and improve the consumption rate of renewable energy.

G4002
14:00-14:15

Real-time Power Dispatch in A Standalone Hybrid Multisource Distributed Energy System Using An Arduino Board

Kelebogile Confidence Meje, Lindiwe Bokopane, Kanzumba Kusakana , Mukwanga Siti
Central University of Technology, South Africa

Abstract: This paper presents the implementation of a real-time automated energy management control in a RE hybrid system, integrated with backup and validated in a laboratory setup. The experimental setup used a fuzzy intelligent controller in Chapters 3 and 4 for energy management on the software tool platform, the control board layout designed with aid of the Proteus Design Suite 8.1 software and the Arduino MEGA2560 hardware platform board, uploaded from Arduino integrated development Environment (IDE). The utilized hardware platform has the ability to monitor the real-time voltage dissipated by each component and is balanced by the controller via the voltage regulator, by adjusting it to an acceptable and readable voltage of 5V by Arduino to the load. Arduino IDE has been programmed and uploaded to the hardware platform using C++ language. Furthermore, there are two different Arduino types, Arduino MEGA and Arduino UNO. Arduino MEGA2650 was selected in this study, as it has a more pin size compared to UNO and it may further accommodate a hybridized system with more components. The experimental results, therefore, was observed through experimental work that was based on the Arduino control preferences; the model capable of providing automatic supply of power to the load without human interferences, visualised in MATLAB plotting.

G129
14:15-14:30

Research on HIL-based HVRT and LVRT Automated Test System for Photovoltaic Inverters

Fei Li, **Ms. Mengtao Liu**, Yingfeng Wang, Xing Zhang
Hefei University of Technology, China

Abstract: As an important capability of the photovoltaic grid-connected inverter, high voltage ride-through (HVRT) and low voltage ride-through (LVRT) capability are related to the stability of the whole power grid system. Therefore, according to the requirements of HVRT and LVRT standards, an automatic test and analysis system of the photovoltaic inverter is designed based on a hardware-in-the-loop (HIL) simulation platform, which saves time and human resources. Firstly, this paper analyzes the specific requirements for HVRT and LVRT capabilities in Q/GDW 1617- 2015. Secondly, a HIL simulation platform is built. Thirdly, an automatic test and analysis system is developed based on Python and m language using RT-LAB and Matlab software, which can realize the automation of HVRT and LVRT test, data collection and storage, data processing and standard index calculation, and test results report generation of the photovoltaic inverter under different steady-state conditions. Finally, the correctness of the system is verified on the HIL simulation platform.

G146
14:30-14:45

Distributed Demand Response with Multi-Type Air Conditioner Integration: A Numerical Case

Yu Liu, **Mr. Tian Gao**, Yiwen Shen, Xin Zhao, Shan Gao, Xueliang Huang
Southeast University, China

Abstract: Green and clean energy are increasingly becoming the top priority of global energy development, in which demand response plays an important role to improve the consumption of green energy generation and the process of energy substitution. The cluster of air-conditioning loads has great potential to participate in demand response, while different control methods and operating characteristics corresponding to different air-conditioning types will have different effects on the results of demand

response. Based on the research on the load features of fixed-frequency and variable-frequency air conditioners and the characteristics of participation in demand response, through a distributed response strategy of slacked consistency, the influence of different control methods and different proportions of two types of air conditioning loads is compared and analysed through simulation cases. The results show that when the number of response users is the same, the schedulable potential of air-conditioning cluster is positively correlated with the proportion of fixed-frequency air-conditioning in the cluster.

G082
14:45-15:00

Tariff Approach to Regulation of the European Gas Transportation System: Case of Nord Stream

Dr. Vadim Fetisov, Pavel Tcvetkov, Johannes Müller
Saint Petersburg Mining University, Russia

Abstract: Nord Stream 2 is one of the most discussed energy projects, which affects the economic and political interests of many countries, not only the direct participants. Despite some uncertainty, the project is highly likely to be completed. In this regard, it is important to understand what impact it will have on the European gas market. This article proposes a simulation model for calculating the total cost of construction of the Nord Stream 2 and determines the cost of natural gas. It was concluded that Nord Stream 2 has an economic advantage over liquified natural gas (LNG) delivery schemes, a strategic value for the economies of the EU countries and will ensure the stability of gas supply, which is undoubtedly a priority for European energy policy.

G061
15:00-15:15

Optimal Dispatch of Integrated Energy System Considering Demand Response and Load Inertia

Feng Hong, Haixin Wang, Junyou Yang, Yunlu Li, Xiran Zhou, Liu Gao
Shenyang University of Technology, China

Abstract: Renewable energy has the characteristics of strong anti-peak regulation and uncertainty, which cause severe challenges to system peak shaving and renewable energy accommodation. To cope with the challenges of system peak shaving and renewable energy accommodation, this paper proposes an optimal dispatch model of integrated energy system (IES), which considers the price-based demand response and load inertia. Firstly, the impact of changes in energy price on users' energy consumption is analyzed, and the cool and heat loads inertias are considered in their unbalanced constraints. Secondly, the objective function of the minimum operation costs of the IES is established, including the penalty cost of wind power and photovoltaics curtailments, and operation costs. Finally, the optimal dispatch model of IES is established and solved by YALMIP and GUROBI, respectively. The proposed model is compared with other conventional models. The accommodation capacity of renewable energy with the proposed model is enhanced.

Symposium-Modeling and Experimental Characterization of Advanced Materials and Systems for Energy Applications

Chair: Prof. Dr. J. A. Paixão, The University of Coimbra, Portugal

9:00-11:20, June 12 (GMT+2)

Zoom Link: https://zoom.com.cn/j/99207634433

Speech I
9:05-9:30

Prof. M. Aziz
The University of Tokyo, Japan

Bio: Professor Dr. M. Aziz, is a world-class expert in energy engineering and process integration. His research interests span several fields such as green energy, integrated energy harvesting, electric vehicles, and electrical engineering. His research publications quality index i10-index is 75 with about 2800 citations, publishing in top journals such as "Energies". He is the Head of the Energy Laboratory, The University of Tokyo, Japan

G137
9:30-9:45

Research on Suppression of External Magnetic Field Interference of Tunnel Magnetoresistive Sensor Based on Versoria Variable Step Improved Adaptive Filtering Method

Dr. Jicheng Yu, Changxi Yue, Chengzhou Jiang, Dongdong Zhang, Xiaoning Huang, Chengshun Yang, Lei Li
China Electric Power Research Institute, China

Abstract: As a new generation of magnetic sensors, tunnel magnetoresistive sensors have the advantages of good temperature characteristics and high sensitivity and have been extensively studied and applied in electric energy measurement. External magnetic field interference is an important essential factor affecting the measurement accuracy of magnetic sensors. The article studies the measurement principle of the tunnel magnetoresistive sensor, establishes an array model with interference sources, and then proposes an improved adaptive filtering method based on the versoria variable step to suppress external magnetic field interference. Then specific to the DC distribution network's current measurement scenario, the influence of the ratio of the interference source distance to the array radius and the initial angle of the array on the measurement error is analyzed. The interference suppression effects of different other algorithms are analyzed compared. Finally, it is verified by building finite element simulation and simulation tests. The research results show that when the measured current I_1=300A, the interference current I_2=-300A or I_1=-300A, I_2=300A, the relative error before filtering and after filtering based on the improved algorithm drops from 4.2907% to 0.02667%, which is much smaller than 1%. This provides a theoretical basis for tunneling magnetoresistance sensors to measure energy in the DC distribution network further.

G093 9:45-10:00	Research on Three-Phase Four-Wire NPC Rectifier for Tokamak Low-Frequency Resonance Suppressor **Xianshun Shen,** Ge Gao, Yanan Wu, Jun Qu, Zhiwei Mao, Liang Tan, Jing Lu, Mingyan Dai, Jiansheng Wang, Jie Yang Institute of Plasma Physics, Chinese Academy of Sciences

Abstract: A low-frequency harmonic resonance scheme is proposed in this paper to repress low-order harmonics generated by Tokamak power system. The low-frequency resonance suppressor based on hybrid active filter can effectively restrain the low-order harmonic current and its resonance amplification. The low-frequency harmonic suppression principle of LFRS is analyzed. Meanwhile, the mathematical model of three-phase four-wire neutral-point-clamped rectifier is established in the LFRS. According to the mathematical model, the double closed-loop and zero sequence current control strategies are proposed to realize the unity power factor operation on AC side and neutral point potential balance control on DC side of three-phase four-wire rectifier. Finally, the correctness and effectiveness of the control strategy are verified by simulation.

Speech II 10:20-10:45	**Prof. Dra. M.H. Braga** The University of Porto, Portugal

Bio: Prof. Helena Braga, is a world-class expert in energy storage devices and materials. Her research interests span several fields such as green energy, ferroelectric materials, energy harvesting, and storage cells. Her research publications quality index i10-index is 17 with about 1000 citations, publishing in top journals such as Journal of the American Chemical Society. She is the Director of the Engineering Physics Department, The University of Porto, Portugal

G085 10:45-11:00	Analysis of Transient Recovery Voltage and Secondary Arc Current in Transposed Extra-High Voltage Lines in A Two-Phase Auto-Reclosing Karomatullo Makhmudov, Tatyana Krasilnikova, Murodbek Safaraliev, Sergey Kokin, Anvari Ghulomzoda, **Assoc. Prof. Stepan Dmitriev** Ural Federal University, Russia

Abstract: Extra-high voltage (EHV) lines of 500-750 kV, providing transmission of electricity over long distances and at the same time performing the functions of intersystem communication at the level of the national power system, play an important role not only in normal modes, but also in emergency modes, ensuring the dynamic stability of the power system as a whole. In these lines, the overwhelming proportion of power cuts are caused by single-phase short circuits (90%), a significant part of which, being unstable arc faults, are successfully eliminated in the single-phase auto-reclosing cycle. Also, about 5-10% of failures can be constituted by two-phase short circuits, which can be eliminated in a two-phase auto-reclosing cycle (TPhAR). The purpose of this paper is to study two-phase auto-reclosing in transposed EHV lines equipped with four-radial shunt reactors (ShR). The paper analyzes the efficiency of using a two-phase auto-reclosing to eliminate two-phase short-circuits in the lines connecting the power systems of Kyrgyzstan and Tajikistan. An algorithm is proposed for calculating the transient recovering voltages (TRV) and secondary arc currents (SAC) in the real transposed line Datka - Khujand - Dushanbe. The obtained results of TRV and SAC, which are within the permissible limits for the Dushanbe - Khujand line section, make it possible to have a dead time of TPhAR of no more than 0.6 sec, in order to maintain the dynamic stability of the power system.

For lines with a length of about 500 km (Datka - Khujand), equipped with three reactors, a successful TPhAR is impossible due to the appearance of resonant TRV in the circuit. The paper proposes the use of banks of capacitors connected in series in the phases of the ShR for the implementation of a successful TPhAR with the duration of the required pause of about 0.6 sec

G091
11:00-11:15

Simulation Calculation and Comparative Analysis of Three Dimensional Temperature Field of UHV Through Wall Casing Under Different Current Carrying Capacity

Shi Yunfei, Gengsheng Xie, Shoufeng Jin, Shouwen Liu, Peng Liu, Zongren Peng
Xi'an Jiaotong University, China

Abstract: With the development of UHV technology, the working current and voltage level of UHV power transmission and transformation equipment are constantly improving. As the key equipment of UHV transmission and transformation line, UHV bushing needs to carry the ultra-high voltage and large current of UHV power system at the same time. UHV bushing will also work in the harsh conditions of electricity, heat and force for a long time. With the increasing of UHV transmission capacity, the current carrying capacity on the bushing will also increase, so it is increasingly important to analyze and solve the heating problem of the bushing. In the actual operation process of UHV bushing, its electrical and mechanical characteristics will be affected by the temperature field, resulting in the deviation between the electrical and mechanical characteristics in the actual working state and those in the simulation analysis. When the operating temperature of UHV bushing is too high, the operation failure rate will increase significantly, which will affect the stability and safety of UHV transmission line. Therefore, it is particularly important to analyze the temperature field characteristics of UHV casing. This paper takes UHV casing as the research object. The finite element software is used to carry out the electrothermal coupling calculation. The three-dimensional thermal field distribution characteristics of UHV bushing are simulated and analyzed. By analyzing the temperature field distribution of UHV bushing under different current conditions, the temperature field distribution law of UHV bushing under different current conditions is obtained, and the temperature of each structure of UHV bushing is analyzed. The difference of temperature distribution in the internal structure of UHV bushing under different current conditions provides an important basis for the structural design and operation maintenance of UHV bushing under different current conditions.

Session 3-Smart Grid and Micro Grid

Chair: A/Professor Amjad Anvari-Moghaddam, Aalborg University, Denmark

13:30-15:30, June 12 (GMT+2)

Zoom Link: https://zoom.com.cn/j/99207634433

G020
13:30-13:45

Research on the Double-layer Intra-day Management and Control Method of Ring Structure Microgrid Cluster Based on Multi-time Scale

Ms. Ning Yan, Guangchao Ma, Tao Yan, Shaohua Ma
Shenyang University of Technology, China

Abstract: In general, a tree-like or radial connection structure is adopted by the microgrid cluster (MGC) to connect to the power grid. However, the power interaction is restricted by the bus capacity, and the management and control are complicated in the tree-like or radial connection structure. Therefore, the ring structure MGC is proposed to solve the above problems. Intra-day rolling correction method based on the ring structure MGC at different time levels is investigated in this paper. Firstly, ring connection is used to build the structure of multi-connected MGC, and power interaction between MGC is carried out through tie lines. Secondly, MG is taken as the lower layer object, and the lowest generation cost is taken as the target to control the lower level. Taking MGC as the upper layer object, the double-layer intra-day management and control model is established with consideration of the power balance and steady-state security constraints of the MGC. Finally, a lower layer control method based on the robust adaptive characteristic is proposed, which uses the asynchronous coordinated control method to modify the MGC. Based on the construction of demonstration projects, the power consumption of different architectures is compared to verify the accuracy and economy of this regulation method.

G030
13:45-14:00

System Level Simulation of Micro Grid Power Electronic System

Kristian Takacs, Michal Frivaldsky
University of Zilina, Slovakia

Abstract: In this paper, the modeling procedure of comparison of non-modular and modular power electronic concept for household DC microgrid system (10 kW) is being described. The aim was to develop simulation model with accurate behavior compared to experimental sample, due to implementation of the model within system-level simulations of complex microgrid systems. Simulations have been performed with PLECS circuit simulator. Also experimental sample similar to circuit topology of simulation model was realized within reduced power ration of the target application (1:10). Based on achieved experimental results, optimization of simulation models have been realized in order to achieve as close accuracy of operational properties as possible. This approach consequelty enables to develop simulation models of DC microgrid system with high level of accuracy thus giving possibility to investigate any operational scenarios at required power delivery. Proposed simulation model analyses two different energy flow scenarios between photovoltaics (PV), battery storage system (BSS) and AC grid (load), while efficiency of power flow and qualitative indicators on AC grid are evaluated.

G052
14:00-14:15

Application of Microgrids to Improve Resilience with a Focus on Healthcare
Alejandro Reyes-Ascanio, Antonio Colmenar-Santos, **Prof. Pérez-Molina**, Enrique Rosales-Asensio
Telematics and Applied Engineering Chemistry, UNED, España

Abstract: In this work, we will address the benefits of installing microgrids in order to improve energy resilience, mainly in critical and essential facilities, and more specifically in the healthcare sector. The use of renewable energy sources and sustainable models in the use of these, will be the central pillar by which this study will be governed. To show the benefits that can be generated by this type of microgrids, which can be many and diverse, mainly to reduce supply and maintenance costs and increase energy independence. This type of system works both in operation and in power outages or in times of energy shortages of any kind for this we will use several calculation tools mainly REopt® which contains simulations that allow us to show in an intuitive and graphical way the different cases that we will develop in the study recreating the cases to evaluate the behavior of the system. As it was said at the beginning of this introduction, we will try to guarantee in all the assumptions the continuity in the supply of the critical loads to which a hospital site such as the one of this study is subjected, prioritizing the surgical procedures, the conservation of drugs and for example the refrigeration of organs for transplantation or heating in the winter months. To ensure these and other services that will be detailed later, the microgrid designed for this purpose is composed of a storage station consisting of a set of lithium-ion batteries, a set of diesel generators (own of the site), a photovoltaic generation plant and a wind turbine. With each of the elements contained in the proposed microgrid we would improve the energy resilience but the full potential offered by this system is shown in all its splendor when combined this will be expanded and a deeper study will be conducted in the following points of this study.

G140
14:15-14:30

A Hybrid Model of Energy Scheduling for Integrated Multi-Energy Microgrid with Hydrogen and Heat Storage System
Dr. Mengge Shi, Youwei Jia, Han Wang, Cheng Lyu, Peng Xie, Zhao Xu
Southern University of Science and Technology, China

Abstract: To increase the energy utilization efficiency, it becomes fairly promising to convert the surplus electricity from renewable generation to other forms of energy for multi-dimensional consumption. In this paper, we propose a hybrid energy scheduling model for a multi-energy microgrid with the integration of the hydrogen energy system (HESS) and the heat storage system (HSS). In our study, the operational uncertainties induced by renewables and load (including electrical, hydrogen, and heat demand) are comprehensively considered. We investigate such an operating regime that HESS stores the surplus electricity in case of abundant renewable generation and generate electricity through hydrogen fuel cell otherwise. Further, heat units including HESS, combined heat and power (CHP), and external heat suppliers are modeled in this paper. We split the decision-makings of energy scheduling for both day-ahead and real-time stages to tackle the power balancing issues. To effectively solve the aforementioned optimization model, a flexible weighted model predictive control (weighted-MPC) strategy is proposed, in which the receding horizon can be suitably adjusted according to the forecasting accuracy of system uncertainties. The effectiveness of the proposed hybrid model for microgrid energy scheduling is comprehensively verified through extensive case studies.

G077
14:30-14:45

Security-aware Stochastic Optimization Method for Operating Active Distribution Networks with Resilience Enhancement

Jia Liu, Peter Pingliang Zeng, Zhen He, Yalou Li, Qiuwei Wu
Hangzhou Dianzi University, China

Abstract: This paper proposes a stochastic optimal operation method for active distribution networks to improve system resilience. The source-network-load uncertainties are handled with a set of typical scenarios, and the system post-contingency security level is quantitatively evaluated by security distance. The formulated problem determines the on-load tap-changer tap position, the distributed generator (DG) output power, the DG power factor angle, the demand side management participation rate and the switch status to achieve the economic operation solution. The off-the-shelf solver is deployed to solve the proposed mixed-integer nonlinear programming model. Numerical simulations studied on a modified 104-bus distribution network validate the effectiveness and high performance of the presented method. The solutions indicate that the security-aware operation scheme can simultaneously improve system economy and resilience compared with the existing operation model. Moreover, the operation solution accommodates more renewable DGs.

G174
14:45-15:00

General Average Model of T-type Three-level Converter for Active Compensation Circuit of Distribution Network

Hao Jin, Jianhua Wang, Jianfeng Zhao
Southeast University, China

Abstract: The active compensation device, between the distribution network's neutral point and the ground, compensates for the single-phase short-circuit current. And the T-type three-level circuit is a possible scheme for compensation devices. This paper proposes the T-type average model based on the above topology, with a controlled voltage/current source, regardless of modulation or control methods. Compared with the two-level converter topology, the three-level converter topology improves the rated voltage stress, with few switching devices' requirements. The modeling and simulation indicate that the T-type's average model is identical to its switch model. And the T-type three-level converter can achieve the desired active compensation.

G120
15:00-15:15

A High Performance Grid Synchronization Method For Renewable Energy Grid-Connected Applications

Nanmu Hui, Haixiang Xu, Yingying Feng
Shenyang University, China

Abstract: Aiming at the problem of insufficient harmonic suppression capability for distributed renewable energy grid-connected application equipments, a high-performance grid synchronous phase-locked loop(PLL) which will suppress harmonics is proposed. Firstly, a novel high-order generalized integral (NHOGI) is presented in traditional αβ-frame, and the dual novel high-order generalized integral (DNHOGI) structure is proposed. Secondly, to remove the interference of harmonic voltage on SRF-PLL, the moving average filter(MAF) is added to reduce the influence of multi-order harmonic components on the phase-locked accuracy. Finally, DNHOGI and MAF filters are combined into a cascade filter, and a phase-locked loop used the cascade filter is proposed. The feasibility of the new approach is tested by experimental comparison with traditional methods.

G197	Economic-Based Residential Flexible Resource Allocation in Microgrid
15:15-15:30	**Zishan Guo**, Hanhui Guo, Qinran Hu, Xiangjun Quan, Qi Wang, Zaijun Wu
	Southeast University, China

Abstract: As the penetration of distributed renewable generation increases, their intrinsic uncertainty and random raise neutral concerns on the reliability of microgrid. Demand side resources are considered helpful in facilitating the operation of microgrid. In recent years, the development of Internet of Things and electric vehicle enables the capability of residential demands serving as flexible grid assets to provide various ancillary services and enhance operation reliability. For the residential flexible resource, their control modes and subsidy prices greatly affect the performance and operation cost, and different resources, such as air conditioner and electric vehicle (distributed energy storage), have considerably different flexible capability, capacity and quantity. Thus, this paper provides an economic-based resource allocation model for residential flexible resources. The proposed model finds the cost-effective plan about how to allocate residential flexible resources to enhance reliability of microgrid. Case studies are conducted on a modified IEEE 9-node network to illustrate the effectiveness of the proposed model.

Session 4-Power Electronics and Transmission Technology

Chair:

13:30-15:30, June 12 (GMT+2)

Zoom Link: https://zoom.com.cn/j/91210761834

G040
13:30-13:45

Optimal Design of High Frequency Planar Magnetic Integrated Matrix Transformer for LLC Converter

Assoc. Prof. Xiao Long, Li Pu, Dongdong Chen, Botao Zhang
Minnan University of Science and Technology, China

Abstract: Matrix transformer is widely used in the high voltage input and high current output LLC converter where primary transformer windings are connected in series and output windings are connected in parallel. However, traditional discrete magnetic core implemented matrix transformer suffers from high print circuit board (PCB) area occupation and magnetic core loss. To further promote the efficiency and power density of LLC converter, this paper has proposed an optimal design method for planar magnetic integrated matrix transformer. Based on magnetic flux cancellation principle, two discrete magnetic cores have been integrated into one core with PCB space occupation and magnetic core loss reduced. Besides, magnetic core and transformer winding loss calculation model has been constructed, based on which optimal design has been achieved by trading off between the transformer loss and PCB area occupation. The correctness of the proposed planar magnetic integrated matrix optimal design method has been verified by experiment.

G156
13:45-14:00

Ester-based Dielectric Fluid for Power Transformers: Design and Test Experience Under the Greenest Project

Salvador Moreira Paes Carvalhosa, Helder Leite, Mário Soares, Fábio Branco, Carlos A. Sá, Ricardo Castro Lopes, João Espírito Santos
Faculdade de Engenharia da Universidade do Porto, Portugal

Abstract: Ester-based dielectric fluids have now been on the market for several decades, providing fire-safe and environmentally friendly alternatives to mineral oils, which have traditionally been used in transformers and other electrical equipment. This opens the door to innovation in power transformers. However, the use of esters-based dielectrics in power transformers is still very limited, especially for the higher voltage levels. The usage of these esters-based dielectrics in higher voltage power transformers is not yet consensual. this work present results with the use of natural esters in power distribution transformers. Tests carried out on mineral oil and natural ester oil found that the ester-based dielectric can withstand higher voltage thresholds for AC and Impulses tests, mainly within the specs of destructive tests, e.g., the natural ester was able to withstand a 185kV impulse without registering dielectric rupture while the natural oil registered a dielectric rupture with a 160kV impulse. Heating and mechanical tests demonstrated that ester-based dielectric oils for power transformers lead to a flow reduction between 16,8% and 18,2% in the cooling system that was design for mineral oils but they achieve a higher heat transfer coefficient, between 0,5% to 5% depending on the location of measurement

G094
14:00-14:15

Soft-Starting Scheme for a DC Solid-State Transformer Based on a Modular Multilevel Converter

Assoc. Prof. Zhendong Ji, Rui Rao, Qiantong Wang, Dongye Li, Yichao Sun, Jianhua Wang, Jianfeng Zhao
Nanjing University of Science And Technology, China

Abstract: Direct current (DC) solid-state transformers based on modular multilevel converters (MMC–DCSSTs) have wide application prospects in DC transmission and distribution systems. However, after starting such a system, the normal operation of its MMC–DCSST may generate relatively large inrush and magnetizing currents on the primary and secondary sides. In this study, a soft-starting scheme for MMC–DCSSTs, which is divided into the primary-side and secondary-side charging stages, has been designed to limit these currents before the system reaches the normal operation stage. The effectiveness of the proposed method is validated experimentally, and the reliability of MMC-DCSSTs can be improved with the controllable currents.

G192
14:15-14:30

Impact of Governor Non-Linearities Representation on Power System Ultra-Low Frequency Oscillations

Mouhamed Niasse, Qi Zheng, Ai Xin, Odbayar Urnukhbayar, Patrobers Simiyu, Mahamadou Negue Diarra
NCEPU Beijing, China

Abstract: Power system dynamic models are essential for the stability analysis of a perturbed electrical system. In recent years, hydro-dominant power systems have experienced the occurrence of ultra-low frequency oscillations (ULFO). While power system dynamic simulation stands as an essential tool for the research community to analyze and understand this phenomenon, such systems involve non-linearities in their dynamic model affecting the ULFO analysis's validity. This present work investigates the impact of governor non-linearities representation on the validity of the ULFO analysis. Sinusoidal-input describing function (SIDF) is borrowed from control theory to appreciate existing governor non-linearities models' capacity to respond accurately to ULFOs. Through rigorous test-cases, results prove the imperativeness of prior accurate measurement of those governor non-linearities before their numerical implementation to ensure the power system dynamic simulation model's validity for ULFO analysis.

G190
14:30-14:45

High Frequency Inductor Proximity Loss Calculation with 3D Finite Element Analysis Considering Non-Sinusoidal Current Distortion

Dr. Chaohui Liu, Xiao Chen, Guidong Xiu, Liman Xiong, Lianghui Yang
National New Energy Vehicle Technology Innovation Center, China

Abstract: This paper describes a 3D finite element (FE) based method to calculate the proximity losses for magnetic components in power conversion system. The proximity loss is the main concern of copper loss which causes ac losses in the winding. The FE model is built based on the definitions of the geometries, meshes, materials, electric circuits, boundary conditions, load conditions, as well as the characteristics of the wire. The total proximity loss is the sum of the power losses of each element calculated with the power loss density function using the obtained nodal flux densities via finite element analysis (FEA) at the given load condition. Owing to a detailed model with all the geometric parameters and thus the flux leakage and end-winding effects can be considered, this FEA approach can predict the flux density more accurately. In addition, non-sinusoidal current is analyzed to calculate the actual power loss in current distortion condition. Experimental tests have been implemented to validate the method.

G182
14:45-15:00

Improved Droop Control Strategy Based on Voltage Feedforward Current Compensation
Bo Zhang, **Xing Fu**
North China Electric Power University, China

Abstract: In order to achieve the stable operation of different-capacity parallel distributed generators, this paper proposes an improved droop control strategy according to the control strategy of parallel synchronous generators. By the improved control strategy, the active power and reactive power of parallel distributed generators can be automatically allocated by ratio of distributed generators capacity, and the function of plug and play of the distributed generators in microgrids can be realized. It will improve the flexibility of distributed generator's interconnection and solve the technological problem of different-capacity distributed generator interconnection. In addition, the proposed control strategy can keep unchanged while switching microgrid operation mode, realizing the smooth transition between grid mode and island mode, and improving the stability and reliability of microgrid. Simulation results verify that the improved droop control strategy can make the different-capacity parallel distributed generators work stably under static and transient operation.

G187
15:00-15:15

Design of GIS Switch State Detection System Based on Wireless Power Transfer
Wenhan Zhao, **Dr. Feng Wen**, Chen Han, Kesong Ji, Zhoujian Chu
Nanjing University of Science and Technology, China

Abstract: The opening and closing speeds of GIS switches are relatively fast, so it is difficult to judge the possible defects of the mechanism through manual observation. In order to quickly and accurately identify the switch state or defect type, this paper designs a GIS switch state detection platform based on image recognition technology and wireless power transfer (WPT) technology. The wireless charging capability creates the conditions for the platform's versatility and portability to some extent. This paper mainly analyzes the stability and anti-offset of the WPT system. According to the theoretical analysis, the efficiency of the wireless charging system is more stable than that of the traditional LCC WPT system under the same output power. Within the offset distance of 0.11 m, the efficiency can be maintained at about 92%, with almost no change. The results show that the proposed method is effective.

G198
15:15-15:30

The Impact of Extreme Weather Condition on the Voltage Regulation in Distribution Systems with High Penetration of Roof-Top Photovoltaic
Weiqi Pan, Mingming Mao, Yufeng Zhou, Xiangjun Quan, Yang Li
Southeast University, China

Abstract: With the rapid growing penetration of solar power, extreme weather conditions may cause disturbance to power grids. Previous works have studied the impact of extreme weather conditions on active power balance at transmission level, while few studies investigated the potential voltage issue in distribution systems. As most small-scale rooftop photovoltaics are invisible to system operators and cannot participate in voltage regulation in practice, the sudden increase of the unknown amount of reactive power demand caused by extreme weather conditions may lead to a severe voltage fluctuation in the distribution systems with high penetration of roof-top photovoltaics. Hence, this paper investigates this potential voltage issue. We first explicitly modeled the solar power output during extreme weather conditions, and demonstrated the voltage issue in IEEE 33-bus system. Then, we formulated a model for optimal deployment of smart inverters to empower the rooftop photovoltaics at selected nodes to mitigate the voltage issue with minimum cost. With the optimal and efficient allocation plan generated by the proposed model, the distribution systems, with high penetration of solar power, are expected to remain stable and robust to extreme weather conditions.

Session 5-Battery Technology and Electric Vehicles

Chair: Dr. Chaohui Liu, National New Energy Vehicle Technology Innovation Center, China

10:00-12:00, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/99207634433

G008
10:00-10:15

Combination Prediction Method of Electric Vehicle Charging Load Based on Monte Carlo Method and Neural Network

Ms. Wanying Yang, Yunlu Li, Haixin Wang, Jiawei Feng, Junyou Yang
Shenyang University of Technology, China

Abstract: In recent years, electric vehicles (EVs) have been widely used. A large number of EVs connected to the power grid will affect the economy and stable operation of the grid. Load prediction of EVs is the basis to solve the above problems. In practical application, the parameters of traditional model are difficult to obtain accurately and the calculation speed is slow. In order to solve this problem, a combination prediction method of electric vehicle charging load based on Monte Carlo method and neural network is proposed in this paper. Firstly, the Monte Carlo model is built to fit the electric vehicle charging load (EVCL) according to the user's behavior characteristics. Then, the neural network is guided by the Monte Carlo model to learn the EVCL under different user behavior characteristics, and the mapping relationship from the basic data to the predicted load is established. Finally, the trained neural network model can realize the EVCL directly and quickly based on the basic data of EVs. The simulation results show that the proposed combined prediction method can realize the prediction of EVCL quickly. It is applicable to the daily total load prediction of large-scale electric vehicle cluster

G170
10:15-10:30

Optimal Configuration of Battery Energy Storage System in Primary Frequency Regulation

Su Dawei, **Mr. Lei Zhen**
State Grid Jiangsu Electric Power Co., Ltd, China

Abstract: This article proposes a novel capacity optimization configuration method of battery energy storage system (BESS) considering the rate characteristics in primary frequency regulation to improve the power system frequency regulation capability and performance. By analyzing the charge or discharge rate characteristics of BESS, combined with the equivalent conversion method of the action time at different rates, the capacity optimization configuration method of BESS for frequency regulation considering the rate characteristic is proposed. Taking typical peak load working condition of a certain power grid as an example, the capacity configuration of three batteries (BESS 1, BESS 2 and BESS 3) considering the rate characteristics under different control methods is compared and analyzed. The results show that rate characteristics take most advantages of the corresponding control method and the high rate battery, and BESS requires a much lower capacity configuration for the same effect in grid frequency regulation. This indicates that the proposed optimal configuration method for BESS considering rate characteristics in frequency regulation can effectively reduce the configuration capacity, and this helps to realize the economic potential of BESS.

G134
10:30-10:45

Design and Simulation of Proton Exchange Membrane Fuel Cell System
Di Wu, Kai Li, Yan Gao, Cong Yin, Hao Tang
University of Electronic Science and Technology of China

Abstract: Proton exchange membrane fuel cell system has been proposed as an alternative to the internal combustion engine due to its clean and high efficiency. Analysis of the coupling effects among components is critical to improve the design of the fuel cell system and shorten the development cycle. In this paper, the steady-state modeling of a fuel cell system is developed, focusing on the coupling effects between various components and the influence of operating conditions on the internal parameters. Firstly, the model of each component is established based on the mechanism or experience, and the boundary conditions of each component model are defined. Then, the component models are integrated into a system model, and the operation parameters of the system are solved by an iterative method. The operation conditions at different ambient temperatures are simulated and the results are discussed. It is indicated that a higher ambient temperature will significantly increase auxiliary power consumption and decrease system efficiency. The steady-state model proposed in this paper predicts the operation parameters of the system, which is helpful to reduce the development cost.

G145
10:45-11:00

Low Electromagnetic Vibration Design of Double-Layer Interior Permanent Magnet Machines for Electric Vehicle
Mr. Chengxu Sun, Qi Li, Tao Fan, Xuhui Wen, Ye Li
Tianjin Zhongke Huarui Electrical Technology Development Co.,Ltd., China

Abstract: Electromagnetic vibration and noise of driving motor affect the comfort for electric vehicles. Considering low harmonic component and pole design flexibility of double-layer interior permanent magnet (IPM) machines, in this paper, an improved analytical method of no-load air gap flux density for double-layer IPM machines is introduced, and the harmonic spectrum of electromagnetic force is analyzed. A commercial double-layer IPM machine is taken as benchmark, the electromagnetic-structure-sound coupling model is established. The main spatial and temporal order of electromagnetic force for benchmark motor is indicated. Based on this analytical model, a method to minimize the electromagnetic force of specific harmonic component is proposed to reduce electromagnetic vibration and noise, by optimizing parameters of double-layer IPM machine rotor pole without impairing the motor performance. The vibration and noise of the optimized motor under working condition and no-load are compared with the results of the benchmark motor by multi-physics simulation, and validate the proposed optimization approach

G046
11:00-11:15

Position Detection for Electric Vehicle DWCS Using VI-SLAM Method
Jun Cheng, Liyan Zhang, Qihong Chen, Rong Long
Wuhan University of Technology, China

Abstract: The dynamic wireless charging system (DWCS) is developed to solve the problems of large battery volume and mileage anxiety of electric vehicles. However, the accurate position detection for electric vehicle DWCS is facing challenge. The traditional communication, detection and estimation methods are difficult to accurately obtain the position. To tackle this problem, the visual inertial simultaneous localization and mapping (VI-SLAM) method is applied to the electric vehicles DWCS. Firstly, the graph optimization based tight coupling method is used to integrate the monocular visual and IMU measurements. Secondly, the NVIDIA TX2 and MYNT VI-sensor suite are assembled, which the MTi300-IMU is treated as the ground truth system. Finally, the mobile vehicle is controlled to race on the simulated DWCS pathway. The experimental result shows that the method achieves great performance with the accuracy of centimeter level. In particular, the root mean square error (RMSE) in X, Y, Z directions are 0.086,0.092,0.102, respectively.

G175
11:15-11:30

Comparative Analysis of Energy Consumption Standards Based on Electric Passenger Vehicle Economic Simulation Platform
Yu Yang, Zhengtianlei, Liuzhichao
China Automotive Technology and Research Center, China

Abstract: This paper compares and analyzes the electric vehicles standards of energy consumption, and concludes the main factors that affect the driving range and energy consumption of electric vehicles. Based on a certain vehicle model, through the establishment of pure electric passenger vehicle economic simulation platform. It is calculated that: compared with GB/T18386-2017, the driving range of vehicles tested according to GB/T18386.1 is increased, and the energy consumption is reduced, but for the vehicle with large load, the reverse results may appear; the cycle correction method under GB/T18386.1 is better and more scientific than that of GB/T18386-2017, which helps to reduce the difference of vehicle driving range and energy consumption before and after the test cycle correction, but in general, the driving range of vehicles under the uncorrected test cycle is lower and the energy consumption is higher.

G012
11:30-11:45

Load Forecasting of Electric Vehicle Charging Station Based on Grey Theory and Neural Network
Mr. Jiawei Feng, Junyou Yang, Yunlu Li, Haixin Wang, Huichao Ji, Wanying Yang
Shenyang University of Technology, China

Abstract: The rapid development of electric vehicles (EVs) makes the load of electric vehicle charging stations (EVCSs) affect the power grid. Aiming at the low accuracy of charging station load forecasting caused by the number of EVs, temperature and electricity price, and other factors, this paper proposes a load forecasting method of EVCSs based on a combination of multivariable residual correction grey model (EMGM) and long short-term memory (LSTM) network. Firstly, load influencing factors are analyzed, and the grey theory is introduced into the load forecast of EVCSs. The role of EMGM in taking into account the effects of multiple factors and eliminating cumulative errors is analyzed. Then, the EMGM and LSTM networks are combined to establish a mapping from the influencing factor data to the forecast, reducing the load forecast error of EVCs. Simulation and experimental results show that this method can improve the accuracy of EVCSs load prediction. load forecasting; grey theory; neural network

G195
11:45-12:00

The Coordinated Operation of Dual Batteries Energy Storage System for Cold Areas
Haohui Ding, Qinran Hu, Kai Hou, Xiaobo Dou, Chi Zhang
Southeast University, China

Abstract: Utilizing energy storage systems have been considered as a feasible pathway to achieve carbon neutrality. However, the common battery type for energy storage systems is the cheap lithium iron phosphate battery, which has low output efficiency and is almost impossible to charge in cold areas. Lithium titanate battery has high output efficiency and charge efficiency in cold areas. Meanwhile, the price of a lithium titanate battery is three times that of a lithium iron phosphate battery with the same capacity. To achieves the complementary advantages of lithium iron phosphate battery and lithium titanate battery, this paper proposes the dual battery framework of energy storage systems. Based on this, the operation model of energy storage systems is formulated. Besides, five cases are designed to demonstrate the effectiveness of the proposed method and the results show that the dual battery framework has high output efficiency with a cheaper cost than lithium titanate battery.

Session 6-Fault Diagnosis and Maintenance

Chair: Assoc. Prof. Wei Deng, Institute of Electrical Engineering, Chinese Academy of Sciences

10:00-11:45, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/91210761834

G111
10:00-10:15

Generator Stator Windings Ground Fault Diagnosis for Generator-grid Directly Connected System of Floating Nuclear Power Plant

Mr. Yikai Wang, Xianggen Yin, Jian Qiao, Liming Tan, Wen Xu, Wei Li
Huazhong University of Science and Technology, China

Abstract: For floating nuclear power plants, the internal power system adopts the generator-grid directly connected structure. Generator ground fault diagnosis enable the protective device to adaptively determine the generator tripping control mode based on the fault degree, and shorten the troubleshooting time by fault location. To accurately calculate the ground fault current under different system operating modes, a real-time grounding capacitance parameters calculation method without injection devices is proposed based on third harmonic voltage. Using the fault component principle, the ground fault current is calculated including the fundamental and the third harmonic components. Through fuzzy membership function, the ground fault degree function is established including the ground fault current and the system overvoltage. It comprehensively reflects the damage degree of both the generator operating security and the system insulation security. According to the 60° phase-band distribution characteristic of the stator windings, a fault coil location method based on windings electric potential distribution is proposed. PSCAD/EMTDC simulation results show that the proposed method has high computational accuracy.

G080
10:15-10:30

Research on Operation and Fault Diagnosis Technology for EHV/UHV SF6 Circuit Breakers Pre-insertion Resistors

Bo Niu, Feiyue Ma, Shangpeng Sun
Power Research Institute of State Grid Ningxia Power Co., China

Abstract: Pre-insertion resistors (PIR) are critical components for suppressing the closing inrush current and operating overvoltage during the closing process of the circuit breaker. And it is widely adopted in 800kV and above transmission lines and alternating current filters of converter substations. These special application environments lead to higher failure rates than other electrical components. However, in the daily operation and fault diagnosis of PIR, there is no systematic method to analyze whether there are defects in PIR and the cause of failure after the PIR fails. Based on two PIR failure in series and parallel structures, this paper proposes methods such as dynamic resistance fitting, acoustic and vibration signal detection, insulation performance test, and heat capacity test during operation. In the aspect of fault diagnosis, methods such as PIR splicing based on Iterative Closest Point, stress analysis, and electric field simulation are proposed. Finally, proposed methods can be adjusted to estimate the operating state of PIR through the disassembly inspection to avoid the GIS breakdown accident during the operation of the circuit breaker.

G086
10:30-10:45

Bird-Related Fault Analysis and Prevention Measures of ±400 kV Qinghai-Tibet DC Transmission Line

Yujian Ding, Jun Zhou, Changkan Li, **Guilin Liu,** Huapeng Wang, Xiuyuan Yao, Xi Wang, Shenghui Wang
China Electric Power Research Institute, China

Abstract: Birds' activities may cause short-circuit damages of transmission line (TL), especially in the areas without tall trees and other vegetation. ±400 kV Qaidam-Lhasa DC TL with an average altitude of about 4,650 m in China is the highest DC TL in the world. Since November 2011 to the end of January 2017, there have been a total of 102 short-circuit damages, including 95 damages caused by birds. The damages were mainly caused by the defecation of birds. This paper analyzes the characteristics and causes of flashover damages of the Project. Moreover, A survey of birds along the TL was carried out by using line transect method and point count method, and then the comprehensive improvement measures for such bird-related outages were put forward. The results show that a total of 26 species of birds are involved in the damages, mainly including large or clustered birds such as *Gyps himalayensis*, *Aegypius monachus*, *Buteo hemilasius*, Buteo *buteo* and *Corvus corax*. The damages often occur at night in winter and spring. The prevention measures shall be dominated by guiding type and supplemented by isolation type and expulsion type, and focus on the treatment of tension tower. Through improvement, the outages have been greatly reduced from 2018 to now.

G166
10:45-11:00

Fault Ride-Through Control for the Sending-End AC System Based on Reactive Power Auxiliary in LCC-MMC Hybrid HVDC System

Assoc. Prof. Liangliang Hao, Chang Liu, Qingqing Zhan, Zhengguang Chen, Xingguo Wang
Beijing Jiaotong University, China

Abstract: The hybrid HVDC system based on line commutated converters and modular multilevel converters is a feasible method that addresses the common commutation failure at the receiving end of conventional HVDC systems. At present, project Gezhouba-Shanghai in China is under the scheme demonstration of the upgrade for conventional receiving end, which introduces the difficulty in riding through the sending-end AC system failure. For this purpose, an electromagnetic simulation model is established in the PSCAD/EMTDC simulation platform firstly, then a transient analytical expression of DC current is deduced through the system equivalent circuit and verified through the simulation model. The expression deeply reveals the variation pattern of DC current and lays the theoretical foundation for fault ride-through control. Base on this expression, the decreasing level of MMC DC voltage after fault is deduced, however, it is difficult to realize the decreasing of MMC voltage due to the modulation index limitation of DC voltage. To manage that problem, the decreasing range of DC voltage is broadened through MMC reactive power that absorbs from the AC grid. On this basis, due to the conflict between the rapidity and stability of fault ride-through control, a current ride-through control based on reactive power auxiliary is proposed in this paper. This control strategy can regulate the reactive power transmission according to fault states between MMC and AC grid dynamically, in this way MMC DC voltage is reduced and the constant current control is enabled so as to realize the sending-end AC system fault ride-through. Finally, the effectiveness of this control is verified with various simulation results. The sending-end AC system fault ride-through control method has profound project meaning on upgrade transformation for the conventional receiving end.

G038
11:00-11:15

Fault Diagnosis Method for PV Array Based on An Improved KNN Algorithm
Lina Wang, **Hongcheng Qiu,** Pu Yang, Jihong Gao
Beihang University, China

Abstract: Rapid and accurate fault diagnosis under limited data has become one of the most important factors of PV power generation systems. This study proposes an improved K-Nearest-Neighbor method, which is based on the current at the maximum power point, voltage at the maximum power point and weather data. By using this method, short circuit, open circuit and shading of a PV array can be diagnosed quickly based on data obtained by transformer and weather monitor. Finally, a large number of data was obtained through a credible model whose data is proved to be consistent with the measured data greatly. Diagnosis result of the method was evaluated through these data.

G147
11:15-11:30

Non-Intrusive Energy Estimation Using Random Forest Based Multi-Label Classification and Integer Linear Programming
Yu Liu, **Mr. Congxiao Liu**, Yiwen Shen, Xin Zhao, Shan Gao, Xueliang Huang
Southeast University, China

Abstract: Home energy management system is proposed to reduce the influences caused by the high ratio penetration of renewable energy generation, through managing and dispatching the residential power and energy consumption in the demand side. Being aware of how the electric energy is consumed is a key step of this system. Non-intrusive Load Monitoring is regarded as the most potential method to address this problem, which aims to separate individual appliances in households by decomposing the total power consumption. In recent years, NILM is framed as a multi-label classification problem and many researches has been investigated in this field. In this paper, a non-intrusive method which can identify appliances power usage information from the total power consumption is proposed and thoroughly investigated. Firstly, the random k-labelset multi-label classification algorithm is enhanced by introducing random forest algorithm as base classifier. Then, grid search method and cross validation method are integrated to determine the optimal paraments set. This algorithm is used to achieve the appliances identification. Finally, based on the identification result, the integer linear programming is employed for power estimation of each appliance, especially multi-state appliances. Experimental results on low voltage networks simulator demonstrate that the proposed method has a high identification accuracy compared with the traditional random k-labelset multi-label classification methods with other base classifiers, and it is capable of identifying the power usages of different appliances accurately. The desirable performance of power estimation has broadened the applications of machine learning based non-intrusive energy monitoring.

G110
11:30-11:45

An Accurate Fault Location Method for Distribution Network Based on Active Transfer Arc-suppression Device
Dr. Jian Qiao, Xianggen Yin, Yikai Wang, Wen XU, Liming Tan
Huazhong University of Science and Technology

Abstract: Active transfer arc-suppression device is a kind of arc suppression device which has been widely used in the distribution network. When a single-phase grounding fault occurs, the bus of faulty phase is actively grounded metallicity in the substation to limit the voltage of faulty phase, so as to realize arc extinction. In this paper, an accurate fault location method is proposed for the distribution network equipped with active transfer arc-suppression device. According to the variation characteristics of the fault traveling wave signals before and after arc-suppression device operation, the fault location formula based on the

traveling wave velocity difference of different modes and the fault location formula based on the mutation of aerial-mode traveling wave are combined to obtain the final fault location method that is not affected by ground-mode wave velocity. The proposed method expands the function of active transfer arc-suppression device, makes it have additional fault location ability, and greatly improves the economy of the device. Simulation verifies that the proposed method is not affected by fault conditions, soil resistivity and extreme fault. The absolute error is within 50m in all cases, which has high reliability.

Session 7- Advanced Electronic Technology and Engineering

Chair: Assoc. Prof. Zhendong Ji, Nanjing University of Science and Technology, China

10:00-12:00, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/92266961196

G092
10:00-10:15

Simulation Analysis and Calculation of Electric Field Distribution Characteristics of UHV Wall Bushing

Mr. Shi Yunfei, Gengsheng Xie, Qingyu Wang, Xiukun LI, Xi Yang, Peng Liu, Zongren Peng
Xi'an Jiaotong University, China

Abstract: Facing the unbalanced development of resource distribution and productivity, China needs long-distance power transmission and distribution. The long-distance power transmission will lead to a lot of power loss in the process of transmission. In order to achieve long-distance, large capacity, low loss power transmission, it is necessary to build UHV transmission and transformation lines in the power grid for cross regional power allocation. As the key equipment in UHV transmission and transformation, UHV bushing plays a very important role in UHV transmission and transformation line. However, due to working in UHV electric field for a long time, the reduction of UHV bushing failure rate is very important for the smooth operation of UHV transmission line. Therefore, it is necessary to study the electric field distribution characteristics of UHV bushing. In this paper, the electric field distribution characteristics of UHV through wall bushing are studied. The simulation analysis and calculation of electric field are carried out by using COMSOL Multiphysics finite element software. By analyzing the electric field distribution of the complex field areas such as the central conductor of the bushing, the end of the liner, the sheath and the capacitor core, the electric field distribution law and the edge electric field diagram of the bushing and its adjacent key areas under different voltage types are obtained. The radial axial electric field distribution of the capacitor core and the edge electric field distribution of the upper and lower steps are compared and analyzed Based on the analysis of the characteristics and local complex field, the variation law of the electric field distribution of the bushing with the structure design is obtained, which provides an optimization idea for the insulation structure design of UHV through wall bushing.

G033
10:15-10:30

Performance Improvement of PMSM Rotor Position Estimation by Using Adaptive Hybrid Filter based PLL

Dr. Linxin Yu, Dazhi Wang, Di Zheng, Zhen Liu, Mengran Ji
Northeastern University, China

Abstract: To achieve a satisfactory sensorless control performance of permanent magnetic synchronous machine (PMSM), an effective rotor position estimation method is a critical factor. As a useful tool for phase estimation technique, phase-locked loop (PLL) is widely used in this task. However, because of the existence of harmonics in back electromotive force (EMF), the accuracy of position estimation method based on PLL is still low. In this paper, an adaptive hybrid filter based PLL is proposed to improve the estimation performance. The proposed adaptive hybrid filter is frequency-adaptive, which means the performance is not affected under varying-speed operating conditions. Moreover, all the harmonic disturbances can be totally eliminated. The proposed method is validated under simulation. The results confirm the effectiveness of the proposed method.

G132
10:30-10:45

High Temperature Insulation Design of Capacitive Wall Bushing for High-temperature Solid Electrical Heat Storage Devices

Zhe Wang, Fu Qitong, Fan Jinpeng, Xing Zuoxia
Shenyang University of Technology, China

Abstract: The temperature resistance and voltage level of the wall bushing are the key factors restricting the increase of the heat storage capacity of the solid electrical heat storage device. Therefore, by studying the electrical insulation and heat insulation principles of the wall bushing of the solid electrical heat storage device, a new type of capacitive solid electric heat storage device wall bushing suitable for 66~500 kV high voltage and 800 ℃ high temperature was designed, and its internal insulation parameter calculation method considering the influence of high temperature was proposed. The analysis of the bushing through the multi-physics coupling field of temperature field, force field and electric field shows that high temperature deformation does not affect the electrical insulation of the capacitor core. However, in order to reduce the pressure of the outer insulation layer of the bushing, a deformation margin of 3% of the radius of the ground electrode plate still needs to be left. The change of relative dielectric constant will enhance the field strength at the edge of the capacitor core plate and deteriorate the electric field distribution of the bushing. Therefore, when calculating the internal insulation, it is necessary to set a partial discharge calculation margin of 1.4 times and the ratio of the length of the internal and external steps of the capacitor core furnace to 86%. As the voltage level increases, the effect of high temperature on the electric field distribution of the bushing becomes weaker.

G006
10:45-11:00

A High-Speed Bipolar Hybrid Cockcroft–Walton/Dickson Multiplier for Shockwave Non-thermal Food Processing

Prof. Kei Eguchi, Daigo Nakashima, Iori Tabaru, Wanglok Do
Fukuoka Institute of Technology, Japan

Abstract: For the design of shockwave non-thermal food processing systems, a novel high-speed bipolar voltage multiplier is presented in this paper. Unlike conventional high voltage multipliers, the proposed voltage multiplier has bipolar topology employing hybrid Cockcroft-Walton/Dickson multipliers (HCWDMs), where the bipolar HCWDM is driven by a driver circuit generating high speed rectangular pulses. Therefore, the proposed multiplier can achieve high speed operation. Through simulation program with integrated circuit emphasis (SPICE) simulations and experiments, the validity of the proposed multiplier is confirmed. The SPICE simulations and experiments reveal that the proposed multiplier outperforms the conventional HCWDM.

G117
11:00-11:15

Heat Transfer Performance Prediction of Confined Thin Film Boiling

Ms. Yang Shi, Yingxue Yao
Harbin Institute of technology (ShenZhen), China

Abstract: The liquid-vapor phase change is considered as one of the most effective way to transfer heat flux. Improving the heat transfer efficiency and critical heat flux (CHF) is crucial to face our energy-intensive and energy-deficient plight. Pooling in a confined thin liquid film is known to have the ability improve the heat transfer efficiency especially can be easily integrated with immerse cooling. This work theoretically predicted the heat transfer performance of the confined thin film boiling using non-vapor permeable gap through the thermal resistance analysis. The model showed the same trend as the practical situation that the thermal resistance can be reduced by the reducing the liquid thickness but the vapor leaving resistance was

increased at the same time. The critical heat flux showed a trade-off since it can be influenced a lot by the vapor leaving resistance from the gap side and non-vapor permeable lid. The heat transfer efficiency can be increased by the decrement of both the liquid layer conduction resistance and convection resistance at the bubble interface because of the smaller growing size and faster heat transfer inside the confined thin liquid layer with higher temperature. The influence of superheat, gap size and gap length are studied. It also showed the potential to further increase the heat transfer efficiency and CHF if further reducing the vapor leaving resistance using the vapor-permeable gap lid.

G135
11:15-11:30

Modeling and Frequency Characteristic Analysis of DSOGI-PLL in Dq Reference Frame
Mr. Yongxin Zhang, Fei Li, Liuchen Zhang, Shiquan Wen, Mingyao Ma, Xing Zhang
Hefei University of Technology, China

Abstract: Dual second-order generalized integrator phase-locked loop (DSOGI-PLL) is widely used in grid-connected system for grid synchronization because of its simple implementation and good filtering capability. However, the frequency characteristics of DSOGI-PLL affect the impedance modeling of the system, which in turn affect the impedance-based stability analysis. In order to improve the accuracy of system modeling, in this paper, the equivalent transfer function of positive-sequence calculator (PSC) block constructed in *αβ* reference frame in DSOGI-PLL is presented in *dq* reference frame, where the relationship between DSOGI-PLL and traditional synchronous reference frame PLL (SRF-PLL) small-signal model is investigated. Then, based on the established model, DSOGI-PLL and SRF-PLL are compared from the tracking characteristics and robustness characteristics. It is further demonstrated that DSOGI-PLL is able to improve the robustness performance of PLL while maintaining the same tracking performance as SRF-PLL. Finally, simulation results are presented to validate the established model and frequency characteristic analysis.

G101
11:30-11:45

A New Hybrid Frequency Decomposition Algorithm for Short-Term Reactive Power Forecasting
Mingyu Wu, Changxi Yue, Ying Shi, Jicheng Yu, Fan Sun, Changjun Xie, Tao Su, Jiabao Du
Wuhan University of Technology, China

Abstract: To address the poor ability of the existing algorithms in predicting reactive power, this paper proposes a new hybrid frequency decomposition reactive power forecasting algorithm, Ensemble Empirical Mode Decomposition Long Short-Term Memory Random Forest Regression (ELR), which adopts a strategy of frequency decomposition predicting after Ensemble Empirical Mode Decomposition and then data reconstruction. That decomposition compresses the high frequency of reactive power and benefits the following separate forecasting. For the high-frequency feature of reactive power, Long Short-Term Memory is proposed to deal with the forecasting difficulty caused by strong signal disturbance and randomness. For the low-frequency part, Random Forest Regression speeds up the forecasting. The proposed algorithm is compared with four conventional algorithms and four hybrid algorithms based on signal decomposition; the results show that the proposed algorithm has the highest predictive performance.

G196
11:45-12:00

Strategic Interaction to Reduce Customer Fatigue in Load Aggregation
Xinyi Chen, Xiaochun Xu, Xin Dai, Qinran Hu, Xiangjun Quan, Shengzhe Yang
Southeast University, China

Abstract: In demand response programs, the load aggregator would send requests to customers to confirm whether they are willing to participate in the demand response events later, such that there is sufficient

capacity to meet the load adjustment requirement of the power grid in real-time. While sending requests frequently to the customers can increase the understanding of them, it can also lead to customer fatigue, which dampens customers' enthusiasm for demand response. Motivated by this dilemma, an optimization problem of scheduling customers considering fatigue based on the MAB framework is proposed, and the online learning and ranking method: fatigue-aware MAB is presented to solve it. Finally, the numerical simulation demonstrates that the proposed method outperforms the traditional method under different parameter settings. Detailed analysis of how those settings affect the performance of our proposed method is also provided.

Session 8-Voltage and Current Control

Chair:

13:30-15:15, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/99207634433

G121

13:30-13:45

CVT Measurement Error Correction by Double Regression-Based Particle Swarm Optimization Compensation Algorithm

Feng Zhou, **Dr. Jicheng Yu**, Changxi Yue, Siyuan Liang, He Li

China Electric Power Research Institute, China

Abstract: The capacitive voltage transformer (CVT) is a widely-used voltage measuring instrument directly related to the safety and security of the power system operation. As the CVT's range of application scenarios is getting wider, its environmental adaptability requirements become more stringent. Therefore, the CVT measurement error generated from the atmospheric environment is becoming a matter. This paper proposes a CVT measurement error correction method by employing a double regression-based particle swarm optimization compensation algorithm (DR-PSO). In DR-PSO, the double regression algorithm is used to calculate the rough result, and the theoretical formula is used to calculate the multi-type disturbance. Finally, the particle swarm optimization is used to determine the optimal influence factor matrix and obtain accurate results. Based on the transformer's multidimensional operating data, the DR-PSO can be trained by the empirical data, and then the algorithm shall be used to correct CVT errors based on the real-time data. The test by actual data of State Grid proved that the root means the squared error of the proposed algorithm's phase error was only 0.13, and the mean absolute error of the amplitude error is only 0.0009. Compared with other algorithms such as the equal weight method, information entropy method, and multiple regression method, the proposed algorithm can calculate the measurement error with the highest accuracy.

G084

13:45-14:00

Analysis on Switching Overvoltage and Suppression Method of Cable Joint in 500kV Cable Line

Ren Hongtao, Zhang Ying

HuaDong Engineering Corporation Limited, China

Abstract: The breakdown accident of cable joint occurs frequently when the sheath overvoltage cable line is closed, but the cable joint is ignored or simply treated in the previous overvoltage simulation of cable system. To solve this problem, a joint equivalent impedance model is established for a 500kV cable line intermediate joint structure, and a 500kV high voltage cable system simulation model considering the cable intermediate joint is built in the transient simulation software ATP-EMTP to simulate and calculate the switching overvoltage on the core and metal sheath of the cable intermediate joint, and to study the influence of different number of outgoing buses and residual charge of cable core The influence of some factors on the switching overvoltage of cable joint. In addition, the measures to restrain the switching overvoltage of cable joint are analyzed. The research results provide reference for the fault analysis of cable joint and the parameter design of cable insulation coordination.

G115
14:00-14:15

Impedance Modeling and Stability Analysis of MMC Flexible DC System at the DC Side

Xiaolong Xiao, Jianhua Wang, **Shuo Li**, Shang Gao
Southeast University, China

Abstract: Aiming at the stability of modular multi-level converter (MMC) on the dc side, this paper adopts harmonic linearization method to establish impedance model of MMC dc side. This method ignores the higher-order components of voltage and current, and considers the influence of the control loops to guarantee high accuracy at the same time. The high-frequency band of impedance presents inductive characteristics, and the mid- and the low-frequency band is related to the control loop. The parameters of the current loop have a greater influence on the impedance characteristics of the mid-frequency band while the voltage loop parameters have a greater influence on the low-frequency band. For the back-to-back transmission system based on MMC, the voltage at the dc side has obvious oscillation when the impedance mismatch or the stability margin is small. The risk of dc side voltage instability can be eliminated by optimizing the controller parameters and phase angle margin can be improved.

G158
14:15-14:30

Research on Model Predictive Control Strategy of Converter in building DC Power Supply System

Chongyi Tian, Xuerui Wang, Zhuliang Shao, Ruiqi Wang
Shandong Jianzhu University, China

Abstract: The popularization of distributed renewable energy, the change of end-user load charACteristics, and the requirements of energy conservation and environmental protection have brought great challenges to the traditional AC power supply. Compared with AC power supply, DC power supply is widely concerned because of its powerful energy-saving advantages. Building electricity demand fluctuates greatly, and various power loads are frequently switched, which requires a higher demanding for the the dynamic response capability. Based on switched system theory, this paper proposes a switched control method for building dc microgrid converter. The outer voltage loop adopts PI control and the inner current loop adopts predictive current control. The switched control model of the converter is established and the optimal switched rate is designed. An experimental platform based on SiC MOSFET is built for verification. The switched frequency is 50KHz, which verifies the effectiveness of the control strategy.

G098
14:30-14:45

Calculation Method of DC Limit Power Considering Influence of New-generation Synchronous Condensers

Zuowei Wang, **Dr. Fan Xiao**
Hubei Electric Power Research Institute, China

Abstract: Because the new-generation synchronous condenser has strong excitation ability and leading power factor operation ability, the DC transmission power value will be effectively improved. In this paper, the reactive power limit value models of the new-generation synchronous condensers under phase-in and phase-lag operation conditions were established. Then, the correlation model between AC and DC systems considering the effects of new-generation synchronous condensers is established. Based on this, the commutation angle of DC and the parameters related to the inverter side are calculated under rated conditions. Moreover, the AC system equations is combined to solve the potential of the equivalent AC system and the power angle of DC bus voltage. Then, using DC current as an independent variable to find the maximum DC power considering the reactive power limit value of the new-generation synchronous condensers. Therefore, the initial reactive power output of new-generation synchronous condensers and the maximum power of DC transmission can be calculated. The results of this paper provide a theoretical basis for improving DC transmission power in power system analysis, and have an important role in promoting the consumption of renewable energy at the DC-fed AC grid.

G180
14:45-15:00

Medium Voltage DC Distribution System Simulation Based on Average-Value Model
Xiaolong Xiao, Jianhua Wang, **Shuo Li**, Shang Gao
Southeast university, China

Abstract: Transient simulations with of DC distribution system based on switch model(SM) are computationally expensive because of a large number of switching events in power electronics converters. As an alternative, average-value model (AVM) replaces the switch with controlled source, which can effectively improve the simulation efficiency. This paper takes a typical double-ended DC distribution system as an example and introduces the key equipment selected in the system. Then AVMs of corresponding equipment are given. The DC distribution system based on AVM and SM are built respectively in the PLECS software. The simulation result shows that simulation based on AVM can effectively reflect the steady-state and dynamic characteristics of the system and greatly improve the simulation speed, which can provide effective and fast reference for the stable operation of DC distribution system in different working modes.

G133
15:00-15:15

TMR Array with Circular Skeleton Coil for High Current Measurement
Changxi Yue, **Dr. Jicheng Yu**, Hongda Zhang, Siyuan Liang, Lingjie Xu
China Electric Power Research Institute, China

Abstract: DC high current measurement is one of the important supporting technologies of the power system. As an emerging current sensing technology, tunnel magnetoresistance (TMR) has attracted more and more attention due to its advantages of high sensitivity and good linearity. But the TMR sensor is not suitable for high current measurement, and its accuracy can be further improved. Aiming at these problems, this paper proposes a TMR array with a circular skeleton coil for high current measurement. Eight TMR chips are evenly installed on the circular skeleton coil to measure the magnetic field generated by the primary current, and the output of the feedback amplifier generates a compensation current to the feedback winding to generate a compensation magnetic field, so that the magnetic flux in the sensor is almost zero. The circular structure can reduce measurement errors caused by wire offset and external interference. Since there is no iron core, nonlinear errors are also avoided. Simultaneously, the feedback loop designed based on zero magnetic flux principle can reduce the hysteresis error and expand the measurement range, making the sensor suitable for DC high current measurement. This paper proposes the sensor model, builds a prototype and compares it with a closed-loop TMR current sensor with an iron core. Experimental results proved that the TMR array sensor's error can reach 0.01%, which is lower than 0.32% of the closed-loop current sensor. Moreover, when the same primary current is input, the accuracy of the sensor mentioned in this article is always higher.

Session 9-Converter Design and Test

Chair:

13:30-15:15, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/91210761834

G005
13:30-13:45

A Multi-Input Single-Output Dickson-Type AC/DC Converter for Vibration Energy Harvesting

Kei Eguchi, **Daigo Nakashima**, Takaaki Ishibashi, Ichirou Oota

Fukuoka Institute of Technology, Japan

Abstract: In this paper, we propose a novel inductor-less multiple-input single-output (MISO) ac/dc converter for vibration energy harvesting. Unlike existing single-input single-output (SISO) converters, the proposed converter provides high voltage gains and small size by the MISO topology employing Dickson-type converters. The characteristics of the proposed inductor-less MISO converter are clarified by theoretical analysis and computer simulations. For the proposed converter with two modules, the simulation results demonstrate that the voltage gain and power efficiency reach about 6.7 and 89% at 500mW, respectively, for 3.5 V inputs at 50 kHz. Furthermore, the feasibility of the proposed converter is confirmed by breadboard experiments.

G100
13:45-14:00

An Electrical Isolated DC Power Supply with Two Ports Based on LLC Resonant Converter

Hongqiang Li, Huibiao Yang, Bei Tian, Fei Xue, **Hengshan Xu**, Xin Ma

China Three Gorges University, China

Abstract: A modified LLC resonant converter is proposed for isolated dc power supply where two ports are needed. The converter can supply different dc voltages for two isolated loads, and the resonant parameters of two LLC channels can be designed as different. The topology of the proposed LLC resonant converter is introduced, the voltage gain is detailed discussed. A simulation model is built to verify the correctness of the proposed LLC resonant converter`s theory. The simulation results verify that the converter can supply two different dc voltages, and the voltages can keep steady even the load states are changed suddenly.

G183
14:00-14:15

Comprehensive Small-Signal Stability Analysis for Master Hybrid MMC Connected with Strong and Weak AC Systems

Dr. Xiaojun Lu, Mengbo Li, Xiao Lei, Zhangbin Yang, Daixiao Peng, Daijun Lu

Changjiang Institute of Survey, Planning, Design and Research Co. Ltd, China

Abstract: The small-signal stability problem of power electronic converters has always been a critical concern for safe operation. This paper conducts a comprehensive analysis of the small-signal stability for the hybrid modular multilevel converter (MMC), which is promising in the application of future over-head-line high-voltage-direct-current transmission. The impacts of the strong and weak AC system connection are comparatively researched through eigenvalue-based analysis. The newly emerging factors that hamper the stability are identified for the weak AC system integration. The work in this paper provides valuable guidance for robust control parameter configuration of the hybrid MMC.

G142
14:15-14:30

Interleaved Phase-Shift Full-Bridge DC/DC Converters for An Electromagnetic Micro-Actuator
Mr. Zhongtian Ye, Patin Nicolas
Université de Technologie de Compiègne, France

Abstract: Two low voltage parallel full-bridges are proposed for the power supply of a two-axis electromagnetic micro-actuator. GaN FETs are chosen for these converters to achieve high efficiency while switching at high frequencies. The control strategy implements the phase shift between two branches of each full-bridge and the interleaved phase between two full-bridges, which reduces the load current ripple and increase the frequency of input and output current ripples. These properties help us miniaturize filtering coils and decoupling capacitors associated to the converters. The test bench that highly integrates the micro-actuator and converters was fabricated. Simulation and experimental results are compared for analyzing and validating the integration and the proposed control strategy.

G106
14:30-14:45

Bifurcation and Chaos Behaviors of Lyapunov Function Controlled PWM Boost Converter
Xinbing Chen, **Long Xiaoli**, Wei Hu, Binsheng Xie
Guangzhou University, China

Abstract: In this paper, we have derived the mathematical model of the Lyapunov function-based boost converter, which is essentially a voltage and current double-loop controller, and studied the stability of the closed-loop modulation system. The analysis shows that the Lyapunov function controlled boost converter is not globally asymptotically stable when the switching frequency is limited. We also used a Monodromy matrix to analyze the nonlinear dynamic behavior of the system. It is found that with the decrease of the reference current, the Monodromy matrix eigen multiplier gradually jumps from inside to the outside on the unit circle, and correspondingly, the converter will move from the period-one steady state to period-doubling state, and then period-doubling state to the chaotic state. Simulation and experimental results show that the theoretical analysis is correct.

G103
14:45-15:00

An Open-Loop Start-up Method for LLC Resonant Converter with Fixed Frequency and Variable Duty Cycle
Fei Xue, Yong Ren, Yuqi Yang, Lei Zhou, **Hengshan Xu,** Xin Ma
China Three Gorges University, China

Abstract: An open-loop start-up method with fixed frequency and variable duty cycle for LLC resonant converter is proposed in this paper. The start-up method adopts pulse width modulation (PWM) technology to control LLC resonant converter with fixed switching frequency and variable duty cycle. Compared with conventional start-up method that uses a relative high switching frequency to start-up the converter with closed control loop, the proposed start-up method can reduce the start-up frequency, then the switching loss and driving loss during the start-up process can be reduced. Moreover, the proposed method can fast start-up the converter with low device`s electrical stress. Because high start-up frequency is no need for the proposed start-up method, then the hardware cost of driving chip can be decreased. The theory and the logic of the proposed start-up method is detailed analysed in this paper. The correctness and effectiveness of the proposed start-up method are verified by the built simulation results.

G022
15:00-15:15

A Single Inductor LED Driver Combined with a Cross-Connected Fibonacci-Type Converter and a Buck-Boost Converter

Prof. Kei Eguchi, Daigo Nakashima, Wanglok Do, Takaaki Ishibashi, Ichirou Oota
Fukuoka Institute of Technology, Japan

Abstract: To achieve high voltage gains and high power efficiency, a hybrid light emitting diode (LED) driver with a single inductor is proposed in this paper. Unlike existing LED sink drivers, the proposed driver consists of a cross-connected Fibonacci-type converter and a buck-boost converter. In the proposed driver, the cross-connected Fibonacci-type converter drives the anode terminal of LED strings to realize high voltage gains. On the other hand, the buck-boost converter is connected to the cathode terminal of LED strings to provide output current controllability. Furthermore, the proposed driver achieves a small internal resistance, because these two converter blocks are connected in parallel to an input source. The characteristics of the proposed driver is investigated by theoretical analysis, computer simulations, and breadboard experiments. The obtained results demonstrate that the proposed driver outperforms the conventional LED sink drivers.

Session 10-Electrical Engineering and Automation

Chair: Prof. Guangqing Yu, Tsinghua University, China

13:30-15:15, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/92266961196

G124
13:30-13:45

Design Optimization of APMEC Using Chaos Multi-Objective Particle Swarm Optimization Algorithm

Ms. Pengyi Pan, Dazhi Wang, Bowen Niu
Northeastern University, China

Abstract: In order to meet the requirement that the permanent magnet eddy current coupler has larger output torque and smaller eddy current loss in actual operation, the structural parameters and operation performance of axial permanent magnet eddy current coupler (APMEC) are optimized by chaos multi-objective particle swarm optimization algorithm in this paper. The model of APMEC is established by three-dimensional finite element simulation, and the influence of main structural parameters of APMEC on output torque and eddy current loss is analyzed. The central composite design (CCD) method is used to select the appropriate test point, and the response value is obtained by ANSYS finite element analysis software simulation. The second-order response surface regression model of APMEC was established according to the response value. The chaos multi-objective particle swarm optimization algorithm is used to optimize APMEC, and the optimal combination of structural parameters is obtained. By comparing the eddy current density distribution of APMEC before and after optimization with the finite element simulation experiment, it is verified that the optimization method is feasible to optimize the structural parameters of APMEC. The optimization results show that the efficiency of the permanent magnet eddy current coupler is more than 94%, and the energy consumption is reduced to 83% of the original energy consumption.

G136
13:45-14:00

Deadbeat Predictive Power Control for Vienna Rectifier Under Unbalanced Power Grid Condition

Assoc. Prof. Zhao Liu, Yiyan Lu, Shuai Meng, Jiawei Ji, Jianguo Lyu
Nanjing University of Science and Technology, China

Abstract: Due to the low output distortion and switch voltage stress, Vienna rectifiers have been widely utilized in high-power applications such as communication power supplies, wind power systems and electric vehicle charging piles. However, Vienna rectifiers still have to face tough challenges under unbalanced grid considering the inherit operating range limitation caused by its structure. Consequently, a deadbeat predictive power control (DBP-PC) for the Vienna rectifier under unbalanced grid is proposed. Using the positive and negative sequence double *dq* decoupling current control strategy, the operating range of the Vienna rectifier under unbalanced grid is analyzed. Furthermore, an improved DBP-PC for Vienna rectifiers under unbalanced grid is proposed. By the improved DBP-PC, the stable operating range can be effectively extended. Finally, the corresponding simulations and experiments are executed to demonstrate the performance of the proposed control strategy.

G088
14:00-14:15

Fault Prediagnosis of Power Electronic Devices in Urban New Energy System

Lingfeng Shao, Zhenyun Pan, Xiaoyu Xu, Yanhui Zhang
Shanghai University, China

Abstract: The failure mechanism of IGBT modules is the basis of the reliability state monitoring of converters. By studying the aging evolution of IGBT, the failure type and degree of IGBT devices can be accurately judged. An algorithm based on the thermal sensitive electrical parameter method and thermal resistance network method was proposed to identify aging types. Firstly, a healthy junction temperature model of IGBT based on the initial loss of turn-off was established in the double-pulse platform based on experimental data. Secondly, a thermal resistance network model of IGBT was established based on the datasheet. Finally, the accelerated aging of IGBT was carried out through the existing accelerated aging experimental platform of IGBT in the laboratory, and the aging parameters were imported into the above two models. The results show that the output results of the thermal resistance network model and the thermal parameter model are affected by the aging type, which provides a new solution for the aging type research of IGBT.

G168
14:15-14:30

Improved Energy Saving Control of IPMSM Based on the Weighted Average Current Method

Ms. Hanquan Zhang, Hongyu Zhu, Dongdong Zhang, Haisen Zhao, Yanli Zhang, Shenwang Li, Feng Shuang, Thomas Wu
Guangxi University, China

Abstract: Aiming at the low efficiency of vector control system caused by unreasonable current allocation, an improved energy saving control strategy based on weighted average current method is proposed in this paper, and the research is carried out on the background of interior permanent magnet synchronous motor vector control system. This method does not add new parameters, but achieves the goal of reducing motor loss and improving current utilization rate. Firstly, according to the mathematical model of permanent magnet synchronous motor considering iron loss resistance, the relationship between motor torque and *d-q* axis current is deduced. Then, by introducing the weighted average current factor, the minimum copper loss current and the minimum iron loss current are calculated analytically. Finally, the simulation analysis shows that the energy saving strategy proposed in this paper can further reduce the electrical loss of permanent magnet motor compared with the traditional energy saving control method, which proves the feasibility of this method in improving the energy efficiency of the vector control system of permanent magnet motor.

G131
14:30-14:45

AC/DC System Construction and Analysis of Business Model Under Multi-Station Fusion Model

Chutong Wang, Zifeng Yang, Chuangxin Guo Zuxian Wu, Kang Yin, Zhendong Du, Feifei Tong
Zhejiang University, China

Abstract: This paper focuses on a novel model named multi-station fusion (MSF). The proposed model integrates transformer substation, data center, energy storage system (ESS), photovoltaic (PV), electric vehicle charging station (EVCS), connection information base station and other systems. It aims at improving the utilization rate of the spare space in existing substation, reducing operation and maintenance cost, and increasing the revenue of power grid enterprises. This paper designs three types of AC/DC system based on reliability priority, economy priority and retrofit flexibility priority. Markov process Monte Carlo method is introduced to verify data center reliability in MSF. The business model of MSF is analyzed. Finally, the construction scheme of MSF model, the contents of the planning considerations and cost-benefit study demonstrate the economic efficiency of the proposed model.

G179
14:45-15:00

Clustering Analysis of Typical Scenarios of Island Power Supply System by Using Cohesive Hierarchical Clustering Based K-Means Clustering Method

Geng Niu, Yu Ji, Zhihui Zhang, Wenbo Wang, Jikai Chen, Peng Yu
State Grid Shanghai Energy Interconnection Research Institute, China Electric Power Research Institute, China

Abstract: Scenario analysis plays an important role in planning and operation of the island power supply system. In this paper, a cohesive hierarchical clustering based K-means clustering method is proposed and used for clustering analysis of typical scenarios of island power supply system. At first, the source and load characteristics of typical island power supply system are analyzed. Then, three characteristic indexes to distinguish island types are proposed which can realized the feature extraction of typical scenarios of island power supply system. On this basis, the cohesive hierarchical clustering based K-means clustering method is proposed for the clustering analysis of typical scenarios of the island power supply system. A case study is made to verify and illustrate the effectiveness of the proposed method. The case study results indicate that the proposed method can effectively classify different islands into several types and generate the typical scenarios of island power supply system by clustering analysis.

G130
15:00-15:15

A Novel Method for Modeling the Air Gap Flux Density of the Axial-Flux Permanent Magnet Eddy Current Coupler Considering the End-Effect

Wenhui Li, Dazhi Wang, Deshan Kong, Sihan Wang, Zhong Hua
Northeastern University, China

Abstract: The virtual equivalent line method for the axial-flux permanent magnet eddy current coupler is proposed in this paper to solve the problem of the difference in the length of the magnetic flux path between the inner radius and outer radius of the axial section of the radial centerline of the magnetic pole. Different from the average radius equivalent method, the virtual equivalent line method adopts the function of variable pole radius instead of the fixed average radius, which establishes a uniform analytical expression of the air gap flux density and can accurately calculate the magnetic flux density at any magnetic pole radius. Furthermore, the end-effect compensation function is obtained. In order to investigate the effectiveness of the proposed method, the analytical calculation results are compared with the finite element method. It is shown that the air gap flux density calculated by the model proposed in this paper is in good agreement with the FEM.

Session 11-Wind Energy Utilization and Power Generation Technology

Chair:

15:45-17:45, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/99207634433

G018
15:45-16:00

Examination of Turbulence Impacts on Ultra-Short-Term Wind Power and Speed Forecasts with Machine Learning

Mr. Hao Chen, Yngve Birkelund, Fuqing Yuan
UiT The Arctic University of Norway, Department of Technology and Safety, Norway

Abstract: Wind turbines' economic and secure operation can be optimized through accurate ultra-short-term wind power and speed forecasts. Turbulence, considered as a local short-term physical wind phenomenon, affects wind power generation. This paper investigates the use of turbulence intensity for ultra-short-term predictions of wind power and speed with a wind farm in the Arctic, including and excluding wind turbulence, within three hours by employing several different machine learning algorithms. A rigorous and detailed statistical comparison of the predictions is conducted. The results show that the algorithms achieve reasonably accurate predictions, but turbulence intensity does not statistically contribute to wind power or speed forecasts. This observation illustrates the uncertainty of turbulence in wind power generation. Besides, differences between the types of algorithms for ultra-short-term wind forecasts are also statistically insignificant, demonstrating the unique stochasticity and complexity of wind speed and power.

G032
16:00-16:15

A DPS-PLL Based Rotor Position Estimation Method for Permanent Magnet Wind Turbine

Dr. Linxin Yu, Dazhi Wang, Zhen Liu, Di Zheng, Wenhui Li
Northeastern University, China

Abstract: Aiming at the problem of slow response and low tracking accuracy in the synchronous reference frame phase-locked loop (SRF-PLL) estimation of the permanent magnet synchronous generator (PMSG) rotor position when the wind speed changes suddenly, a rotor position estimation method based on the discrete position set phase-locked loop(DPS-PLL) is proposed. The estimated position in certain moment is selected from a discretized alternative position set. Then, combined with sliding mode observer, rotor position is obtained by calculating back-EMF cost function. The experimental results show that the rotor position and speed can be detected accurately under sudden change of wind speed. The convergence time of estimation is within 42ms. The estimated error of position is less than 0.03rad. The results show that the proposed method provides a good dynamic performance and strong disturbance rejection ability.

G112
16:15-16:30

Scenario Forecasting for Wind Power Using Flow-Based Generative Networks

Shifeng Hu, **Assoc. Prof. Rujin Zhu**, Guoguang Li, Like Song
Tibet Agriculture and Animal Husbandry University, China

Abstract: Wind power prediction is an integral part of power system operations and planning. Due to rising penetrations of wind turbines, fluctuation and intermittence of wind powers seriously limit the accuracy of power forecasts. A popular way to mitigate this challenge is to provide a range of possible scenarios instead of deterministic point forecasting values, so operators can account for the uncertainties. This paper proposes a model-free scenario forecasting approach for wind powers using flow-based generative networks, which generate a set of high-quality scenarios to represent possible behaviors based on historical

wind powers and deterministic point forecasting values. Firstly, an unsupervised deep learning framework is proposed to learn the latent patterns in historical wind power curves. Then, a large number of possible future scenarios are obtained by solving an optimization problem. Simulation results show that the proposed approach has better performance than popular baselines such as variational auto-encoder and generative adversarial networks.

G089
16:30-16:45

Impedance Modeling of Wind Turbine-Variable Speed Pumped Storage Combined Operation System

Fangzhou Wang, Shu Zhu, Kaipei Liu, Man Chen, Yixing Du
Wuhan University, China

Abstract: In the combined operation system of variable speed pumped storage and direct drive wind turbine, multiple power electronic devices are coupled with each other, and the operating conditions are complex, it is necessary to conduct deep research on the stability of the system. In the synchronously rotating coordinate *d*-*q*-0 system, this paper introduces the speed of the doubly-fed machine as a variable, and adds the small signal model of the pump turbine, and establishes a joint operation system suitable for 0.1Hz-200Hz stability analysis broadband impedance model. Based on the generalized Nyquist theory, the corresponding stability analysis of the system under different working conditions and different parameters can be carried out.

G155
16:45-17:00

A combined Short-Term Forecast Model of Wind Power Based on Empirical Mode Decomposition and Augmented Dickey-Fuller Test

J Wang, **Dr. Tianyao Ji**, M S Li
South China University of Technology, China

Abstract: The high volatility of wind power time series is an important factor that affects its forecasting results. Hence, it is necessary to analyze and preprocess the historical data. To improve the accuracy of wind power forecasting, a two-predictor combined model based on two data processing algorithms, empirical mode decomposition (EMD) and augmented Dickey-Fuller test (ADF), is proposed in this paper. First, the original wind power time series is decomposed into several sub-components by EMD. Second, the ADF is employed to test the stationarity of each sub-component, and the sub-components are divided into two categories: stationary and non-stationary components. Third, the stationary components are forecasted by least-square support vector machine (LSSVM) while the non-stationary ones are forecasted by the persistence model (Per.). Finally, the prediction value is the summary of the results of the sub-components. Three models, LSSVM, the persistence model and the EMD-LSSVM, are used to compare the performance with the proposed model on two real wind power datasets. The analysis results indicate that the proposed model can achieve higher forecast accuracy and stability than other models.

G185
17:00-17:15

Dynamic Capacity Increase Scheme of Traction Network Considering Capacity Increase Risk

Mr. Zhaoxu Su, Mingxing Tian, Lijun Sun
Lanzhou Jiaotong University, China

Abstract: To make better use of the transmission capacity of the traction power supply system, the static temperature increasing and dynamic capacity increasing schemes are introduced into the traction network to tap the transmission potential of transmission lines. Aiming at the reliability problem of line capacity increasing, the capacity increasing scheme of traction network considering the time-varying characteristics of wind speed is studied. In this paper, the risk assessment scheme of medium-term capacity increase based on the Monte Carlo test and the calculation method of safety time of static temperature rise and

capacity increase is proposed. The influence of time-varying characteristics of wind speed on the reliability of the existing physical capacity increase system is effectively evaluated, and the temperature change process of the transmission line is analyzed. The "thermal inertia" is used to conduct emergency capacity increase of traction network to save scheduling optimization time. The example shows that the method proposed in this paper is a new and effective method, which is of great significance to tap the transportation potential of the existing traction network.

G071
17:15-17:30

Distributed Electrical Resources with Micro Hydroelectric Power Plants In Colombia - Study Case

Alvaro Espine, Iván Díaz, **Prof. Adriana Vega**
Universidad Distrital Francisco Jose de Caldas, Colombia

Abstract: Energy coming from large hydroelectric plants is recognized worldwide due to the great environmental impact caused by the deviation of the rivers during the construction period and the dams while they are operating. This paper shows the design and construction of a micro hydroelectric power plant (MHPP) that was carried out in Cundinamarca Department, in Colombia, in order to analyze the feasibility of generating electric power with micro-power plant, which can be dispatched to the National Interconnected System, taking into account technical and economic aspects for the recovery of the investment. On the other hand, different scenarios are considered, such as self-consumption or the sale of energy to users of the rural sector that are close to the project, performing the financial analysis with economic indicators such as Internal Rate of Return, Uniform Annual Equivalent Cost and Net Present Value. These types of initiatives take special relevance in Colombia because the country issued Law 1715 of 2014, whose purpose is to improve energy reliability, it supports these kinds of projects with tax incentives such as: Discount of Value Added Tax (19%), 50% deduction of the income tax for up to five (5) years and elimination of the tariff levies for the equipment that make up the project. Based on the considerations above and because of the testing of the 24 kVA micro hydroelectric power plant, a paper that deals with the entire construction process of the micro-plant has been prepared, which includes: Flow capacity, turbine selection, selection of the generator, design of the electrical installations and commissioning to verify the effective value of the energy generated and the feasibility of being dispatched to the National Interconnected System.

G194
17:30-17:45

Matching Method of Provincial Peak Regulation Capacity, Safety Constraints and Regional Green Energy Consumption Demand

Zhen Hu, Ting Cui, Yangwu Shen
State Grid Hunan Electric Power Company Limited Research Institute, China

Abstract: In the inter-provincial market trading mechanism, there is a matching problem between the peak shaving capacity of a province and the sending requirements of green power supply in other provinces. In this matching process, it is also necessary to consider the safety and stability constraints and the influence requirements of line thermal stability limit. With the continuous growth of new energy installation in China, the demand for peak regulation is increasing rapidly, so the green energy transactions between provinces will become more and more frequent. In this paper, by analyzing the surplus period of peak regulation capacity of provincial power grid and the peak regulation demand delivery of other provinces, combined with the actual power grid constraints, the matching research of relevant electricity is carried out, and the corresponding capacity calculation method is put forward. To achieve the goal of reducing energy costs, reducing carbon emissions and increasing the proportion of green energy.

Session 12-Renewable Energy and Clean Energy

Chair:

15:45-17:30, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/91210761834

G044

15:45-16:00

Study on Enhancing Hydrogen Production Potential from Renewable Energy in Multi-terminal DC System

Assoc. Prof. Wei Deng, Wei Pei, Yin Yi, Ying Zhuang, Li Kong

Institute of Electrical Engineering, Chinese Academy of Sciences, China

Abstract: Renewable energy complementary hydrogen production can enhance the full consumption of renewable energy and reduce the abandonment of wind and solar power. The integration of renewable energy and hydrogen production equipment through existing multi-terminal DC systems can reduce new power lines construction and save investment in distribution equipment. For integrated renewable energy/hydrogen energy in an existing multi-terminal DC system, this paper investigates its potential of hydrogen production based on renewable energy, while ensuring the normal performance of the existing system being not affected. The typical structure and control strategy of the integrated renewable energy/hydrogen energy in multi-terminal DC system are firstly described. Then the state space model of the system is constructed, and the key parameters affecting the hydrogen production capacity are studied by using the eigenvalues analysis method. Finally, the corresponding system simulation model and test platform are built, and the theoretical analysis results are verified, and the potential of using multi-terminal DC system to enhance hydrogen production is quantitatively analyzed. The proposed scheme can enhance the hydrogen production potential from renewable energy, meanwhile the normal performance of the existing system is not affected.

G160

16:00-16:15

The Model Construction in Airport Renewable Energy System Scale Planning Based in Multi-Criteria Decision Making

Assist. Prof. Qin Jia, Hua-qing Hu, Jing-lei Yu

China Academy of Civil Aviation Science and Technology, China

Abstract: In order to solve the energy consumption and environmental problems, renewable energy was utilized in many airports. However, due to the periodic and intermittent, a single renewable energy generation is difficult to provide a continuous supply all the time. Hybrid energy system was considered to be the important way to alleviate the intermittent. The study focuses on the optimal design of hybrid renewable energy system planning. A model based on Multi-Criteria Decision Making (MCDM) was constructed. This model could achieve the optimization of scale for renewable energy and energy storage devices in hybrid renewable energy. The model was built in consideration of different power grid operation strategies including "Independence-net operation" and "grid connected operation". The results showed that the environmental and social benefits could be calculated at the same time, and the optimal renewable energy system scale planning outcome could be obtained.

G042
16:15-16:30

Construction of Energy Internet Technology Architecture Based on General System Structure Theory
Mr. Jian Geng, Wei Du, Dongmei Yang, Yonghua Chen, Gang Liu, Jinzhou Fu, Guoxin He, Jun Wang, Hui Chen
NARI Group (State Grid Electric Power Research Institute) Corporation，NARI Technology Co., Ltd., China

Abstract: Based on electrical power systems, leveraging renewable energy generation technology, and information technology, the energy internet fuses power grids, gas networks, heat/cold supply networks, electric transportation networks, etc. into an interconnected energy sharing network. The energy internet is an important technology for promoting renewable energy integration and improving energy efficiency. However, due to the complexity of multiple energy networks and the significant differences between them, the planning, operation, and control of energy internet presents several technical difficulties. Based on general system structure theory, the technical system framework for the provincial power grid corporations to construct regional energy internet is constructed, and it proposes a technical route for the development of provincial energy internet based on local conditions

G063
16:30-16:45

The Effect of Correlation of Uncertainties on Collaborative Optimization of Integrated Energy System
Ms. Yu Fu, Qie Sun, Ronald Wennersten
Shandong University, China

Abstract: Integrated energy system is an effective alternative to provide low-carbon sustainable energy to meet growing and complex energy demands. Uncertainty has a great impact on system configuration and operation schedule and the correlation between uncertain parameters increases the difficulty of high-precision optimization and control under this background. Thus, this paper focus on the correlation of uncertainties using copula theory and analyze the effect of correlation on optimization results. The case study shows that considering the correlation between uncertain parameters can affect the optimization results of the system not only in configuration but also the operation characteristics and reduce the total cost of the system.

G053
16:45-17:00

Explicit Basis Function Kernel Methods for Cloud Segmentation in Infrared Sky Images
Mr. Guillermo Terren-Serrano, Manel Martínez-Ramón
ECE Dept. University of New Mexico, United States

Abstract: Photovoltaic systems are sensitive to cloud shadow projection, which needs to be forecasted to reduce the noise impacting the intra-hour forecast of global solar irradiance. We present a comparison between different kernel discriminative models for cloud detection. The models are solved in the primal formulation to make them feasible in real-time applications. The performances are compared using the j-statistic. The infrared cloud images have been preprocessed to remove debris, which increases the performance of the analyzed methods. The use of the pixels' neighboring features also leads to a performance improvement. Discriminative models solved in the primal yield a dramatically lower computing time along with high performance in the segmentation.

G107
17:00-17:15

Optimization of Solar PV System for Fishery Cold Storage based on Ownership Model and Regulation Barrier in Indonesia

Mr. Humaid Thalib, Samsul Maarif, Eko Adhi Setiawan
University of Indonesia, Indonesia

Abstract: Fluctuation in fish catch due to seasonal factors causes instability in fish prices, decreasing the quality of fish and fishermen's incomes because there is no cold storage in some area for storing fish. Applying ownership of cold storage is divided into two models, namely commercial-based and community-based with different financial instruments. Fishery cold storage is an energy-intensive industry and Indonesia is a tropical country with abundant potential for solar irradiation. However, due to limited regulations, the application of solar photovoltaic (PV) in Indonesia is still not optimal. The simulation gives a new result by changing regulation assumptions: the solar photovoltaic on-grid system has a lower Levelized Cost of Electricity (LCOE) because it can produce eightfold more electricity to the grid with higher inverter capacity than before. With the lower LCOE of the solar photovoltaic On-grid system and the community-based ownership model, the rental price of cold storage can be 10 % on average cheaper than the rental price for cold storage based on the energy system from the utility grid.

G036
17:15-17:30

Integration Control of Renewable Energy/Hydrogen Energy System based on Flexible DC Interconnection

Assoc. Prof. Wei Deng, Wei Pei, Ying Zhuang, NingNing Li, Xue Zhang, Li Kong
Institute of Electrical Engineering, Chinese Academy of Sciences, China

Abstract: Wind/solar complementary for hydrogen production and hydrogen energy utilization have become one of the important directions for clean energy transformation and new economic growth point. This paper proposes a renewable energy/hydrogen energy system based on flexible DC interconnection and its coordinated control technology covering AC/DC voltage source converters and photovoltaic units, DC hydrogen production loads and energy storage devices. First, the typical structure of the renewable energy/hydrogen energy system with low-voltage flexible DC interconnection is proposed, and the local control strategy of each unit is analyzed, including the constant DC voltage control strategy and the constant active power control strategy. Then, coordinated control methods between renewable energy/hydrogen energy for different system operation states are proposed. Finally, a corresponding system simulation model and test platform are built, and then used to simulate and verify the proposed coordinated control method.

Session 13-Power System Safety and Reliability

Chair: Prof. Kei Eguchi, Fukuoka Institute of Technology, Japan

15:45-17:45, June 13 (GMT+8)

Zoom Link: https://zoom.com.cn/j/92266961196

G4001
15:45-16:00

Research on Quick Judgment of Power System Stability Using Grid Hierarchy Net
Mr. Dongyu Shi, Lulu Zhang
Tsinghua University, China

Abstract: Although deep learning has been introduced in the stability simulation analysis of power system, the structure of model needs to be further studied. A good structure can reflect the essence and simplify the solving process, like convolutional neural network (CNN) for image recognition. In this paper, a novel neural network model is proposed based on the power grid connection called grid hierarchy net (GHNet). The model can significantly reduce the number of trainable parameters while using more input variables to improve the accuracy of the model. Firstly, the construction method of GHNet is introduced based on electrical distance of stations. Then, some key issues are discussed including input and output selection. Finally, the actual data of the Northeast Power Grid of China was used to verify the feasibility and effectiveness of GHNet which meets the requirements of online security and stability analysis.

G144
16:00-16:15

Quantitative Evaluation of Power Supply Reliability Improvement in Distribution Network by Customer-side Integrated Energy System
Fengzhang Luo, **Ms. Jiaying Xu**, Tianyu Zhang
Tianjin University, China

Abstract: In order to solve the problem of quantifying the construction benefit of distribution system with integrated energy system, a quantitative evaluation method is proposed, taking into account the impact of demand response. Firstly, the power supply model is established to determine power supply region of integrated energy system after distribution network failure. Then, the demand response model integrating time-of-use price and incentive is used to show the load changes before and after the implementation of demand response. Furthermore, the improvement effect analysis method of distribution network reliability by integrated energy system are proposed based on the sequential Monte Carlo method. In addition, the influence of various factors on the reliability is also studied. At last, take the improved RBTS 6 bus F4 as an example. Case study results show that the integrated energy system and demand response can improve the reliability of the distribution network

G138
16:15-16:30

A Hierarchical Power System Transient Stability Assessment Method Considering Sample Imbalance
Mr. Yixing Du, Zhijian Hu, Fangzhou Wang
Wuhan University, China

Abstract: In order to make full use of the dynamic information contained in the electrical response trajectory, improve the reliability of critical sample prediction results, and correct the bias problem caused by sample imbalance to model prediction, a transient stability assessment (TSA) method based on bidirectional long short-term memory (BiLSTM) network is proposed. The method takes the dynamic trajectory of the underlying measurement data as input, abstracts the features step by step from the

multivariate time series through the multilayered neural network, and then establishes the nonlinear mapping relationship between the input feature and the stability category. In this paper, BiLSTM is improved by introducing truncation threshold and penalty coefficient into the loss function to give higher weights to hard samples and unstable samples, thus optimizing the gradient descent direction. Furthermore, this method enables sustainable hierarchical prediction and effectively reduces uncertain samples. The experimental results on the New England 39-bus system integrated with wind farm show that the proposed method significantly reduces the missing alarm rate of unstable samples and the false alarm rate of stable samples, and improves the credibility of the prediction results of critical samples.

G056
16:30-16:45

A novel Methodology for Critical Span Identification for Dynamic Line Rating System Implementation

Mr. Dávid Szabó, Bálint Németh
Budapest University of Technology and Economics, Hungary

Abstract: Nowadays the reliable availability of electricity is expected by both industrial and residential consumers. However, the generation, transmission and distribution all pose engineering challenges in adapting to consumers and sustainable directives while maintaining operational safety. The increasing demand for electricity on the consumer side and the growing number of renewable energy sources (RES) on the generation side are supporting the spread of capacity uprating methods. Dynamic Line Rating (DLR) is a novel, cost-effective line management method with which system operators are able to utilize existing power lines with greater efficiency than with traditional techniques. While the use of DLR has many benefits, there are also challenges that system operators have to cope with at system-level implementation. One of the most significant of these challenges is to find the balance between the required infrastructure for DLR implementation and the reliability of the implemented system. The aim of this article is to present a novel methodology for critical span identification based on which the sensor measurements accurately represent the prevailing conditions along the whole overhead line. Contrary to current methods, the proposed critical span analysis method takes into account the clearance of the conductors, which provides compliance with legal requirements. Furthermore, the uncertainty caused by using weather data to determine local conductor annealing is also eliminated with the recommended method. This way a flexible power system can be created that meets current needs, such as the integration of renewable and distributed energy sources or cross-border energy trade, while at the same time it enhances the operational safety of overhead lines.

G109
16:45-17:00

Electrostatic Discharge Protection of MiniLED Backlight Units on Glass

Juncheng Xiao, **Dr. Feng Zheng**, Jiayang Fei, Ji Li, Quansheng Liu, Wenxue Huo, Jingwen Zhuang, Wenlin Mei, Shengdong Zhang
TCL China Star Optoelectronic Semiconductor Display Technology Co.,Ltd, China

Abstract: Active matrix (AM) MiniLED backlight units (BLU) on glass substrate is developed to solve severe problems of MiniLED on PCB including insufficient heat dissipation and worse swelling and shrinking performance, as well as limited zone number. However, the MiniLED on glass is observed to possess a weak ability of anti-electrostatic discharge (ESD). The MiniLEDs on glass developed by us (short for MLED) are demonstrated to have a powerful ability of anti-ESD by the means of optimization of peripheral circuit design and metal and dielectric materials, also by the improvements of surroundings of module assembly factory. Consequently, the failure ratio of reliability analysis of MLED is observed to be decreased drastically after the improvements of the ability of anti-ESD.

G097
17:00-17:15

A Hybrid Approach Based on Deep Learning and Support Vector Machine for the Detection of Electricity Theft in Power Grids

Dr. Ejaz Ul Haq, Huang Jianjun, Xu Huarong, Kang Li
Shenzhen University, China

Abstract: Electricity theft has significant impact on the power grids in terms of generating non-technical losses, which eventually degrading the power quality and minimizing the outfitted profit. In this paper, we proposed a hybrid approach based on deep learning and support vector machine for the detection of energy theft to facilitate and assess energy supplier companies to eliminate the issue of insufficient power, irregular power expenditure and ineffective electricity monitoring. A deep convolutional neural network is proposed for the feature learning using smart meters data in different times, varying from hours to days. Extracted features were further used to train support vector machine, which classify the features in two categories as theft and non-theft. Furthermore, a dropout layer is introduced in convolutional neural network model to avoid over fitting issues. Several careful experiments were carried out on real time customers smart meter data and the results validate the effectiveness of the proposed method in terms of accuracy and less detection error.

G152
17:15-17:30

Analysis of Electricity Loss and Electricity Consumption Law in Low-Voltage Areas: A Case Study

Xi Chen, Chunhe Song, Tianran Wang
Shenyang Institute of Automation, Chinese Academy of Sciences, China

Abstract: Electric power is an important resource in energy. With the development of society, the consumption of electric power is more and more. Research on electricity consumption and power loss has become a hot topic.In this paper, we conduct statistical analysis on the power supply, power consumption and line loss rate of 395 power supply station.Line loss rate is an indicator to describe electricity consumption.We found that the line loss rate decreased over the course of a year.The overall distribution of line loss rate is approximately lognormal distribution. Total daily electricity supply and electricity consumption in the power supply area approximately obey exponential distribution.In terms of electricity consumption, a statistical analysis was made on the daily electricity consumption of 100,000 users in three years, and it was found that the electricity distribution of users was in line with the power law distribution.

G4003
17:30-17:45

CFD Modeling of An Even-Span Greenhouse Dryer Under Natural and Forced Convection Modes

Mellalou Abderrahman, Bacaoui Abdelaziz, Outzourhit Abdelkader
University Cadi Ayyad, Morocco

Abstract: In this study an even-span greenhouse dryer was designed and simulated under two different drying modes, natural and forced convection modes. The CFD simulation was carried out taking into consideration the weather conditions at the mean day of January (winter season) in Marrakech, Morocco. CFD was employed to predict the air velocity, temperature and relative humidity distribution inside the greenhouse dryer. Under forced convection mode the air temperature and relative humidity were uniformly distributed inside the dryer. The highest air temperature and lowest air relative humidity was recorded at the mean hour of the simulation day, under forced convection mode. They were 37 °C and 12%, respectively. These results reveal that under forced convection mode the greenhouse exhibited significant thermal performances.