PEDG 2019 PARTNERS

Diamond

Fuji Electric  
TBEA 特变电工

Platinum

RTDS Technologies

Gold

ModelingTech  
OPAL-RT Technologies  
Infomatic  
Yan Xu

ITECH  
Kelong  
上海熠速

Silver

Evolution  
上海大周
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Foreword

It is my pleasure to welcome you to the 2019 IEEE 10th International Symposium on Power Electronics for Distributed Generation Systems (PEDG 2019) in Xi’an, China. PEDG brings power electronic professionals, focusing on power electronics for distributed generation, together on an annual basis to participate in a rewarding exchange of technical knowledge, while gaining insight and valuable industry connections. This is an opportunity which is made possible each year through the tireless efforts of the all-volunteer organizing committee and the sponsoring IEEE Power Electronics Society. The faculty and staff of the Power Electronics and Renewable Energy Center (PEREC) at Xi’an Jiaotong University are the dedicated host of this year’s great event and it’s their combined dedication, expertise, and support that got us this far.

PEDG 2019 highlights one of the roles that power electronics plays in the power systems applications, i.e. enabling clean and sustainable distributed energy resources. We have an exciting program that is filled with some unique features. The technical program includes 8 tutorials, daily plenary keynote speeches, an industry keynote session, a panel session, 20 oral sessions in 5 parallel tracks, and 7 poster sessions in parallel tracks. More than 300 participants are expected, which includes 200 from academia and 100 from industry approximately.

The symposium also provides ample opportunities for networking and social interactions throughout the 4-day time frame, including a welcome reception with the celebration of the 10th PEDG on Monday evening, a food exploration at Great Tang All Day Mall on Tuesday evening, a banquet on Wednesday evening, a technical tour to TBEA, a local power electronics company, on Thursday afternoon, and an attraction tour of Tang Dynasty Grand Welcoming Ceremony on Thursday evening.

I would like to express my utmost gratitude to the members of the PEDG 2019 Organizing Committee. Special thanks also go to all the authors, reviewers, session chairs, panelists, and attendees. As we all know, financially we can’t make these conferences work without our dedicated partners, and I appreciate all of them for their generous support. Finally, we would like to thank the IEEE Power Electronics Society as the symposium sponsor.

We welcome you again to Xi’an, the oldest of the Four Great Ancient Capitals in the world, and we hope you have an enjoyable visit and a fruitful symposium.

Jinjun Liu
General Co-Chair, PEDG 2019
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University of New Brunswick, Canada
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RWTH Aachen University, Germany
Deepak Divan
Georgia Institute of Technology, United States
Johan Enslin
Clemson University, United States
Gerard Hurley
National University of Ireland Galway, Ireland
Fred C. Lee
Virginia Polytechnic Institute and State University, United States
Jinjun Liu
Xi'an Jiaotong University, China
Leo Lorenz
European Center of Power Electronics, Germany
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Federal University of Santa Catarina, Brazil
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University of Illinois at Chicago, United States
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University of British Columbia, Canada
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Mark Dehong Xu
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Xiaotian Zhang
Xi'an Jiaotong University
General Information

Registration
All attendees of the conference must be registered for the conference. Attendees with the One-Day registration are just able to participate activities of PEDG 2019 on the day registered, including academic sessions, social events and meal(s).

The conference onsite registration will open at the south lobby of the conference venue.

Registration Hours
South Lobby
Sun, June 2nd ........................................... 02:00PM - 10:00PM
Mon, June 3rd ......................................... 08:00AM - 10:00PM
Tue, June 4th ......................................... 08:00AM - 08:00PM
Wed, June 5th .......................................... 08:00AM - 07:00PM
Thu, June 6th .......................................... 08:00AM - 02:00PM

Conference Venue
PEDG 2019 will be held at the Wyndham Grand Xian South, which is situated at the key position of the prestigious tourism site Great Tang All Day Mall in Xi’an, just minutes away from Dayan Pagoda, international shopping centers, business pedestrian street and many famous historic heritage sites.

Location: 208 East Ci’en Road, Xi’an, China

Local Transportation
Public Transportation
Route #1: From Xi’an North Railway Station
(Est. Cost: 6.00 CNY, Time: 1 Hour)
① Taking Metro Line 2 to arrive the station named Xing Zheng Zhong Xin;
② Transferring to Metro Line 4 to arrive the station named Da Tang Fu Rong Yuan;
③ Walking to the Conference Venue about 1.1 km.

Route #2: From Xi’an Xianyang International Airport
(Est. Cost: 31.00 CNY, Time: 2 Hours)
① Taking the Airport Bus Xi’an high speed railway station line to arrive Xi’an North Railway Station;
② Referring to the Route #1.

Taxi
Please show the Chinese destination below to the driver.
“西安豪享来温德姆至尊酒店
西安市曲江新区慈恩东路 208 号”

Route #1: From Xi’an North Railway Station
(Est. Cost: 80.00 CNY, Time: 1 Hour and 10 Min)

Route #2: From Xi’an Xianyang International Airport
(Est. Cost: 120.00 CNY, Time: 1 Hour and 10 Min)

Meals
Lunch will be served on June 3rd - June 6th to all registered attendees. Besides, the welcome reception held on June 3rd and banquet on June 5th are available to registered attendees as well.

Lunch
Tang Cafe
Mon, June 3rd .................................12:30PM - 02:00PM
Tue, June 4th .................................12:05PM - 02:00PM
Wed, June 5th .................................12:10PM - 02:00PM
Thu, June 6th .................................11:30AM - 01:30PM

Welcome Reception
Grand Ballroom
Mon, June 3rd .................................06:00PM - 08:00PM

Banquet
Xiao Bai Sha
Mon, June 3rd .................................06:30PM - 08:30PM

Wi-Fi and Connection
Attendees have full access to Wi-Fi in all meeting rooms, foyer, and lobby.

Network: wyndham (no password required)

Use your mobile phone to scan the QR code below to access all events of PEDG 2019.
## Schedule-At-A-Glance

### Sunday, June 2nd

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>02:00PM - 10:00PM</td>
<td>South Lobby</td>
</tr>
</tbody>
</table>

### Monday, June 3rd

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td>Registration</td>
<td>08:00AM - 10:00PM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Tutorials</td>
<td>08:30AM - 10:20AM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Break</td>
<td>10:20AM - 10:40AM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Tutorials</td>
<td>10:40AM - 12:30PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:30PM - 02:00PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Tutorials</td>
<td>02:00PM - 03:50PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Break</td>
<td>10:20AM - 10:40AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Tutorials</td>
<td>10:40AM - 12:05PM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:05PM - 02:00PM</td>
<td>Grand Ballroom</td>
</tr>
</tbody>
</table>

### Tuesday, June 4th

<table>
<thead>
<tr>
<th>Event</th>
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<th>Location</th>
</tr>
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<tbody>
<tr>
<td>Registration</td>
<td>08:00AM - 08:00PM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Opening</td>
<td>08:30AM - 08:50AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Plenary Keynote I</td>
<td>08:50AM - 10:00AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Break</td>
<td>10:00AM - 10:20AM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Plenary Keynote II</td>
<td>10:20AM - 12:05PM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:05PM - 02:00PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Oral Sessions</td>
<td>02:00PM - 03:40PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Break</td>
<td>03:40PM - 04:00PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Oral Sessions</td>
<td>04:00PM - 05:40PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Rap Session</td>
<td>05:40PM - 07:10PM</td>
<td>Function Room 1</td>
</tr>
<tr>
<td>PELS Young Professional Reception</td>
<td>07:30PM - 09:00PM</td>
<td>Function Room 1</td>
</tr>
<tr>
<td>Dinner at Own</td>
<td>07:10PM - 10:00PM</td>
<td>Great Tang All Day Mall</td>
</tr>
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</table>

### Wednesday, June 5th

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
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<tbody>
<tr>
<td>Registration</td>
<td>08:00AM - 07:00PM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Plenary Keynote III</td>
<td>08:30AM - 10:15AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Break</td>
<td>10:15AM - 10:40AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Poster Sessions</td>
<td>10:40AM - 12:10PM</td>
<td>Ballroom Foyer</td>
</tr>
<tr>
<td>Industry Keynote</td>
<td>10:40AM - 11:10AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:10AM - 02:00PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Oral Sessions</td>
<td>02:00PM - 04:00PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Break</td>
<td>04:00PM - 04:20PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Oral Sessions</td>
<td>04:20PM - 06:00PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Banquet</td>
<td>06:30PM - 08:30PM</td>
<td>Xiao Bai Sha</td>
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</tbody>
</table>

### Thursday, June 6th

<table>
<thead>
<tr>
<th>Event</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>08:00AM - 02:00PM</td>
<td>South Lobby</td>
</tr>
<tr>
<td>Plenary Keynote IV</td>
<td>08:30AM - 11:10AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Break</td>
<td>09:40AM - 10:00AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Closing</td>
<td>11:10AM - 11:30AM</td>
<td>Grand Ballroom</td>
</tr>
<tr>
<td>Lunch</td>
<td>11:30AM - 01:30PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Technical Tour</td>
<td>01:00PM - 05:30PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Dinner at Own</td>
<td>05:30PM - 07:30PM</td>
<td>Tang Cafe</td>
</tr>
<tr>
<td>Attraction Tour</td>
<td>08:00PM - 09:40PM</td>
<td>Tang Cafe</td>
</tr>
</tbody>
</table>
Special Events

PEDG Welcome Reception
Monday, June 3rd, 6:00PM - 8:00PM
Grand Ballroom, Wyndham Grand
Kick off PEDG2019 with food, drink and conversation at the Monday Welcome Reception! This is your opportunity to join in the celebration of PEDG’s 10th birthday and enjoy wonderful art shows!

PELS Yong Professional Reception
Tuesday, June 4th, 7:30PM - 9:00PM
Function Room 1, Wyndham Grand
The IEEE PELS Students and Young Professionals reception will especially be filled with invited short speeches, meeting new power electronics peers and specialists in distributed power generation, learning about the best practices in industry and academia, and having loads of fun with complimentary drinks and snacks. This event is free and open to all students, young professionals, and engineers. Limited numbers with first come first serve, and please ask for reception desk to join in.

Exploration of Food and Culture
Tuesday, June 4th, 7:10PM - 10:00PM
Great Tang All Day Mall Walking Street
Take an visit to Great Tang All Day Mall Walking Street and get the opportunity to explore the food, music fountain square, art performance of the 2km long pedestrian street

Banquet
Wednesday, June 5th, 6:30PM - 8:30PM
Xiao Bai Sha (55 East Furong Road, Xi’an)
This unique night offers many unforgettable events including lake view dinner, celebration of the first PELS-DAY, presentation of "IEEE PELS Sustainable Energy Systems Technical Achievement Award" and visiting Southern Lake night view and Tang Dynasty City Wall Ruins Park. The bus will depart from the Wyndham Grand during 6:10PM - 6:15PM, and return during 8:30PM - 8:35PM at the location where drop off.

Technical Tour
Thursday, June 6th, 1:00PM - 5:30PM
TBEA Xi’an Electric Technology Co., Ltd.
Take technical visits and conversation to get in touch with state-of-the-art development in the industry. The bus will depart from the Wyndham Grand during 1:00PM - 1:10PM.

South Gate Food Circle
Thursday, June 6th, 5:30PM - 8:00PM
Near the South City Gate
Take a 2.5 hours tour to explore traditional Chinese food and climb the Ming Dynasty City Wall.

Attraction Tour
Thursday, June 6th, 8:00PM - 9:00PM
Xi’an South City Gate
Join in Chang’an Impression — Tang Dynasty Grand Welcoming Ceremony to experience the unique Chinese culture. The bus will depart during 9:45PM - 10:00PM at the location where drop off.
Presenter Information

Oral Presenters
Conference computers will be provided in each oral session room with pre-loaded presentation files. Presenters will not be permitted to utilize alternate computers in the session rooms.

Presenters are required to be in the session room 15 minutes before the start of their sessions to report to the session chair, and to check their presentation files in the conference computers.

Poster Presenters
Posters will be on display on Wednesday, June 5th, in Ballroom Foyer. All presenters are required to preside at their poster panels during the poster session for anticipated discussion with participants. All presenters must have their posters hung at the start of the session and removed at its completion, and scotch tapes will be provided for use. All posters left after the end of the session will be discarded.

Poster Presenters will have access to Ballroom Foyer to set up and tear down their posters at the times listed below.

Set-Up .................................................. 10:20AM - 10:40AM
Poster Session ..................................... 10:40AM - 12:10PM
Breakdown .......................................... 12:10PM - 12:30PM
Tutorials

Tutorial Session I
Monday, June 3rd  8:30AM - 12:30PM
Function Room 2
Chair      Jinjun Liu (Xi’an Jiaotong University, China)

T1 Modeling and Control of Modular Multi-Level Converter
8:30AM - 10:20AM
Fred Lee
Virginia Polytechnic Institute and State University, United States

While a large amount of future renewable energy sources will be networked with high-voltage DC grids, integration between these high-voltage DC grids and the existing AC grids is challenging. Among the limited choices, the modular multi-level converter (MMC) is deemed the most prominent interface converter between the DC and AC grids. This subject has been widely pursued in recent years. One of the important design challenges is to reduce the capacitor size associated with each module. Currently, a rather large capacitor bank is required to store certain amount of line-frequency related circulating energy. A number of control strategies have been introduced to reduce the capacitor voltage ripples by injecting certain harmonic current. Most of these strategies were developed, to my understanding, with good engineering ingenuity together with trial and error. There is a lack of a simple analytical model to provide effective control means to address this issue.

To gain a better understanding of the intricate operation of the MMC, the authors propose a state-trajectory analysis technique in conjunction with the power flow analysis. The proposed model can easily delineate the desired power transfer from the unwanted circulating energy. The model can illustrate visually the convoluted current and power flow between source and load as well as the circulating energy swapping between capacitors in the upper and low arms. Based on the state plane analysis, a decoupled $\alpha\beta$ model of MMC was proposed. This model can be further simplified into an equivalent circuit, which decouples the power flow between source and load and the circulation energy between upper arm and low arm of the MMC converter.

Based on the equivalent circuit, two control law can be identified, one is to achieve the maximize the power throughput and the other is to minimum circulating energy. Two examples of control are illustrated with significant capacitor size reduction beyond the current practice. The authors believe that this model will pave the way for researchers to gain better understanding of this complex system and further development of more advanced control strategies.

Fred Lee received the B.S. degree in electrical engineering from National Cheng Kung University, Tainan, Taiwan, in 1968, and the M.S. and Ph.D. degrees in electrical engineering from Duke University, Durham, NC, USA, in 1972 and 1974, respectively. He is currently a University Distinguished Professor at Virginia Tech, Blacksburg, USA, and the Director of the Center for Power Electronics Systems (CPES), a National Science Foundation Engineering Research Center (NSF ERC) established in 1998, with four university partners—University of Wisconsin-Madison, Rensselaer Polytechnic Institute, North Carolina A&T State University, University of Puerto Rico-Mayaguez, and more than 80 industry members. The Center’s vision is “to provide leadership through global collaboration to create electric power processing systems of the highest value to society.” More than the Ten-Year NSF ERC Program, CPES has been cited as a model ERC for its industrial collaboration and technology transfer, as well as education and outreach programs. His research interests include high-frequency power conversion, renewable energy, high-density electronics packaging and integration, and modeling and control. He holds 69 U.S. patents and has published 238 journal articles and more than 596 refereed technical papers. During his tenure at Virginia Tech, he has supervised to completion 71 Ph.D. and 80 Master’s students. Dr. Lee received the William E. Newell Power Electronics Award in 1989, the Arthur E. Fury Award for Leadership and Innovation in Advancing Power Electronic Systems Technology in 1998, and the Ernst-Blickle Award for achievement in the field of power electronics in 2005. He has served as the President of the IEEE Power Electronics Society (1993–1994). He was named to the National Academy of Engineering in 2011.
MMC is well recognized with the merits of modular design, scalable to very high voltage, and high reliability by means of redundancy, thus it is regarded as a promising approach for high-voltage and high-power applications. At present, MMC is extending to the applications of medium-voltage motor drives and high-power DC-DC conversions in addition to the regular high-voltage direct-current (HVDC) transmission. Various applications impose very different design constraints for MMCs due to the specific control objectives and performance regulations, leading to great technical challenges for MMC. This tutorial will cover some of the cutting-edge technologies of MMC for coping with the newly emerging technical challenges in academia and industry. First, the conventional MMC, practical modulations, and typical controls will be illustrated for recalling the conventional MMC technology. And then, the emerging MMC topologies, operating principles, and circuit characteristics will be analyzed. Moreover, the technical requirements, challenges, and solutions of advanced MMC-based motor drives and applications in AC and DC power systems will be presented. Finally, the trends and future expectations of MMC topologies will be discussed.

Dr. Sixing Du received the Master and Ph.D. degrees in electrical engineering from Xi’an Jiaotong University (XJTU), Xi’an, China in 2011 and 2014, respectively. From 2015 to 2019, he has been a Postdoctoral Research Fellow in the Department of Electrical and Computer Engineering at Ryerson University, and University of Toronto, Respectively. He is going to join as a Distinguished Research Fellow in the School of Electrical Engineering, Xi’an Jiaotong University. His research includes high-power converters and their applications to medium-voltage motor drives and power systems. He has invented several novel MMC topologies for various industrial applications, which not only overcome the major technical issues of conventional MMCs at zero/low-speed operation in medium-voltage (MV) motor drives, but also achieve single-stage DC-DC conversion for HVDC and MVDC applications. Dr. Du has published 20 technical papers in peer-reviewed IEEE Transactions and other international journals as the first author with a total of over 500 citations in the past 6 years. He also published a Wiley-IEEE Press book “Modular Multilevel Converter: Analysis, Control and Applications” in January 2018 as a leading author. He holds 7 issued Chinese patents in power electronics, power quality, and High-voltage direct current transmission (HVDC) as co-inventor. Dr. Du received Excellent Doctoral Dissertation Award from Shaanxi Provincial Department of Education in 2017, and other prestigious awards in past few years.

Liuchen Chang received B.S.E.E. from Northern Jiaotong University in 1982, M.Sc. from China Academy of Railway Sciences in 1984, and Ph.D. from Queen’ University in 1991. He joined the University of New Brunswick (UNB) in 1992 and is a professor in Electrical and Computer Engineering. He was the NSERC Chair in Environmental Design Engineering during 2001-2007, and was the Principal Investigator of Canadian Wind Energy Strategic Network (WESNet) during 2008-2014. He is a vice president of the IEEE Power Electronics Society. He has been a committed volunteer of IEEE since early 1990’s. Dr. Chang was a recipient of CanWEA R.J. Templin Award in 2010 for his contribution in the development of wind energy technologies, Innovation Award for Excellence in Applied Research in New Brunswick in 2016 for his contributions in smart grid and renewable energy technologies, and PELS
Sustainable Energy Systems Technical Achievement Award in 2018 for his contributions in distributed energy systems. He is a fellow of Canadian Academy of Engineering (FCAE). He has published more than 350 refereed papers in journals and conference proceedings. Dr. Chang has focused on research, development, demonstration and deployment of renewable energy based distributed generation systems and direct load control systems.

Shuang Xu received the B. Sc. E.E. in 2012 from Hefei University of Technology, Hefei, China, and the Ph.D. in electrical engineering in 2018 at the University of New Brunswick (UNB), Fredericton, Canada. He is currently a Post-Doctoral Fellow at the Emera and NB Power Research Centre for Smart Grid Technologies at UNB. His research interests include renewable energy systems, energy storage technologies, power electronics, and power system support functions for distributed energy resources.

**T4 Optimization Techniques for Solar Power Plants**

10:40AM - 12:30PM

**Martin Ordonez, Francisco Paz**

*The University of British Columbia, Canada*

Solar power installations are extremely sensitive to the cost of the installation, the expected payback time, and the availability of energy generation over time. Many factors must be weighed in the design of a PV system (e.g., panels, arrays, inverters), but traditional design rules are too simplistic and do not make use of critical information. Often, oversized components are used that do not produce any advantages for the PV system. An alternative to the traditional approach is to optimize the different components of the system to obtain an overall system that minimizes installation cost, payback time, or other user defined targets.

In this tutorial, models, methods, and techniques will be presented to optimize the performance of the PV systems. Three aspects of the design process will be addressed: 1) PV plant size optimization, based on detailed models; 2) PV inverter stage optimization, based on power envelope and mini-boost stages; and 3) maximum power point tracking strategies. The discussion of each of these topics will focus on design considerations and on the trade-offs between different factors that lead to optimal solutions. The topics are discussed in relation to industry standard practices, and this is followed by the introduction of advanced techniques that yield better performance.

Dr. Martin Ordonez is currently a Professor and Canada Research Chair in Power Converters for Renewable Energy Systems with the Department of Electrical and Computer Engineering, University of British Columbia, Vancouver, BC, Canada. He is also the holder of the Fred Kaiser Professorship on Power Conversion and Sustainability at UBC. He was an adjunct Professor at Simon Fraser University, Burnaby, BC, Canada, and MUN. His industrial experience in power conversion includes research and development at Xantrex Technology Inc./Elgar Electronics Corp. (now AMETEK Programmable Power in San Diego, California). With the support of industrial funds and the Natural Sciences and Engineering Research Council, he has contributed to more than 150 publications and R&D reports. Dr. Ordonez is an Associate Editor of the IEEE TRANSACTIONS ON POWER ELECTRONICS, a Guest Editor for IEEE JOURNAL OF EMERGING AND SELECTED TOPICS IN POWER ELECTRONICS, an Editor for IEEE TRANSACTIONS ON SUSTAINABLE ENERGY serves on several IEEE committees, and reviews widely for IEEE/IET journals and international conferences. He was awarded the David Dunsiger Award for Excellence in the Faculty of Engineering and Applied Science (2009) and the Chair's Graduate Award/Birks Graduate Medal (2006) and became a Fellow of the School of Graduate Studies, MUN.

Francisco Paz is a Ph.D. Candidate and Liu Scholar at the University of British Columbia (UBC) in Vancouver, Canada. He serves as vice-chair of the Vancouver IEEE Power Electronics Chapter since 2016 and serves as the Local Organizing Chair for the IEEE PEDG 2016 in Vancouver, Canada. Mr. Paz has been recognized with several scholarships and awards, including the ICICS Graduate Scholarship (2014), the UBC Faculty of Applied Science Graduate Award (2014 to 2016), and the Four Year Fellowship for Ph.D. students (2014 to 2018) from UBC. He also received a Best Conference Paper award by PELS Technical Committee 5 (TC5) at PEDG. Other recognitions include the TICs scholarship from the Argentinian Ministry of Education, Science, Technology and Productive Innovation (2008). He is passionate about teaching and learning, having served as lecturer for seven courses on renewable energy sources, under the Vancouver Summer Program (2016 to 2018), and having delivered tutorials at the IEEE SPEC 2017 in Chile, IEEE PEDG 2018 in Charlotte, and IEEE ECCE 2018 in Portland. For his teaching contributions to UBC, he received the prestigious Killam Graduate Teaching Assistant Award.
Current regulation plays a key role in power electronic conversion systems. The central concept is straightforward – compare a measured current against a defined reference, and minimise the error between these two quantities by adjusting the switching of the associated power electronic converter. However, while apparently simple in principle, achieving this goal in practice for AC inverter systems has proved to be very challenging. Over the last decade, such issues have become especially important for grid connected inverters, where the challenges of low per-unit (p.u.) filter inductances, unbalanced grid voltages with significant harmonics, a preference for direct digital control, and stability concerns with the inverter’s associated phase locked loop subsystem, create unique and particular challenges for current regulation.

This tutorial will present the current state-of-the-art for digital current regulation of grid connected AC converter systems. It will begin by showing how PWM transport and sampling delays are the primary constraints for linear regulators. Strategies to overcome these constraints will then be explored, including back EMF compensation, PR resonant control and its equivalent synchronous d-q frame implementation. An analytical approach to calculate the maximum gains for these strategies will be developed, verified by simulation and matching experimental results. Next, these concepts will be extended to the particular difficulties of current regulation for grid connected inverters. Issues considered will include gain determination when a low p.u. inductive-capacitive-inductive (LCL) filter is used, formal strategies to design a current regulator in the sampled z-domain transform space, how to best manage modulation saturation, and the influence of common mode EMI filtering on the current regulator performance. The tutorial will then explore how to manage grid harmonics, unbalanced grid voltages and high impedance grid networks, by using cascaded PR regulators for each voltage harmonic, and positive/negative sequence current regulators operating in both the synchronous and stationary reference frames. Finally, the tutorial will present some recent advances to maintain stable current regulation for a stand-alone microgrid when stability issues associated with the inverter’s phase locked loop are taken into account. All theoretical material presented will be supported by detailed matching simulations and experimental confirmation.
This tutorial will overview power electronics for grid applications. The focus of the talk will be on SiC benefits for grid power electronics at both the converter and system levels. The converter level benefits include size, weight, efficiency, and/or potential cost reduction. The system-level benefits include improved power quality and enhanced stability. The research needs will also be discussed.

Prof. Fred Wang is a professor and Condra Chair of Excellence in Power Electronics at the University of Tennessee, Knoxville. He holds a joint position in Oak Ridge National Lab. He is the Technical Director of CURENT. He is a guest Changjiang Scholar Professor at Xi’An Jiaotong University. His experience also includes 8 years as an associate professor and the Technical Director at the Center for Power Electronics in Virginia Tech, and 10 years as an engineer and R&D manager at General Electric. His interests include power electronics and power systems. He is a fellow of the IEEE and a fellow of the US Academy of Inventors.

Dr. Johan H Enslin is the Duke Energy Endowed Chaired Professor in Smart Grid and Executive Director for the Power Program at Zucker Family Graduate Education Center for Clemson University in North Charleston SC. He comes as Director for the Energy Production and Infrastructure Center (EPIC) and the Duke Energy Distinguished Chair in Power System at UNC Charlotte. Enslin has combined a 37-year career with leadership in industry and academia, in the US, Europe and South Africa. He served as an executive for private business operations and a professor in electrical engineering. Dr. Enslin initiated and led renewable energy teams, companies and executed multi-disciplinary power system projects. Over the course of his career Johan worked for more than 90 US, European, Asian and African power utilities, governments and industries. He authored and co-authored more than 300 technical journal and conference papers for IEEE and other organizations, and has written several chapters in scientific books. Johan is a life-long leader in the IEEE and CIGRÉ working groups and committees. He holds more than 25
provisional and final patents. He received the 2014 Charlotte Business Journal Energy Leadership Award. He is a registered Professional Engineer in South Africa, Fellow of the SAIEE and Fellow of the IEEE.

**T8 Small-Signal Modeling and Stability Analysis of Grid-Converter Interactions**

4:10PM - 6:00PM

**Xiongfei Wang**  
*Alborg University, Denmark*

Power electronic converters are increasingly found in ac power grids, e.g. renewable energy generations, flexible ac/dc power transmissions, and energy-efficient power consumptions. As the number of grid-connected converters increases, the converter-grid interactions tend to bring in a number of stability and power quality challenges. This tutorial thus provides a systematic discussion on the small-signal modeling and dynamic analysis of grid-connected converters, considering both grid-forming and grid-following operations. A critical review of mathematical foundations for the multi-frequency small-signal models of ac power converters will be discussed. The impedance modeling and stability analysis of grid-converter interactions will be presented, and the influences of different control loops will be characterized with case studies. Prospects and challenges on the model validation and system stability analysis will conclude the tutorial.

Xiongfei Wang is a Professor and Research Program Leader for Electronic Power Grid (eGrid) with the Department of Energy Technology, Aalborg University, Denmark. His research interests include modeling and control of grid-interactive converters, stability and power quality of power-electronic-based power systems, active and passive filters. He has delivered tutorials at a few IEEE conferences/workshops, e.g. APEC, ECCE, PEDG, EPE, eGrid, PEAC, etc.

In 2016, Dr. Wang was selected into Aalborg University Strategic Talent Management Program, which aims at developing next-generation research leaders for Aalborg University. He received six IEEE prize paper awards in both Transactions and conferences, the outstanding reviewer award of IEEE Transactions on Power Electronics in 2017, and the IEEE PELS Richard M. Bass Outstanding Young Power Electronics Engineer Award in 2018. He serves as the Associate Editor for the IEEE Transactions on Power Electronics, the IEEE Transactions on Industry Applications, and the IEEE Journal of Emerging and Selected Topics in Power Electronics.
Plenary Keynotes

Plenary Keynote I
Tuesday, June 4th 8:50AM - 10:00AM
Grand Ballroom
Chairs  Dehong Xu (Zhejiang University, China)
Ralph Mario Kennel (Technical University of Munich, Germany)

P1.1 Decentralized Solutions for Grid Control
8:50AM - 9:25AM
Deepak Divan
Georgia Institute of Technology, United States

The requirement for distributed real-time control in the future grid using power converters is being driven by rapid growth in distributed energy resources, microgrids and the need for dynamic real-time balancing between generation and loads. The move from centralized control to massively decentralized and distributed control raises further challenges, both in terms of the converters and feasible control strategies, as well as the architecture and infrastructure required to manage and operate such a system. This presentation will discuss power converter topologies, control strategies and system architecture for managing such a future grid and related loads. Key topics include hybrid transformers, solid state transformers and universal converters for a variety of applications, and grid integration strategies for managing a fleet of such devices to deliver value for the future and present grid.

Dr. Deepak Divan is Professor, John E Pippin Chair, GRA Eminent Scholar and Director of the Center for Distributed Energy at the Georgia Institute of Technology in Atlanta, GA. His field of research is in the areas of power electronics, power systems, smart grids and distributed control of power systems. He works closely with utilities and industry and is actively involved in research, teaching, entrepreneurship and starting new ventures. Dr. Divan is an elected Member of the US National Academy of Engineering, member of the US national academies Board for Energy and Environmental Systems and a member of the national academies committee for modernizing the US electricity system. He is also a Fellow of the IEEE, past President of the IEEE Power Electronics Society, and is a recipient of the IEEE William E Newell Field Medal.

Dr. Divan also serves as Founder and Chief Scientist at Varentec, in Santa Clara, CA, and was President and CTO from 2011-14, leading the company as it developed its suite of innovative distributed real-time grid control technologies. Varentec is funded by leading green-tech Venture Capital firm Khosla Ventures and renowned investor Bill Gates. He has 40 years of academic and industrial experience, 65 issued and pending patents, and over 250 refereed publications. He has founded or seeded several new ventures including Soft Switching Technologies, Innovolt, Varentec and Smart Wires, which together have raised >$160M in venture funding. He received his B. Tech from IIT Kanpur, and his MS and PhD degrees from the University of Calgary, Canada.

P1.2 Challenges and Solutions for Grid Integration of Renewable Energy in China
9:25AM - 10:10AM
Weisheng Wang
China Electric Power Research Institute, China

China has actively promoted the renewable energy development in recent years. By the end of 2018, the accumulative installed capacity of wind and PV power ranked No.1 in the world. The output of wind power and PV power is characterized with uncertainty and volatility, which is a big challenge to the safe operation of existing power system. In addition, grid ability of accommodation becomes prominent concern in some areas in China. The curtailment of wind power or PV power becomes severe which limits the further integration of renewables. The presentation will introduce the basic information of integration and accommodation of renewable energy in China. Then the main challenges on operation security and existing curtailment of wind and PV power are studied systematically. Moreover, the research activities and actual applications in China are described. Finally, the further research issues are proposed for the healthy and rapid development of renewable energy.

Prof. Weisheng Wang received his Doctor degree in Electrical Engineering at Xi’an Jiaotong University in 1996. Then, he joined China Electric Power Research Institute (CEPRI) in Jan. 1997. Now, He is the director of Renewable Energy Research Center of CEPRI. His main interests include research and consulting in the field of renewable energy generation and its grid integration. He is fellow of Chinese Society for Electrical Engineer(CSEE), senior member of IEEE, and member of board of directors of China Renewable Energy Society.
Denizar Cruz Martins was born in São Paulo, Brazil, in 1955. He holds Electrical Engineering degree (1978), and Master's degree in Electrical Engineering (1981), all at the Federal University of Santa Catarina (UFSC) and PhD degree in Electrical Engineering from the National Polytechnic Institute of Toulouse, Toulouse, France (1986). He has published over 300 (three hundred) scientific papers. He has developed several technological projects in partnership with Brazilian Companies, resulting in the realization of some patents of invention. He is the author of four national books in the area of Power Electronics and two chapters of international books in the area of Electronic Processing of the Photovoltaic Solar Energy. He is a Founding Partner of SOBRAEP (Brazilian Power Electronics Society), having been its President for two years. He was Coordinator of the Post-Graduation Program in Electrical Engineering at UFSC. He was Head of the Electrical and Electronic Engineering Department at UFSC for two consecutive terms, and He is currently Supervisor of INEP (Power Electronics Institute). He is a full professor in the Electrical and Electronic Engineering Department at the Federal University of Santa Catarina, where He teaches undergraduate and postgraduate courses. He is accredited by the Post-Graduate Program in Electrical Engineering of UFSC for guiding students in master and in doctoral thesis. He is representative of the Power Electronics area in the Post-Graduation Program in Electrical Engineering at UFSC. He has experience in Electrical Engineering, with emphasis on Power Electronics, working mainly on the following topics: DC-DC and DC-AC static converters, power factor correction, power quality, electronic power processing, distributed generation systems, DC and AC microgrids, simulation of static converters and electric drive.

**P2.1 Development of Microgrids in Brazil**

Denizar Cruz Martins

*Federal University of Santa Catarina, Brazil*

Brazil has an average solar radiation on the order of 5400 Wh/m2 day. With regard to wind energy, Brazil has a potential around 140 GW, with an average annual wind speed of 6.25 m/s (to 50 m of ground height). Brazil still has a great potential of energies generated from the oceans, still very little explored. It is estimated that the 8 thousand kilometers of coastal extension in Brazil can receive enough wave power plants to generate 87 GW.

From these data it is evident that Brazil is one of the most promising countries for the use of renewable energy in its industrial, commercial and residential areas. Therefore, in my presentation I intend to discuss the latest advances presented in Brazil regarding the development of microgrids. It will be show some successful experiences involving sectors of the Brazilian Electric Power Network. Techniques employing the modified droop feature to enable the state of charge balancing of a multiple battery system in a hybrid microgrid, combining wind and PV solar energy, are described. This balancing is realized without the use of logical communication between the different converters that form the microgrid. Thus, it is possible to distribute the converters through an microgrid, helping to improve the quality of the energy supplied to the loads. Preliminary results of a microgrid consisting of a photovoltaic solar array, a set of wind turbines and a diesel generator, are presented, whose main focuses are: the description of the system, the mode of operation, and the design of the converters.

**P2.2 Next-Generation Device- and Network-Centric Control/Modeling of Power-Electronic Systems and Networks**

Sudip K. Mazumder

*University of Illinois at Chicago, United States*

This keynote presentation will begin with an outline on the role of control in traditional power-electronic systems and networks and how they shape the behavior of such hybrid dynamical systems. Subsequently, an overview of the traditional power-electronic control, analysis, and modeling approaches will be provided along with brief discussions on their strengths and limitations. That leads to the future of controls in power electronics and what should and could be done beyond traditional power-electronic control that addresses existing, evolving, and future applications needs spanning nano- to mega-power scales and encompassing wide variation in temporal and spatial scales? This talk will provide some insights as to how and what radically-new ideas may need to be synthesized that reach far beyond historical and conventional power-electronic control needs with applications including but not limited to sustainable-energy systems.

Sudip K. Mazumder received his Ph.D. degree from Virginia Tech in 2001. He is a Professor and the Director of Laboratory for Energy and Switching-Electronics Systems in the Department of Electrical and Computer Engineering at the University of Illinois at Chicago. He also serves as the President of the small business NextWatt LLC. He has over 25 years of professional experience and has held R&D and design positions in leading industrial organizations and has served as a Technical Consultant for several industries. His current areas of interests are switching-sequence and switching-transition based control of power-electronics systems and interactive-power networks; power electronics for renewable energy, micro/smart grids, energy storage; wide-bandgap (GaN/SiC) power electronics; and optically-triggered wide-bandgap power semiconductor devices.
His research has attracted about 50 sponsored-research projects from leading federal agencies and industries and yielded over 215 peer-reviewed publications in prestigious tier-one international journals and conferences, 11 patents, 10 book chapters and 1 book, and about 100 invited/plenary/keynote lectures and presentations. He has guided/guiding 13 post-doctoral researchers and 16 Ph.D. and 11 M.S. students. He is the recipient of University of Illinois at Chicago’s Inventor of the Year Award (2014), University of Illinois’ University Scholar Award – university’s highest award (2013), IEEE International Future Energy Challenge Award (2005), ONR Young Investigator Award (2005), NSF CAREER Award (2003), and IEEE PELS Transaction Prize Paper Award (2002). In 2016, he was elevated to the rank of an IEEE Fellow and he was elected to serve as a Distinguished Lecturer for IEEE PELS beginning in 2016. Since 2019, he is also the Editor-at-Large for IEEE Transactions on Power Electronics. Currently, he also serves as the Chair for IEEE PELS Technical Committee on Sustainable Energy Systems. He is the Chair for IEEE PEDG’21, the TPC Chair for IEEE DEAS’19, and the Tutorial Chair for ECCE’19. He is an AdCom Member for IEEE Power Electronics Society.

P2.3 New Power Semiconductor for Realization of a Sustainable Society
11:30AM - 12:05PM

Seiki Igarashi
Fuji Electric Co., Ltd., Japan

We will see a movement to realize a sustainable society by achieving economic growth while also addressing social issues pertaining to energy, the environment, human rights, and other areas. This movement is exemplified by the adoption of the Paris Agreement and the United Nations Sustainable Development Goals. Fuji Electric’s corporate philosophy and management policies emphasize its commitment to contributing to the creation of a sustainable society through its energy and environment businesses. In other words, our core principles are congruent with the contemporary needs of society and customers.

In electric power equipment for the industrial applications and Auto motive applications, more energy-saving and more resource-saving, efficient systems must be developed. Power semiconductor devices are the key to develop more efficient electric power equipment. In this paper is introduced for RC-IGBT with 3G Direct Water Cooling Module and 2G-trench SiC MOSFET module. Those new devices increase the output power density per weight or per volume, reduce the consumption of natural resources, and increase the efficiency of electric power conversion systems. Fuji Electric stands committed contributing to the realization of a responsible and sustainable society through its business in order to address the energy and environmental issues that threaten the earth.

Dr. Seiki Igarashi is Senior Manager for Device Application Technology Department Fuji Electric Co., Ltd., Japan. In 1984, he started working at Fuji Electric Corporate R&D Center. He was development of the high efficiency Fuel Cell Inverter, UPS and Industrial Power supplies. From 2003, he moved to the Semiconductor Group. Now he interests New Power Device Development planning and its application technologies. He is member of IEE Japan. He received an Excellent Paper Award from IEE Japan in 2000.
P3.1 Wind Power - A Technology Enabled by Power Electronics
8:30AM - 9:05AM

Frede Blaabjerg
Aalborg University, Denmark

The steady growth of the installed wind power, will reach 600 GW capacity in 2019, together with the up-scaling of the single wind turbine power capability - 12 MW’s are announced by manufacturers, has pushed the research and development of power converters towards full scale power conversion, lower cost pr kW, higher power density and need for a higher reliability. Substantial efforts are carried out to comply with the more stringent grid codes, especially grid faults ride-through and reactive power injection, which challenges the power converter topologies, because the need for crowbar protection and/or power converter over-rating has been seen in the past in the case of a doubly-fed induction generator. The presentation will first give a technology overview. Next power converter technologies are reviewed with focus on single/multi-cell power converter topologies. Further - case studies on the Low Voltage Ride Through demand to power converter are presented including a discussion on reliability. Finally, discussions about topologies for wind farms will be provided where they need to be operating like large power plants like a large synchronous generator.

Frede Blaabjerg was with ABB-Scandia, Randers, Denmark, from 1987 to 1988. From 1988 to 1992, he got the PhD degree in Electrical Engineering at Aalborg University in 1995. He became an Assistant Professor in 1992, an Associate Professor in 1996, and a Full Professor of power electronics and drives in 1998. From 2017 he became a Villum Investigator. His R&D experience include power electronics converters for AC motor drive systems. He has published 20+ peer reviewed papers and holds 10+ patents.

from 2005 to 2007 and for the IEEE Industry Applications Society from 2010 to 2011 as well as 2017 to 2018. In 2019-2020 he serves a President of IEEE Power Electronics Society. He is Vice-President of the Danish Academy of Technical Sciences too.

P3.2 Control of Power Electronics Converters for Wind Turbines
9:05AM – 9:40AM

Hongwu She
Envision Energy, China

Power electronics converters enabled the wide deployment and high penetration of the variable speed wind turbines in the modern power system. With the increase of the hub height and rotor diameter, there are great challenges for the turbine control. Robust and high dynamic control of the power converter and pitch driver plays an important role in modern wind turbines.

Dr. Hongwu She received the B.S. degree from the Naval University of Engineering, Wuhan, China, in 2004; and then received the M.S. and Ph.D. degrees from the Huazhong University of Science and Technology (HUST), Wuhan, China, in 2007 and 2011, respectively. From 2011 to 2017, he was with the GE Global Research Center (Shanghai). Since 2017, he has been with the Envision Energy, currently he is the Technical Director for Grid Integration. His R&D experience include wind energy conversion system control, grid integration, and AC motor drive systems. He has published 20+ peer reviewed papers and holds 10+ patents.

P3.3 Impact of Distributed Generation on CSG Power Grids
9:40AM - 10:15AM

Xuzhu Dong
China Southern Power Grid, China

In last decade distributed generation (DG) develops rapidly in China Southern Power Grid (CSG) service territory, CSG takes a lot of measures, including policy, management, and techniques, to actively cope with integration of various distributed generation. This presentation will introduce status and prospect of DG development in CSG, especially addressing distributed photovoltaic (PV) and small hydro power generation. DG impact on power systems will then be analyzed in details, including power grid planning, load forecast, integration and acceptance requirements, feeder voltage violation issues, reliability impact, protection and control, policy and tariff, environmental issue, and etc. In the end CSG R&D and demonstration related to DG integration will be shared, for example, integrated energy internet and microgrids.

Dr. Xuzhu Dong was born in Shaanxi, China. He received his first Ph. D in high voltage engineering from Tsinghua University in 1998, and the second Ph. D in electrical engineering from Virginia Tech in 2014. He was the Editor-in-Chief of the IEEE TRANSACTIONS ON POWER ELECTRONICS from 2006 to 2012. He has been Distinguished Lecturer for the IEEE Power Electronics Society.
engineering from Virginia Tech in 2002. He is Deputy Chief Engineer of CSG EPRI. He was Director of Smart Grid Institute at CSG EPRI. Before joined CSG in 2010, he worked with Progress Energy, FirstEnergy, and EPRI solutions in USA, as senior engineer, stuff engineer, and lead engineer. His research interests were smart grids and power equipment asset management. He is involved into several key smart grid demonstration projects at CSG. Dr. Dong is senior member of IEEE, and member of CIGRE.

Plenary Keynote IV
Thursday, June 6th  8:30AM - 11:10AM
Grand Ballroom

Chairs  
Juan Carlos Balda (University of Arkansas - Fayetteville, United States)
Dong-Choon Lee (Yeungnam University, Korea)

P4.1 Power Electronic Converters and the Emerging Smart Grid
8:30AM - 9:05AM

Grahame Holmes
RMIT University, Australia

For most of the 20th century, electrical energy has been generated by high power rotating generators that supply customers through a network of high voltage transmission lines and lower voltage distribution feeders. However, as the world moves inexorably towards Distributed Generation of renewable electrical energy, present day power system technologies are finding it harder and harder to meet the requirements of this new paradigm. Their fundamental limitations are clear – conventional generation assumes the availability of large scale stored energy for a small number of large generators, and energy is always assumed to flow unidirectionally from generators to consumers. Neither construct matches well with Smart Grid concepts, and alternative operating approaches are clearly required!

One foundational technology of Distributed Generation is the Power Electronic Converter, which can rapidly and flexibly control electrical energy almost instantaneously on a moment by moment basis. Since the 1950’s, PE converters have become mainstream technology for industry, accurately controlling rotating machines, precisely processing energy with minimum energy wastage, and supporting a myriad of other applications. More recently, as their power handling capacity continues to increase, they are becoming very attractive for distributed generation systems where they can manipulate electrical energy in ways that simply cannot be done using rotating machines. The challenge at present is to decide exactly what we want to do with this capability.

This presentation will explore why power electronic converters are so flexible and attractive for Distributed Generation systems. It will firstly reflect on how the fundamental properties of these systems make them so versatile, and then will proceed to show how these properties particularly suit Distributed Generation needs and requirements. Finally, the current challenges of large scale usage of power electronic converters in electrical grid systems will be considered, looking at both technical challenges that are still to be overcome, and the operational control challenges that are still in the early stages of development.

Professor Holmes graduated from the University of Melbourne with a B. Eng. in 1974. He has a Masters degree from the same university in power systems engineering, and a PhD from
Monash University in power converter modulation theory. He was a faculty member at Monash University for 26 years, where he established the Power Electronics Research Group in 1996 to support graduate students and research engineers working together on both pure and applied R&D projects. The interests of the group include fundamental modulation theory, VSI current regulators, active filter systems, resonant converters, current source inverters, and multilevel converters. In 2002 he formed a commercial R&D company from this group, specialising in the development of tailored power electronic conversion systems for unusual applications. In 2010, Professor Holmes was appointed as Innovation Professor – Smart Energy Systems at RMIT University, where he is currently extending his research interests to work with industry and government in the area of Smart Grids and Smart Energy technologies.

Professor Holmes has been a major contributor to the field of power electronics research for nearly 30 years. His primary research focus has been to investigate fundamental questions concerning the principles of modulation and closed loop control of switching power converters. He has published a major theoretical reference book on this subject, together with over 250 refereed journal and conference articles (11000+ citations). He is a Fellow of the IEEE, reviews papers for all major IEEE transactions in his area, and has been an active member of the Industrial Applications, Power Electronics Societies of the IEEE for over 25 years.

P4.2 Technical Challenges to More Electronic Power Systems and Distributed Generation

Jinjun Liu
Xi’an Jiaotong University, China

Electric power systems have been experiencing many changes towards future, among which turning into more electronic, i.e. integrating more and more electronic power converters, and incorporating more and more distributed generations are the two major ones. The technical challenges that the future power systems will be facing accordingly are then identified in detail. The major issues caused by being more electronic and more distributed are discussed, with some possible state-of-the-art solutions also introduced. The issues that are elaborated include the disputation about system inertia, the concern about lower transient over-rating tolerance, and new framework and specifications that need to be set up to ensure the user-friendly networking capability. Future work that needs further research efforts are addressed too.

Jinjun Liu received the B.S. and Ph.D. degrees in electrical engineering from Xi’an Jiaotong University (XJTU), Xi’an, China, in 1992 and 1997, respectively.

He then joined the XJTU Electrical Engineering School as a faculty. From late 1999 to early 2002, he was with the Center for Power Electronics Systems, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA, as a Visiting Scholar. In late 2002, he was promoted to a Full Professor and then the Head of the Power Electronics and Renewable Energy Center at XJTU, which now comprises 20 faculty members and over 100 graduate students and carries one of the leading power electronics programs in China. He coauthored 3 books, published over 400 technical papers in peer-reviewed journals and conference proceedings, holds nearly 50 invention patents (China/US). His research interests include power quality control and utility applications of power electronics, microgrids for sustainable energy and distributed generation, and more/all electronic power systems.

Dr. Liu received for eight times governmental awards at national level or provincial/ministerial level for scientific research/teaching achievements. He also received the 2006 Delta Scholar Award, the 2014 Chang Jiang Scholar Award, the 2014 Outstanding Sci-Tech Worker of the Nation Award, and the IEEE Transactions on Power Electronics 2016 Prize Paper Award. He is an IEEE Fellow, an Associate Editor for the IEEE TRANSACTIONS ON POWER ELECTRONICS, and from 2015, the Vice President for membership of IEEE PELS. He is on the Board of China Electrotechnical Society and was elected the Vice President of the CES Power Electronics Society in 2013. Since 2013, he has been a Vice President for China Power Supply Society (CPSS) and since 2016, the inaugural Editor-in-Chief of CPSS Transactions on Power Electronics and Applications. Since 2013, he has been serving as the Vice Chair of the Chinese National Steering Committee for College Electric Power Engineering Programs.

P4.3 PV and Storage Depth Fusion for RE100

Wei Zhao
Sungrow Power Supply Co., Ltd., China

The realization of 100% renewable energy application is the ultimate goal of the energy revolution and an effective means to solve the problem of climate change. With the increasing penetration of PV system, the application of energy storage system will be more and more common. The PV&storage system may become the basic load of the future power grid. Based on the development of PV and energy storage inverter, the optimization design, high efficiency, robustness, economy and grid friendliness of PV&storage system are discussed in this report.

Dr. Wei Zhao received power electronics and electric drive technology Ph. D degree at HeFei University of Technology in 2003. He was in the auspices of a number of national Ministry of science and technology "Tenth Five Year Plan", "Eleventh Five Year Plan", "863 Plan" and other major science and technology projects, and won the Anhui province science and Technology Progress Award and prize. In 2003, he joined Sungrow Power Supply Ltd, and now is the group's senior vice president, in charge of the Central Research Institute of Sungrow.
Power Electronics Transformer Technology Exploration and Application Share
10:35AM - 11:10AM

Tao Liu
TBEA Sunoasis Co., Ltd., China

Power electronics transformer is drawing wide attention from both industry and academia. However, there are still numerous problems when pushing power electronics transformer into practical use. This report presents the development of 10kV/1MVA power electronics transformer prototype. The detailed design on topology, key component and control system is introduced. Moreover, to replace the conventional power converting method in PV and micro-grid, this presentation has fully analyzed the problem of using power electronics transformer in real applications. The methodology of handling these problems is also illustrated. Finally, the outlook of power electronics transformer in smart grid is presented.

Mr. Tao Liu received his M.S degree in Xi’an Jiaotong University in 2013. He has been research assistant at Virginia Tech from 2013 to 2015. From 2015, he started to work for TBEA Sunoasis Co., Ltd. He has been software engineer, system engineer, project manager in TBEA renewable energy research institute from 2015 to 2018. He is now the vice manager of Micro-grid product line of TBEA Sunoasis Co., Ltd. He has published more than 20 research papers in IEEE conferences and journals. He is also the holder of 7 Chinese patents. His research interest lies in power electronics transformer, PV system, storage system and Micro-grid.
Rap Session

Youth Panel
Tuesday, June 4th  5:40PM - 7:10PM
Function Room 1

Opportunities and Challenges that Wide-Band-Gap Devices Bring to Distributed Generation

Moderator
Laili Wang
Xian Jiaotong University, China

Panelists
Yunwei(Ryan) Li
University of Alberta, Canada
Martin Ordonez
University of British Columbia, Canada
Wuhua Li
Zhejiang University, China
Yongheng Yang
Aalborg University, Denmark
Milijana Odavic
University of Sheffield, United Kingdom
Kai Sun
Tsinghua University, China
Industrial Keynote

Looking towards Future Real Time Digital Simulation Technology

Yi Zhang
RTDS Technologies Inc., Canada

Presentation Outlines
- Introduction real time digital simulation
- Trend #1: Custom designing hardware
- Trend #2: Modelling of large power grids
- Trend #3: Modelling of power electronics circuit
- Trend #4: Exploring the use of FPGA
- Trend #5: Advanced models of magnetic devices
- Trend #6: Post analysis of simulation results
- Conclusions and hope

Yi Zhang joined RTDS Technologies Inc. in 2000, where he now serves as Vice-President R&D and Chief Technology Officer (CTO). Dr. Zhang has over 28 years of experiences working in the area of power system simulation and analysis. His expertise includes the Real Time EMT Simulation, Voltage Stability and HVDC, etc. As a principle member of the RTDS development team, Dr. Zhang developed a number of power system models on RTDS Real Time Simulator in the past over 19+ years. At present, he leads the research and development activities in RTDS Technologies. Dr. Zhang obtained Ph.D. degree from Shanghai Jiao Tong University and The University of Manitoba. He is a registered professional engineer in the province of Manitoba and a senior member of IEEE. Dr. Zhang also serves as an adjunct professor in the University of Manitoba in Canada and in Hunan University in China, and an editor of IEEE Transactions on Power Delivery.
Oral Sessions

S01: DC-DC Converters I
Tuesday, June 4th  2:00PM - 3:40PM
Function Room 2
Chairs  Sudip K Mazumder (University of Illinois at Chicago, United States)
        Xiong Du (Chongqing University, China)

2:00PM - 2:20PM

S01.1 PSO-Algorithm-Based Optimal Design of the LCLC Resonant Converters for Space Travelling-Wave Tube Amplifiers Applications
Bin Zhao¹, Jinsong He², Xin Zhang²
¹Institute of Electronics, Chinese Academy of Sciences, China; ²Nanyang Technological University, Singapore

2:20PM - 2:40PM

S01.2 High Efficiency Bidirectional Half-Bridge Three-Level DC-DC Converter
Leilei Zhu, Hongjian Lin, Tao Yin, Rongxin Chen, Wentao Hu, Zeliang Shu
Southwest Jiaotong University, China

2:40PM - 3:00PM

S01.3 A Novel Non-Coupled Non-Isolated Double-Input Bidirectional High-Gain Converter for Hybrid Energy Storage Systems
Parham Mohammadi¹, Rahim Samanbakhsh², Fernando Davalos Hernandez², Peyman Koohi¹, Federico Ibanez²
¹Amirkabir University of Technology Tehran, Iran; ²Skolkovo Institute of Science and Technology, Russia; ³Islamic Azad University South Tehran, Iran

3:00PM - 3:20PM

S01.4 A New Soft-Switching Synchronous Buck Converter without Auxiliary Switch
Haifu Wu, Jianzhong Zhang, Jin Zhao, Yaqian Zhang, Lucai Hu
Southeast University, China

3:20PM - 3:40PM

S01.5 Analysis and Circuit Implementation of a Novel Quadratic Boost Converter with Low Inductor Current
Guanlin Li, Xin Jin, Xiyou Chen, Xianmin Mu
Dalian University of Technology, China

S02: DC-AC Converters
Tuesday, June 4th  2:00PM - 3:40PM
Function Room 7
Chairs  Fred Wang (University of Tennessee, United States)
        Milijana Odavic (University of Sheffield, United Kingdom)

2:00PM - 2:20PM

S02.1 An Integrated Structure for Transformer and Output Filter of a Micro-inverter with Flexible Multilayer Foil Technique
Jie Ma, Changsheng Hu, Wenxing Zhong, Dehong Xu
Zhejiang University, China

2:20PM - 2:40PM

S02.2 Single-Phase High-Gain Bidirectional DC/AC Converter Based on High Step-Up/Step-Down DC/DC Converter and Dual-Input DC/AC Converter
Liu Yang¹, Junrong Peng², Fan Yang¹, Yinghui Zhang², Hongfei Wu¹
¹Nanjing University of Aeronautics and Astronautics, China; ²Science and Technology on Ship Integrated Power System Technology Laboratory, China

2:40PM - 3:00PM

S02.3 A New Single-Phase Single-Stage Photovoltaic Grid-Tied Inverter with Leakage Current Eliminating and Power Decoupling
Jianbo Jiang, Shangzhi Pan, Xiaoming Zha, Lidong Hao
Wuhan University, China

3:00PM - 3:20PM

S02.4 Improved Y-source Inverter
Xupeng Fang, Xiaokang Ding, Yingying Tian
Shandong University of Science and Technology, China

3:20PM - 3:40PM

S02.5 A Transformerless Boost Inverter for Stand-alone Photovoltaic Generation Systems
Zhixiang Yu, Xuefeng Hu, Meng Zhang, Lezhu Chen, Shunde Jiang
Anhui University of Technology, China
**S03: High Power Converters I**

*Tuesday, June 4th  2:00PM - 3:40PM*

*Function Room 10*

**Chairs**  
Deepakraj M Divan (Georgia Institute of Technology, United States)  
Dongsheng Yu (China University of Mining and Technology, China)

**2:00PM - 2:20PM**

**S03.1 Design and Development of an Experimental Testbench Based on Multi-pulse and Multilevel Converters**

Daniel L. Mon-Nzongo¹, Paul Gistain Ipoum Ngome², Jinquan Tang¹, Joseph Song Manguelle³, Tao Jin²  
¹Pearl Electric, Co., France; ²Fuzhou University, China; ³Exxon Mobil, United States

**2:20PM - 2:40PM**

**S03.2 The Impact of Execution Frequency in Sorting Algorithm on Nearest Level Modulated Modular Multilevel Converter**

Jiahao Niu, Fred Wang  
University of Tennessee, United States

**2:40PM - 3:00PM**

**S03.3 Direct Digital Controlled Modular Multilevel Converters with Cell-Distributed Controllers and Hot-Swap Features**

Tsai Fu Wu¹, Tzu Chieh Chou¹, Kai Sun²  
¹National Tsing Hua University, Taiwan; ²Tsinghua University, China

**3:00PM - 3:20PM**

**S03.4 A Battery Lifetime Improved Control Strategy of Modular Multilevel Converter for Electric Vehicle Application**

Di Wang¹, Jinjun Liu¹, Luigi Piegari², Shuguang Song¹, Xingxing Chen¹, Davide De Simone²  
¹Xi’an Jiaotong University, China; ²Politecnico di Milano, Italy

**3:20PM - 3:40PM**

**S03.5 Topology, Modulation and Control Strategy of a MMC Based Multi-port DC/DC Converter**

Yanlin Zhu, Shuhuai Shi, Sheng Cheng, Runchu Ding, Xiaotong Du, Fang Zhuo  
Xi’an Jiaotong University, China

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**S04: Control of Grid-Tied Converters I**

*Tuesday, June 4th  2:00PM - 3:40PM*

*Function Room 11*

**Chairs**  
Dushan Boroyevich (Virginia Tech, United States)  
Yongheng Yang (Aalborg University, Denmark)

**2:00PM - 2:20PM**

**S04.1 A Novel Adaptive Observer-Based DC-Link Voltage Control for Grid-Connected Power Converters**

Guanhong Song, Bo Cao, Liuchen Chang, Riming Shao  
University of New Brunswick, Canada

**2:20PM - 2:40PM**

**S04.2 Design of Observer-Based SMC Controller for Three-Phase LCL-Filtered Grid-Connected Inverters with Less Sensors**

Li Han, Weimin Wu, Huang Min  
Shanghai Maritime University, China

**2:40PM - 3:00PM**

**S04.3 Partial Shading Mitigation in Photovoltaic Arrays using Shade Dispenser Technique**

Mahdieh Aliaslkhiaabani, Francisco Paz, Martin Ordonez, Liwei Wang  
The University of British Columbia, Canada

**3:00PM - 3:20PM**

**S04.4 An Enhanced Transfer-Delay Frequency-Locked Loop Method for Single-Phase Grid Voltage Synchronization**

Peiqi Zhao¹, Juxiang Zhang¹, Zhiyong Dai¹, Xiaolei Chen²,³, Mingdi Fan⁴  
¹Xidian University, China; ²Key Laboratory of Industrial Internet of Things and Networked Control, Ministry of Education, China; ³Chongqing University of Posts and Telecommunications, China; ⁴Soochow University, China

**3:20PM - 3:40PM**

**S04.5 A DC Bus Signaling Based Autonomous Power Management Strategy for a Grid-Connected PV-Battery System**

Liangcai Wu¹, Jianwu Zeng², Hao Cheng¹, Qixing Ren¹  
¹Shenzhen Growatt New Energy Technology Co., Ltd., China; ²Minnesota State University, Mankato, United States
S05: Control of Microgrids I  
Tuesday, June 4th  2:00PM - 3:40PM  
Function Room 12

Chairs  
Jinjun Liu (Xi’an Jiaotong University, China)  
Kai Sun (Tsinghua University, China)

2:00PM - 2:20PM

S05.1 Ripple Energy Buffer for Microgrid Connected Hydrogen Energy Storage System  
Anima Ganeshan, Grahame Holmes, Lasantha Meegahapola, Brendan McGrath  
RMIT University, Australia

2:20PM - 2:40PM

S05.2 Robust Droop Control of AC Microgrid Against Nonlinear Characteristic of Inductor  
Wenbin Yuan¹, Yanbo Wang¹, Dong Liu¹, Fujin Deng², Zhe Chen¹  
¹Aalborg University, Denmark; ²Southeast University, China

2:40PM - 3:00PM

S05.3 Distributed Cooperative Control for Multiple DC Electric Springs with Novel Topologies Applied in DC Microgrid  
Daojun Zha¹, Qingsong Wang¹, Ming Cheng¹, Fujin Deng¹, Giuseppe Buja²  
¹Southeast University, China; ²University of Padova, Italy

3:00PM - 3:20PM

S05.4 Power Sharing between Parallel Inverters by Using Droop Control with a Secondary Control Loop  
Li Lei, Mohammed Elgendy, Neal Wade, Salaheddine Ethni  
Newcastle University, United Kingdom

3:20PM - 3:40PM

S05.5 Microgrid Power Sharing Using Variable Droop Coefficient Control  
Rongcai Pan, Peide Sun  
Donghua University, China

S06: Wideband Gap Applications  
Tuesday, June 4th  4:00PM - 5:40PM  
Function Room 2

Chairs  
Tsai-Fu Wu (National Tsing Hua University, Taiwan)  
Weimin Wu (Shanghai Maritime University, China)

4:00PM - 4:20PM

S06.1 High-Efficiency Fault-Tolerant Three-Level SiC Active NPC Converter for Safety-Critical Renewable Energy Applications  
Ramin Katebi¹, Jiebing He², Timothy A. Bobeck¹, Waqar A. Khan¹, Nathan Weise¹  
¹Marquette University, United States; ²University of Kentucky, United States

4:20PM - 4:40PM

S06.2 An RC Snubber Circuit to Suppress False Triggering Oscillation for GaN Based Half-Bridge Circuits  
Jian Chen, Quanming Luo, Zhiqing Wang, Pengju Sun, Xiong Du, Yuqi Wei  
Chongqing University, China

4:40PM - 5:00PM

S06.3 Novel Three-Phase Two-Third-Modulated Buck-Boost Current Source Inverter System Employing Dual-Gate Monolithic GaN e-FETs  
Mattia Guacci¹, Mina Tatic¹, Dominik Borits¹, Johann Walter Kolar¹, Yusuke Kinoshita², Hidetoshi Ishida²  
¹ETH Zurich, Switzerland; ²Panasonic Corporation, Japan

5:00PM - 5:20PM

S06.4 Design of SiC MOSFET Medium Voltage Bipolar DC-DC Converter Based on Buck Structure  
Zuoyu Wei, Kefan Yu, Dongxin Zhang, Xiaoping Sun, Yuguo Li, Feng Wang, Fang Zhuo, Hao Yi  
Xi’an Jiaotong University, China

5:20PM - 5:40PM

S06.5 Design of Bidirectional Isolated DC/DC Converter Based on SiC Device  
Xuan Wang¹, ², ³, Liang Zhang¹, ², ³, Beibeibei Wang¹, ², ³, Zeming Yang⁴, Yongsheng Fu¹, ², ³, Kuntao Zha¹, ², ⁵  
¹NARI Group Corporation, China; ²State Grid Electric Power Research Institute, China; ³China EPRI Science & Technology Co., Ltd., China; ⁴Beijing Jiaotong University, China; ⁵C-EPRI Electric Power Engineering Co., Ltd., China
S07: Storage Conversion Systems
Tuesday, June 4th  4:00PM - 5:40PM
Function Room 7
Chairs  Martin Ordonez (The University of British Columbia, Canada)
   Xin Zhang (Nanyang Technological University, Singapore)

4:00PM - 4:20PM
S07.1 A Review of On-Board Integrated Charger for Electric Vehicles and a New Solution
Tuopu Na, Xue Yuan, Jiaqi Tang, Qianfan Zhang
Harbin Institute of Technology, China

4:20PM - 4:40PM
S07.2 A Three-Level Boost-Buck Converter for the Ultracapacitor Applications
Guorun Yang, Haichao Wang, Fei Xiao, Xuexin Fan, Ruitian Wang, Xinsheng Zhang, Yifei Luo
Naval University of Engineering, China

4:40PM - 5:00PM
S07.3 Fast Integrated Charger Solution for Heavy-Duty Electric Vehicles
Henri Josephson Raherimihaja, Zimo Yuan, Jinxin Wang, Qianfan Zhang
Harbin Institute of Technology, China

5:00PM - 5:20PM
S07.4 A Load Combination Prediction Algorithm Considering Flexible Charge and Discharge of Electric Vehicles
Jia Cui1, Sitong Liu1, Junyou Yang1, Weichun Ge2, Xiaoming Zhou1, Anni Wang3
1Shenyang University of Technology, China; 2Science and Technology Communication Department, Liaoning Province Electric Power Company, China; 3Operation Monitoring Center, Liaoning Province Electric Power Company, China

5:20PM - 5:40PM
S07.5 Multi-Parameter Optimization Strategy for Vanadium Redox Flow Battery Operation Based on Genetic Algorithm
Ziru Wang1, Binyu Xiong1, Jinrui Tang1, Yunhui Huang1, Guanxing Zhang2, Jizhong Chen3
1Wuhan University of Technology, China; 2SHANGHAI ELECTRIC POWER, China; 3China Electric Power Research Institute, China

S08: Stability of Grid-Tied Converters
Tuesday, June 4th  4:00PM - 5:40PM
Function Room 10
Chairs  Frede Blaabjerg (Aalborg University, Denmark)
   Xiongfei Wang (Aalborg University, Denmark)

4:00PM - 4:20PM
S08.1 Stability Assessment of a Three-Phase Grid-Tied PV Inverter with Eigenvalue-Based Method
Zhiqing Yang1, Qilei Wang2, Julia Warmuz3, Rik W. De Doncker4
1RWTH Aachen University, Germany; 2Xi'an Jiaotong University, China

4:20PM - 4:40PM
S08.2 Impedance Scanning Method of Grid-Tied Converters under Nonzero Grid Impedance Condition
Yuxin Zhang1, Xiong Du1, Ying Shi1, Cheng Zeng1, Junliang Liu1, Heng-Ming Tai2
1Chongqing University, China; 2University of Tulsa, United States

4:40PM - 5:00PM
S08.3 Subsynchronous Resonance Mitigation for Series Compensation Transmission System of DFIG Based on PR Control
Liang Dong, Jiashou Kong, Junmou Feng, Yue Zhang
Nanjing University of Science and Technology, China

5:00PM - 5:20PM
S08.4 Analysis and Comparison of Various Dual Loop Active Damping Methods for the LCL-Type Grid Connected Inverter
Jiansong Zhang, Xu Yang, Hongwei Zhou
Xi'an Jiaotong University, China

5:20PM - 5:40PM
S08.5 Analysis of Inertia and Damping Characteristics of Grid-Connected Photovoltaic Power Generation System Based on Droop Control
Yongbin Wu1, Sue Wang1, Liansong Xiong2, Donghui Zhang3
1Shaanxi University of Science & Technology, China; 2Nanjing Institute of Technology, China; 3Hunan University of Technology, China
S09: Modeling and Analysis of Microgrids
Tuesday, June 4th  4:00PM - 5:40PM
Function Room 11
Chairs  Johan Enslin (Clemson University, United States)
        Shuang Xu (University of New Brunswick, Canada)

4:00PM - 4:20PM
S09.1 Analysis of Negative Influence of Harmonic Circulation between Parallel STATCOMs and Suppression Method
Jikai Chen¹, Peng Wang¹, Yang Hu¹, Hui Shao¹, Guoqing Li¹, Xiaozhe Wang², Jiangchao Qin³
¹Northeast Electric Power University, China; ²McGill University, Canada; ³Arizona State University, United States

4:20PM - 4:40PM
S09.2 Real-Time Models of Advanced Energy Conversion Systems for Large-Scale Integration Studies
Felipe Arrano-Vargas, Georgios Konstantinou
University of New South Wales, Australia

4:40PM - 5:00PM
S09.3 Identification Modeling Method of Voltage and Frequency Response Model for microgrid in Islanded Mode
Dong Xu, Yong Shi, Jianhui Su, Chi Feng
Hefei University of Technology, China

5:00PM - 5:20PM
S09.4 Sequence Impedance-based Stability Analysis of Droop-Controlled AC Microgrids
Marc Dokus, Axel Mertens
Leibniz Universität Hannover, Germany

5:20PM - 5:40PM
S09.5 Day-Ahead Optimal Scheduling Strategy of Microgrid with EVs Charging Station
Zhaoxia Xiao, Hui Li, Tianli Zhu, Huaimin Li
Tianjin Polytechnic University, China

S10: Fault and Protection
Tuesday, June 4th  4:00PM - 5:40PM
Function Room 12
Chairs  Juan Carlos Balda (University of Arkansas - Fayetteville, United States)
        Jinwei He (Tianjin University, China)

4:00PM - 4:20PM
S10.1 A Short-Circuit Fault-Tolerant Strategy for Three-Phase Four-Wire Flying Capacitor Three-Level Inverters
Hao Wang, Hafinj Lin, Cheng Yan, Dehong Xu
Zhejiang University, China

4:20PM - 4:40PM
S10.2 High-Impedance Fault Detection Method for DC Microgrids
Francisco Paz, Martin Ordonez
University of British Columbia, Canada

4:40PM - 5:00PM
S10.3 A Current Residual-Based Open-Circuit Fault Diagnosis Method for Cascaded H-Bridge Multilevel Converters
Dong Xie, Xinglai Ge
Southwest Jiaotong University, China

5:00PM - 5:20PM
S10.4 Fault Isolation in the DC Distribution Grid Using Current Signature Analysis
Ting Wang, Yibo Wang, Antonello Monti
RWTH Aachen University, Germany

5:20PM - 5:40PM
S10.5 Control of a Cascaded H-Bridge Multilevel Inverter with Failed Cells for Grid-Connected Application
Pascal M. Lingom¹, Joseph Song Manguelle², Jean-Maurice Nyobe-Yome¹, Daniel L. Mon-Nzongo³, Tao Jin¹, Mamadou Lamine Doumbia²
¹Fuzhou University, China; ²University of Quebec, United States; ³University of Douala, Cameroon; ⁴Pearl Electric, France
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<td>Huazhong University of Science and Technology, China</td>
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<td>Comprehensive Analysis of Three-Phase Three-Level T-Type Neutral-Point-Clamped Inverter with Hybrid Switch Combination</td>
<td>Hongwu Peng, Zhao Yuan, Balaji Narayanasamy, Xingchen Zhao, Amol Deshpande, Fang Luo</td>
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<td>Improved IGBT Dynamic Model and Electro-Thermal-Mechanical Multi-Field Coupling Failure Analysis</td>
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<td>Vinicius Fiamoncini Souza, Eduardo Eller Behr, Gierr Waltrich, Denizar Martins, Roberto Coelho</td>
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<td>Jiacheng Wen, Huiqing Wen, Qinglei Bu</td>
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<td>An Automatic Power Decoupling Control Method on Three Level DC-AC Converter to Suppress the Double-Line-Frequency Ripple</td>
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<td>Shaanxi Electric Power Research Institute of State Grid Corporation, China; Shannxi Electric Power Company of State Grid Corporation, China; Shanghai Zhixin Electric Co., Ltd., China; Xi'an Thermal Power Research Institute Co., Ltd., China</td>
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### S15: Control of Microgrids II
**Wednesday, June 5th 2:00PM - 4:00PM**
**Function Room 12**
**Chairs**
- Fred Blaabjerg (Aalborg University, Denmark)
- Changsheng Hu (Zhejiang University, China)

#### S15.1 Island Interconnection Device - Enabling a Simplified Approach to Integrate Microgrids with the Grid
Nishant Bilakanti, Frank Lambert, Deepak Divan
*Georgia Institute of Technology, United States*
**2:00PM - 2:20PM**

#### S15.2 Hybrid Microgrid Controller Analysis and Design for a Campus Grid
Moazzam Nazir, Trupal Patel, Johan Enslin
*Clemson University, United States*
**2:20PM - 2:40PM**

#### S15.3 Overcurrent Limiting and DC Bus Voltage Ripple Minimization in Grid-Forming PV Sources under Grid Voltage Sags
Zhe Chen, Robert H. Lasseter, Thomas M. Jahns
*University of Wisconsin – Madison, United States*
**2:40PM - 3:00PM**

#### S15.4 Adaptive Droop Control Strategy of Autonomous Microgrid for Efficiency Improvement
Wenbin Yuan¹, Yanbo Wang¹, Dong Liu¹, Fujin Deng²
¹*Aalborg University, Denmark; ²Southeast University, China*
**3:00PM - 3:20PM**

#### S15.5 A Negative Sequence Voltage Control Strategy Based on Adaptive Virtual Impedance Implementation for Microgrid Inverter under Three-Phase Unbalanced Load
Zhongnan Jiang, Hongtao Shi, Lina Zhu, Tianji Gao
*North Minzu University, China*
**3:20PM - 3:40PM**

#### S15.6 Design of DC Micro-Grid System for Integration of PMSM Elevator and Renewable Energy Sources
Jyh-Wei Chen, Thanh Nhat Trung Tran, Yen-Chen Liu
*National Formosa University, Taiwan*
**3:40PM - 4:00PM**

### S16: DC-DC Converters II
**Wednesday, June 5th 4:20PM - 6:00PM**
**Function Room 2**
**Chairs**
- Liuchen Chang (University of New Brunswick, Canada)
- Dong Jiang (Huazhong University of Science and Technology, China)

#### S16.1 Clamped-Resonant Interleaved Boost Converter: Analysis and Design
Giorgio Spiazzi Padova
*University of Padova, Italy*
**4:20PM - 4:40PM**

#### S16.2 An Interleaved Boost Converter with Parallel Input and Output Series for Renewable Energy System
Xing Liu, Xuefeng Hu, Hao Chen, Lezhu Chen, Yujia Zhang
*Anhui University of Technology, China*
**4:40PM - 5:00PM**

#### S16.3 Performance of Submodule Level Differential Power Processing Architecture in Mismatched PV Systems
Dong Peng, Huiqing Wen, Guanying Chu, Bin Xu
*X‘ian Jiaotong-Liverpool University, China*
**5:00PM - 5:20PM**

#### S16.4 A Dual-Transformer-Based Isolated DC-DC Converter with Hybrid Voltage-Multiplier for Wide and High Output Voltage Applications
Chong Shen¹, Jiahao Shi², Yuhui Ji², Shang Gao¹, Mengxi Li¹, Hongfei Wu¹
¹*Nanjing University of Aeronautics and Astronautics, China; ²Shanghai Institute of Space Power-source, China*
**5:20PM - 5:40PM**

#### S16.5 Topology and Control Strategy of Multi-Port DC Transformer Based on Dual-Active-Bridge
Runchu Ding, Kefan Yu, Shuhuai Shi, Sheng Cheng, Nan Zhang, Yanlin Zhu, Fang Zhuo, Feng Wang
*X‘ian Jiaotong University, China*
**5:40PM - 6:00PM**
S17: High Power Converters II  
Wednesday, June 5th  4:20PM - 6:00PM  
Function Room 7  
Chairs  
Meiqin Mao (Hefei University of Technology, China)  
Sixing Du (University of Toronto, Canada)  

4:20PM - 4:40PM  
S17.1 An Experimental Study of Cascaded H-Bridge Multilevel Inverter for Obtaining Multiple Voltage Waveforms Containing Different Number of Levels  
Ashique Anan Abir, Tapan Kumar Chakraborty, Khandaker Sultan Mahmod  
University of Asia Pacific, Bangladesh  

4:40PM - 5:00PM  
S17.2 Smart Transformer Modelling and Hardware-in-the-Loop Validation  
Yuxiaoying Tu1, Junru Chen2, Heping Liu1, Terence O’Donnell2  
1Chongqing University, China; 2University College Dublin, Ireland  

5:00PM - 5:20PM  
S17.3 Half-Bridge Submodule Test Circuit for MMC-Based Voltage Sourced HVDC System  
Byuong-Jun Seo1, Kwon-Sik Park1, Kwang Rae Jo1, Jin-Yong Heo1, Eui-Cheol Nho2, Byung-Moon Hae2  
1Pukyong National Univ., Korea; 2Myongji University, Korea  

5:20PM - 5:40PM  
S17.4 A Partial-Power Regulated Hybrid Modular DC-DC Converter to Interconnect MVDC and LVDC Grids  
Jingxin Hu, Yutian Zhang, Shenghui Cui, Philipp Joebges, Rik W. De Doncker  
RWTH Aachen University, Germany  

5:40PM - 6:00PM  
S17.5 Design of a Medium Voltage AC Fast Solid-State Transfer Switch  
Wanxu Yang1, Yongmei Gan1, Fan Zhang1, Yanwei Yu2, Hongyue Yuan2, Hailin Wang1, Chenhao Zhao1  
1Xi’an Jiaotong University, China; 2Henan Mechanical and Electrical Vocational College, China  

S18: Wind Power Conversion Systems  
Wednesday, June 5th  4:20PM - 6:00PM  
Function Room 10  
Chairs  
Grahame Holmes (RMIT University, Australia)  
Andrés Escobar Mejia (Universidad Tecnológica de Pereira, Colombia)  

4:20PM - 4:40PM  
S18.1 A Vector Selection Based Common Mode Voltage Reduction Strategy for Dual Three Phase Permanent Magnet Synchronous Wind Power Generators Considering Harmonic Suppression  
Jin Xu1, Milijana Odavic1, Ziqiang Zhu1, Zhanyuan Wu2  
1University of Sheffield, United Kingdom; 2Siemens Gamesa Renewable Energy, United Kingdom  

4:40PM - 5:00PM  
S18.2 Simplified Model Predictive Flux Control for Dual Inverter Fed Open End Winding Induction Motor  
Di Wu1, Jifeng Chen2, Rui Zhu2, Guowu Hua2  
1Huaihai Institute of Technology, China; 2China University of Mining and Technology, China  

5:00PM - 5:20PM  
S18.3 A Sensorless Control Method based on MRAS for 12-Phase PMSM in FESS  
Biyang Chen, Jingliang Lv, Xinjian Jiang  
Tsinghua University, China  

5:20PM - 5:40PM  
S18.4 MPPT for Small Wind Turbines: Zero-Oscillation Sensorless Strategy  
Tomas Syskakis, Martin Ordonez  
University of British Columbia, Canada  

5:40PM - 6:00PM  
S18.5 Speed Estimator to Improve Efficiency in a Wind Generation System  
Daniel Memije1, Oscar Carranza1, Jaime Jose Rodriguez2, Ruben Ortega2, Edgar Peralta2  
1Instituto Politecnico Nacional, Mexico; 2Universidad Popular Autónima del Estado de Puebla, Mexico
### S19: Wireless
Wednesday, June 5th  4:20PM - 6:00PM
Function Room 11

**Chairs**  
Denizar Cruz Martins (Federal University of Santa Catarina, Brazil)  
Jianing Wang (Hefei University of Technology, China)

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<td>Coil Design and Shielding Method for Resonant Wireless Charging System</td>
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### S20: Power Quality
Wednesday, June 5th  4:20PM - 6:00PM
Function Room 12

**Chairs**  
Fang Zhuo (Xi’an Jiaotong University, Brazil)  
Jinwei He (Tianjin University, China)

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<td>Liang Sun, Lan Gao, Heli Xu</td>
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Poster Sessions

**D01: Devices and Components**
Wednesday, June 5th  10:40AM - 12:10PM
Ballroom Foyer

Chairs  
**Jiangbiao He** (University of Kentucky, United States)  
**Kangping Wang** (Xi'an Jiaotong University, China)

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**D01.1 A Novel Passive Integrated Unit for Multi-Component Resonant Converter**  
Cheng Deng, Jiankun Lv  
Xi'an Jiaotong University, China

**D01.2 Electro-thermal Stress Comparison between Full Pressure and Silver Sintered Package Press Pack IGBT**  
Yaosheng Li¹, Peng Wang¹, Jinyuan Li¹, Haiyang Long², Ran Yao², Xiao Wang², Li Hui²  
¹Global Energy Interconnection Research Institute, China; ²Chongqing University, China

**D01.3 SiC MOSFET Switching Characteristic Optimization and Application in Battery Charging/Discharging**  
Chen Peng, Guochun Xiao, Shuai Zhang, Chun He, Zhihao Zhai, Xinwei Wang, Qilei Wang, Xudong Du  
Xi'an Jiaotong University, China

**D01.4 A Cost-Effective Series-Connected Gate Drive Circuit for SiC MOSFET**  
Chengzi Yang, Laili Wang, Mengyu Zhu, Longyang Yu  
Xi'an Jiaotong University, China

**D01.5 Design and Evaluation of a High Performance Silicon Carbide MOSFET Driver**  
Zuoyu Wei, Kefan Yu, Yuguo Li, Hao Yi, Fang Zhuo, Feng Wang  
Xi'an Jiaotong University, China

**D01.6 Study of Magnetic Core Geometries for Coupling Systems Through a Magnetic Bus**  
Lucas Brighenti¹, Wabermark dos Santos², Denizar Martins¹  
¹Federal University of Santa Catarina, Brazil; ²Federal University of Espírito Santo, Brazil

**D01.7 Design and Optimization of Magnetic Coupler Based on Series-Series Compensation for EV Wireless Chargers**  
Xuemei Diao, Bing Li, Qiya Wu, Weiyao Mei, Lijun Diao  
School of Electrical Engineering, Beijing Jiaotong University, China

**D01.8 An Investigation of Snubber and Protection Circuits Connections for Power-Electronic Switch in Hybrid DC Circuit Breaker**  
Qiang Yi, Yifei Wu, Fei Yang, Yi Wu, Mingzhe Rong, Jian Wen, Weibin Zhuang  
Xi'an Jiaotong University, China

**D01.9 IGBT Open-Circuit Fault Diagnosis for Modular Multilevel Converter with Reduced-Number of Voltage Sensor Measuring Technique**  
Xingxing Chen, Jinxin Liu, Shuguang Song, Shaodi Ouyang, Zhifeng Deng  
Xi'an Jiaotong University, China

**D01.10 A New Coupled Inductor Structure with Larger Leakage Inductance for EMI Suppression**  
Yechi Zhang, Dong Jiang  
Huazhong University of Science and Technology, China

**D01.11 Avalanche Capability Characterization of 1.2 kV SiC Power MOSFETs Compared with Si CoolMOS**  
Jinwei Qi, Xu Yang, Xin Li, Kai Tian, Wang Hua, Leidang Zhou, Xuhui Wang  
Xi'an Jiaotong University, China
D02: Topology and Control of Power Converters
Wednesday, June 5th  10:40AM - 12:10PM
Ballroom Foyer

Chairs Yan Zhang (Xi'an Jiaotong University, China)
Fan Zhang (Xi'an Jiaotong University, China)

D02.1 A Novel Full-Soft-Switching Full-Bridge Converter with a Snubber Circuit and Coupled Inductor
Lingzhi Yi1, Hexiao Zhu1, Binren Wang1, Liang Fang2, Wenbing Ma2, Xiangxiang Liang2
1Xiangtan University, China; 2 CRRC Zhuzhou Electric Co., Ltd., China

D02.2 An LED Driver with Adjustable Output Current
Lili Zhu1, Bin Zhang2
1Chongqing Vocational Institute of Engineering, China; 2Chongqing Aerospace Polytechnic, China

D02.3 Design of Controller Based on ADRC Strategy for Three-Phase UPS
Shaokang Gong1, Jingtao Huang1, Guofeng He2
1Henan University of Science and Technology, China; 2Henan University of Urban Construction, China

D02.4 Control Strategy of Three-Phase Four-Wire Three-Leg Inverters
Haofan Xiong
Shanghai Key Laboratory of Power Station Automation Technology, Shanghai University, China

D02.5 Output Voltage Adjustable Resonant Converter Based on Auxiliary LLC with Winding
Yifan Lu, Congze Gao, Shunkang Mao
Beijing Institute of Technology, China

D02.6 Topology Analysis of Basic Non-Isolated DC/DC Converter and DC Distributed Power System
Jian Huang, Quanming Luo, Qingqing He, Aqian Zu, Xiong Du
Chongqing University, China

D02.7 Design of Rapid-Control-Prototype Platform for Modular Multilevel Converter Based on RT-lab
Wei Dong1, Xiaolin Zhang1, Long Jing2, Wu Wen2
1China Electric Power Research Institute, China; 2Beijing Jiaotong University, China

D02.8 A Comparative Study of S-S and LCC-S Compensation Topology of Inductive Power Transfer Systems for EV Chargers
Yafei Chen, Hailong Zhang, Chang-Soo Shin, Kyung-Ho Seo, Sung-Jun Park, Dong-Hee Kim
Chonnam National University, Korea

D02.9 A High Step-Down DC-DC Converter
Longyang Yu, Laili Wang, Mengyu Zhu, Chengzi Yang, Yongbin Jiang
Xi'an Jiaotong University, China

D02.10 A High Step-Down DC-DC Converter Based On Switched-Capacitor and Two-Phase Buck
Longyang Yu, Laili Wang, Mengyu Zhu, Chengzi Yang
Xi'an Jiaotong University, China

D02.11 A Predictive Current Control Method for the T-Type Three-Level Inverters Fed Dual Three-Phase PMSM Drives with Reduced Current Harmonics
Zhixian Xu, Zheng Wang, Xueqing Wang
Southeast University, China

D02.12 A Single-Carrier PWM Strategy for Multilevel Converters
Pascal M. Lingom1, Joseph Song Manguelle2, Jean-Maurice Nyobe-Yome3, Daniel L. Mon-Nzongo4, Tao Jin1, Mamadou Lamine Doumbia5
1Fuzhou University, China; 2University of Quebec, United States; 3University of Douala, Cameroon; 4Pearl Electric, France

D02.13 A Graphical Performance Tool for Design and Comparative Assessment of Predictive Torque Control Methods in Motor Drive Applications
Paul Gistain Ipoum Ngome1, Daniel L. Mon-Nzongo2, Rodolfo Flesch3, Joseph Song Manguelle4, Tao Jin1, Jinquan Tang1
1Fuzhou University, China; 2Pearl Electric, France; 3Federal University of Santa Catarina, Brazil; 4Université du Quebec a Trois-Rivieres, United States; 5Pearl Electric, Co., China

D02.14 A Delay Compensation Method to Improve the Current Control Performance of the LCL-Type Grid-Connected Inverter
Lin Wang, Pengju Sun, Jie Wang, Kunlong Zhu, Tongyu Xue, Yuxin Zhang
Chongqing University, China

D02.15 Pre-Synchronization Control Method of Virtual Synchronous Generator with Alterable Inertia
Pengxiang Xing1, Xuanyue Jia2, Chunzheng Tian1, Yubin Mao1, Linlin Yu1, Xiaoliang Jiang1
1State Grid Henan Electric Power Company Economic Research Institute, China; 2Central China Electric Power Engineering Corporation Limited, China

D02.16 A Reconfigurable Three-Phase Dual-Active-Bridge DC-DC Converter Designed for Wide-Range High-Efficiency Operation
Akif Zia Khan, Ka-Hong Loo
The Hong Kong Polytechnic University, Hong Kong
D02.17 Active Selection of Current Commutation Loop for Hybrid Three-Level Dual Active Bridge DC-DC Converter with TPS Control
Qing Gu, Liqiang Yuan, Shuxian Yi, Jintong Nie, Zhengming Zhao
Tsinghua University, China

D02.18 Design of Parallel Converters with L-Filter and Reduced Filter Size
Zhongyi Quan, Yunwei Li
University of Alberta, Canada

D02.19 Modeling and Hybrid Controller Design of CLLLC
Kai Li, Yue Wang, Jinghui Xu, Guoqing Gao, Pengfan Xu, Tian Li, Xiaojie Zhang
Xi'an Jiaotong University, China

D02.20 A Novel Topology and Operation Mechanism of Unipolar-to-Bipolar DC Transformer
Shuhuai Shi¹, Yanlin Zhu¹, Zhuan Zhao², Sheng Cheng¹, Nan Zhang¹, Fang Zhuo¹, Feng Wang¹, Tianhua Zhu¹
¹Xi'an Jiaotong University, China; ²Zhengzhou Electric Power College, China

D02.21 Research on Overvoltage Distribution of HVDC Converter Valve and Influence of Parasitic Capacitance in Special Environment
Cuicui Liu, Yating Gou, Zebin Yang, Hui Yan, Fang Zhuo, Feng Wang
Xi'an Jiaotong University, China

D02.22 Model Predictive Control of Dual Active Bridge Converter Based on the Lookup Table Method
Guoqing Gao, Wanjun Lei, Yao Cui, Kai Li, Xiufang Hu, Jinghui Xu, Gaotai Lv
Xi'an Jiaotong University, China

D03: Modeling, Simulation and Control
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Ballroom Foyer

D03.1 An Improved Power Decoupling Strategy Based on Newton Interpolation for Electric Locomotive
Chun He, Guochun Xiao, Shuai Zhang, Chen Peng, Zhihao Zhai, Zebin Yang
Xi'an Jiaotong University, China

D03.2 Research on Feeder Power Balancing Technology Based on SNOP Droop Control
Changbao Xu¹, Xufeng Yuan², Yutao Xu¹, Zhukui Tan¹, Chenghui Lin¹, Mingyang Chen²
¹Guizhou Electric Power Research Institute of China Southern Power Grid Company Limited, China; ²Guizhou University, China

D03.3 Attitude Tracking of Enhanced Flexible Hybrid Nanogenerator in Human-Computer Interaction
Guoting Xia, Shuo Li, Kai Wang
Qingdao University, China

D03.4 Research on Optimizing PI Parameter of Skin Effect Electric Trace Heating System Based on Deep Learning
Pengyu Xiao, Lei Fu, Jiusheng Wang, Guangxue Cui, Liguo Wang
Harbin Institute of Technology, China

D03.5 Unbalanced Harmonic Suppression of Three-Level Active Power Filter with Optimal Hybrid Control
Jiaxuan Yao, Weiwei Zhu, Linghui Meng, Hongjian Lin, Zeliang Shu, Liang Liu
Southwest Jiaotong University, China

D03.6 A Real-time Simulator Using a Cluster of FPGAs for Testing Distributed Generations
Weihua Wang, Bingjie Wang, Bowen Liang, Fei Gao
OPAL-RT Technologies Inc., Canada

D03.7 Intelligent Nano-Ground Based on Triboelectric Nanogenerator for Motion Tracking
Peng Dong, Fabing Duan, Kai Wang
Qingdao University, China

D03.8 Decoupled Feedback Linearization Control for SOP
Likai Hou¹, Guorong Zhang¹, Bo Peng¹, Yi Lu², Feng Xu²
¹Hefei University of Technology, China; ²State Grid Zhejiang Electric Power Co., Ltd. Research Institute, China
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<td>A Tuning Method of Selective Harmonic Voltage Compensator for Distributed Generators</td>
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**D04: Reliability, Fault and Protection**

**Wednesday, June 5th ** 10:40AM - 12:10PM  
Ballroom Foyer

**Chairs**  Sixing Du (University of Toronto, Canada)  
Xiaotian Zhang (Xi’an Jiaotong University, China)

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<td>¹Army Engineering University, China; ²Nanjing University of Science and Technology, China</td>
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<td>¹CMIG New Energy Investment Group Limited, China; ²Xiangtan University, China</td>
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Botao Wang, Chenxi Yu, Yutao Yang, Chuanwen Shen
Xi'an Jiaotong University, China

D04.10 Current Status and Development of Fault Current Limiting Technology for DC Transmission Network
Chaoran Zhuo, Xu Yang, Xiong Zhang, Xiaotian Zhang
Xi'an Jiaotong University, China

D04.11 Optimized Method for Reliability and Redundancy Analysis of MMC Based on Component Operating Conditions
Gaotai Lv1, Yue Wang1, Taiyuan Yin1, Jiazhuo Xuan2, Chaoliang Wang2, Chao Ding2, Guoqing Gao1
1Xi'an Jiaotong University, China; 2State Grid Zhejiang Electric Power Co., Ltd. Research Institute, China

D05: Microgrids
Wednesday, June 5th 10:40AM - 12:10PM
Ballroom Foyer

Chairs Jinde He (Tianjin University, China) Ning Li (Xi'an University of Technology, China)

D05.1 Virtual Synchronous Generator Technology and Its Parallel Control Strategy in Isolated Island Microgrid
Ning Li1,2, Xiang Zhang2, Yujie Cao1, Fuxing He1, Shiqian Zhang1, Yelin Wang1
1Xi'an University of Technology, China; 2China Ship Development and Design Center, China

D05.2 Model Predictive Direct Power Control Method of Energy Storage Converter in Microgrid
Zhonghua Chen1, Caiqian Wang1, Jiamin Chen1, Hua Xue2, Jia Wang3
1Hangzhou Electric Power Design Institute Co., Ltd., China; 2College of Electrical Engineering, Shanghai University of Electric Power, China; 3State Grid Electric Power Research Institute, Nari Group Corporation, China

D05.3 A Coordination Control Method for Multi-Terminal AC/DC Hybrid System Based on MMC Transmission Technology
Jikai Chen, Qiang Zeng, Guoqing Li, Yechun Xin, Lin Li, Peng Wang
Northeast Electric Power University, China

D05.4 An Improved Parallel Strategy for Auxiliary Inverter without Control Interconnection in Metro Applications
Mingxia Xu1, Zhiqiang Wang1, Xiangzhong Che2, Ninghui Wang1
1Dalian University of Technology, China; 2CRRC Dalian R&D Co., Ltd., China

D05.5 Micro-Grid Scheduling of Electric Boiler and CHP with Thermal Energy Storage Based on Wind Power Accommodating
Hongxia Yu1, Kun Zhang1, Junwen Dai2, Yuying Liu2, Zhenting Sun3
1Shenyang University of Technology, China; 2Dalian Electric Power Survey & Design Institute Co., Ltd., China; 3State Grid Liaoning Electric Power Co., Ltd., China

D05.6 Grid-Connected Control Strategy for Bidirectional AC-DC Interlinking Converter in AC-DC Hybrid Microgrid
Jiao Jiao, Runquan Meng, Zheng Guan, Chunguang Ren, Lei Wang, Baifu Zhang
Taiyuan University of Technology, China
D05.7 A Risk Evaluation Method of Ship Micro Grid with Distributed Generations
Huilin Ge, Pengfei Zhi, Wanlu Zhu, Zhiyu Zhu, Hui Wang, Wei Chen
Jiangsu University of Science and Technology, China

D05.8 Electricity Quality Analysis of Teuri-Yagishiri Island Microgrid
Shoki Fujimoto, Shin'ya Obara
Kitami Institute of Technology, Japan

D05.9 Generic Derivation of Optimal Architecture for a Resilient Microgrid with Graph Theory
Na Chen, Hao Wang, Haijin Li, Dehong Xu
Zhejiang University, China

D05.10 Model Predictive Control Based Energy Management of a Household Microgrid
Hui Yan, Fang Zhuo, Nian Lv, Hao Yi, Zhenxiong Wang, Cuicui Liu
Xi'an Jiaotong University, China

D05.11 Power Decoupling Control of Parallel Converters Based on Negative Virtual Impedance under Unbalanced Conditions
Zhongping Yu1, Honghao Guan1, Fen Tang2, Zefu Xu2, Tao Yan1, Xinfu Song1
1State Grid Xinjiang Electric Power Co., Ltd., China; 2Beijing Jiaotong University, China

D06: Renewable Energy and Storage Systems
Wednesday, June 5th 10:40AM - 12:10PM
Ballroom Foyer

D06.1 Modeling and Studies of the Two-winding Three-Phase Permanent Magnetic Synchronous Generator of Offshore Wind Turbines
Honglin Zhou, Shu Jun, Jingbo Liu
Dongfang Electric Corporation, China

D06.2 A Short-Term Photovoltaic Output Prediction Method Based on Improved PSO-RVM Algorithm
Zhuo Li, Wei Xiong, Xufeng Yuan, Xiaosong Zou
Guizhou University, China

D06.3 Life Prediction Method for VSG Energy Storage Unit
Bo Zhang, Xiaolei Zhang, Xiangwu Yan, Jinzuo Han
North China Electric Power University, China

D06.4 An Original Self-Turning PI Controller for STATCOM in Wind Farm with Voltage Fluctuation Based on IABC Algorithm
Minglei Wang1, Liguo Wang1, Xinxin Chang1, Xiangyu Wang2
1Harbin Institute of Technology, China; 2Northeast Petroleum University, China

D06.5 A MPPT Method for Photovoltaic System with Multi Output Power Peaks
Jianqiang Ji1, Shuliang Yu2, Tingting Sun3, Dongsheng Yu1
1Zhejiang Hi-Tech Renewable Energy Co., Ltd., China; 2State Grid Anhui Electric Power Co., Ltd., China; 3China University of Mining and Technology, China

D06.6 An Improved Three Phase PWM Rectifier Active Damping Control Strategy with State Observer for Battery Charging and Discharging System
Shuai Zhang, Guochun Xiao, Chun He, Chen Peng, Fujian Li, Xudong Du, Qilei Wang
Xi'an Jiaotong University, China

D06.7 Topologies for Reduction of Second Harmonic Ripple in Battery Energy Storage Systems
Yixi Feng1, Georgios Konstantinou1, Branislav Hredzak1, John Fletcher1, Kai Sun2
1University of New South Wales, Australia; 2Tsinghua University, China

D06.8 Life Prediction of Hybrid Supercapacitor Based on Improved Model-Extreme Learning Machine
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<td>The Application of Cascade Power Electronic Transformer in Large-Scale Photovoltaic Power Generation System</td>
<td>Yanting Zhou, Shuo Li, Kai Wang</td>
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<td>Power Management of a Residential Hybrid Photovoltaic Inverter with Battery Energy Storage System</td>
<td>Wei Xiong1, Jianwu Zeng2, Liangcai Wu1, Hao Cheng1</td>
<td>Xi'an Jiaotong University, China; Shenzhen Growatt New Energy Technology Co., Ltd., China</td>
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<td>Xi'an Jiaotong University, China; Electric Power Research Institute State Grid Zhejiang Electric Power Company, China</td>
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<td>An Electro-Thermal Coupled Model of Vanadium Redox Flow Battery for Large-Scale Energy Storage System</td>
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<td>Wuhan University of Technology, China; State Grid Xiangyang Power Supply Company, China; Zhengzhou Metro Group Co., Ltd., China</td>
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<td>Sensorless Control Scheme of DFIG Wind Energy Conversion Systems Based on SOGIs and FLL</td>
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Chairs Dongdong Zhao (Northwestern Polytechnical University, China)
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D07.1 Research on Demand Side Resources Planning Strategy of Load Aggregator Considering CVaR
Zhang Peng, Jingjing Zhang, Hongbin Wu, Xianjun Qi
Hefei University of Technology, China

D07.2 Distributed Generation Admittance Capacity Calculation of Distribution Network Based on Multi-Scenario Analysis and Active Management
Chi Zhang1, Jie Zeng1, Qi Xu1, Lin Guo1, Zhijun Ren2, Minhua Guo2
1Electric Power Research Institute of Guangdong Power Grid Co., Ltd., China; 2South China University of Technology, China

D07.3 Double-Layer Optimal Configuration of Active Distribution Network with Multiple Market Entities under Power Reform
Hongxia Guo, Zhijun Ren
School of Electric Power, South China University of Technology, China

D07.4 Power Flow Calculation and Operating Parameter Optimization of Fractional Frequency Power Transmission System
Rui Liu, Xiuli Wang
Xi'an Jiaotong University, China

D07.5 Research on Load Clustering Algorithms Based on Hierarchy and Fuzzy Theory
Min Wang1, Yuanzhi Jiang1, Yi Shi1, Mingze Zhang2, Yichao Huang3, Minghan Yuan4
1Hohai University, China; 2Shanghai Power Company Economics Institute, China; 3State Grid Shanghai Power Company Shibei Power Company, China; 4State Grid Shanghai Power Company, China

D07.6 Non-Intrusive Load Decomposition Based on SAMME.R-DT Algorithm
Yanchao Wang1, Meiqin Mao1, Liuchen Chang2
1Hefei University of Technology, China; 2University of New Brunswick, Canada
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