



Proposal for ISIE 2021 Tutorial

Title of Tutorial:

Reliable Power Electronics for Affordable and Sustainable Energy Systems

Contact Information of Speakers:

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Background of Speakers:

Huai Wang

- Reliability and robustness of power electronic components and systems
- Smart passive components and their applications in power electronics
- Condition and health monitoring of power electronic systems
- Artificial intelligence for power electronics design, control, and condition monitoring

Brief description of the tutorial (500 words max):

Power electronic converters are “CPUs” processing electrical energy from generation to end-use. They play an essential role in renewable energy generation, smart grid, e-mobility, data centers, industrial automation, smart home appliances, and consumer electronics. With more than 70% of electricity processed through power electronics, optimizing the efficiency and reliability of converters is critical to affordable and sustainable energy systems. Industry-leading companies are making efforts to transition from product providers to service providers. The life-cycle performance of power electronic systems in industrial applications is becoming more and more critical. Power electronic converters are to be designed and manufactured by considering not only the time-zero performance but also the life-cycle performance in terms of reliability and efficiency.

This tutorial will present various case studies of the failure mechanism of critical power electronic components, lifetime and reliability modeling, and condition monitoring for predictive maintenance. Perspectives on research challenges and opportunities will also be put up throughout the discussions. The proposed outline of the tutorial is as below:

- **The motivation for reliable power electronics (15 minutes)**
 - Beyond efficiency and power density
 - Impact of reliability performance on life-cycle-cost and cost-of-energy
- **Physics-of-failure of power electronic components (30 minutes)**
 - Type of failure and field experiences
 - Failure mechanisms of power electronic components
 - Concept of the mission profile
- **Design for reliability of power electronic systems (30 minutes)**
 - Mission profile-based reliability prediction for power electronic systems
 - Reliability-oriented design and case studies
- **Condition monitoring for predictive maintenance of power electronic converters (30 minutes)**
 - Application demands for condition monitoring of power electronic converters
 - Case study on a converter-level non-invasive condition monitoring method
 - Case study on a digital-twin based condition monitoring method
- **Final Q&A and wrap up (5 minutes)**

Biography:

Huai Wang is currently a Professor with the Center of Reliable Power Electronics (CORPE) and Vice Leader of the Efficient and Reliable Power Electronics Research Program at Aalborg University, Denmark. He has given more than 20 tutorials at leading power electronics and reliability engineering conferences (e.g., IECON, APEC, ECCE, PCIM Europe, etc.), 50+ invited talks and a few keynote speeches. His research addresses the fundamental challenges in modeling and validating power electronic component failure mechanisms and application issues in system-level predictability, condition monitoring, circuit architecture, and robustness design. He collaborates with various industry companies across the value chain, from power electronic components to systems. He lectures three Industrial/PhD courses on Reliability of Power Electronic Systems, Capacitors in Power Electronics Applications, and Design FMEA in power electronics at Aalborg University. He has contributed more than 280 journal and conference papers and co-edited a book on the Reliability of Power Electronic Converter Systems in 2015.

He received his PhD degree from the City University of Hong Kong, Hong Kong, China, and B. E. degree from the Huazhong University of Science and Technology, Wuhan, China. He was a short-term visiting scientist with the Massachusetts Institute of Technology (MIT), USA, and ETH Zurich, Switzerland, in 2013 and 2014, respectively. He was with the ABB Corporate Research Center, Baden, Switzerland, in 2009. He received the Richard M. Bass Outstanding Young Power Electronics Engineer Award from the IEEE Power Electronics Society in 2016 for the contribution to the reliability of power electronic converter systems. He serves as the Chair of IEEE PELS/IAS/IE Chapter in Denmark, and as an Associate Editor of IET Electronics Letters, IEEE Journal of Emerging and Selected Topics in Power Electronics, and IEEE Transactions on Power Electronics.

Brief description of the intended audience

The intended audiences are: 1) researchers and engineers interested in power electronics or reliability of engineering systems; 2) energy system operators interested in predictive maintenance solutions for power electronic converters; 3) power electronic component designers interested in the application-side challenges of their products.

Support technical committee in IES (if any)

N/A