by Qing-Chang Zhong

Power Electronics-Enabled Operation of Power Systems

Power systems are going through a paradigm shift as millions of distributed energy resources are connected to the grid worldwide. This imposes unprecedented challenges to the operation of future power systems, which will be power electronics based instead of electric machines with millions of active, intermittent, nonsynchronous, and heterogeneous players. It is important to identify the fundamental challenges and needs in multidisciplinary research and education in the control of power electronics-enabled power systems for enhanced grid stability, autonomy, scalability, operability, reliability, security, and resiliency, while strengthening collaborative efforts to tackle these issues and raise awareness within funding agencies and among policy makers. To help do so, the Energy, Power, Control, and Networks Program of the U.S. National Science Foundation (NSF) sponsored a workshop, Power Electronics-Enabled Operation of Power Systems, at the Illinois Institute of Technology (IIT), Chicago, from 31 October to 1 November 2019, under award 1933207.

The workshop's organizing committee included Prof. Qing-Chang Zhong (chair), IIT; Prof. Sairaj Dhople, University of Minnesota; Prof. Brian Johnson, University of Washington; Prof. Beibei Ren, Texas Tech University; Dr. Thanh Long Vu, Pacific Northwest National Laboratory; Prof. Ziang Zhang, Binghamton University; and Annette Lauderdale, IIT.

More than 130 participants from funding agencies, regulatory commissions, utilities, national labs, universities, and vendors attended (Figure 1). The vice provost for research at IIT, Prof. Fred J. Hickernell, welcomed them. Dr. Anil Pahwa from the NSF kicked off the workshop with "NSF Perspectives: Challenges and Opportunities," followed by 10 keynotes, nine short talks, and two panel discussions. The participants also visited the IIT microgrid and the SYNDEM Smart Grid Lab.

The talks included

- "Enabling a Power Electronics Grid," Prof. Deepak Divan, Georgia Institute of Technology
- "Power Electronics-Enabled Autonomous Power Systems: Synchronized and Democratized (SYNDEM) Smart Grids," Qing-Chang Zhong, IIT
- "Optimizing Ubiquitous Power Electronics for the Future Power Grid," Dr. Zhenyu Henry Huang, Pacific Northwest National Laboratory
- "Technical Challenges of High Level of Inverter-Based Resources in Power Grids," Prof. Robert Lasseter, University of Wisconsin–Madison
- "Research and Education in CURENT on Power Electronics for Power Systems," Prof. Fred Wang, University of Tennessee, Knoxville
- "Growing Deployment of Power Electronics in Power Systems: Challenges, Opportunities, and Research Initiatives," Dr. Abraham Ellis, U.S. Department of Energy
- "Flexible Division and Unification Control Strategies for Resilience Enhancement in Networked Microgrids," Prof. Mohammad Shahidehpour, IIT

FIG 1 Workshop attendees gather for the first day.

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- "Medium-Voltage Power Electronics Technology," Prof. Alex Huang, University of Texas at Austin
- "Power Engineering Education in the Age of Climate Crisis: A Holistic View," Prof. Ned Mohan, University of Minnesota
- "Power Electronics in Transportation Electrifications," Prof. Ali Emadi, McMaster University.

The short talks were

- "Protection of High-Voltage dc Transmission Systems," Prof. Maryam Saeedifard, Georgia Institute of Technology
- "Grid-Forming Photovoltaic Inverter: Opportunities and Challenges," Dr. Hariharan Krishnaswami, U.S. Department of Energy
- "The Advanced Grid Innovation Lab for Energy: A Collaborative Program of the New York Power Authority (NYPA)," Dr. George Stefopoulos, NYPA
- "Microgrid Testbeds at Different Scales for Research and Education," Prof. Beibei Ren, Texas Tech University
- "Resilient Architectures and Algorithms for Generation Control of Inertialess ac Microgrids," Prof. Alejandro Dominguez-Garcia, University of Illinois at Urbana-Champaign
- "Nonlinear Decentralized Control for Future Grids," by Prof. Brian Johnson, University of Washington
- "Multi-Scale Control of Power Electronics for Power Systems," Prof. Sudip K Mazumder, University of Illinois at Chicago
- "High-Frequency Power Electronics at the Grid Edge: Opportunities and Challenges," Prof. Minjie Chen, Princeton University
- "Impedance-Based Evaluation of Stability Impacts of Inverter-Based Resources," Dr. Shahil Shah, National Renewable Energy Laboratory.

The workshop was a success, and the participants found it informative and useful for further work. It will be organized annually in the future.

About the Author

Qing-Chang Zhong (zhongqc@ieee.org) received his Ph.D. degree in control theory and engineering from Shanghai Jiao Tong University, China, in 2000 and his Ph.D. degree in control and power engineering from Imperial College London in 2004. He is the Max McGraw Endowed Chair Professor in energy and power engineering in the Department of Electrical and Computer Engineering, Illinois Institute of Technology, Chicago, and founder and chief executive director of Syndem, Chicago. His research focuses on power electronics, advanced control theory, and the seamless integration of both to address fundamental challenges in energy and power systems. He is a Fellow of the IEEE.