1. Tutorial Title

Resiliency-Oriented Grid-Interactive Converters: Concepts, Design, and Field Implementation

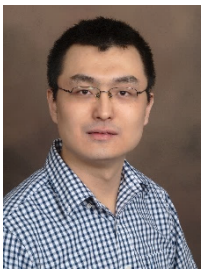
2. Abstract

As the penetration level of inverter-based distributed energy resources (DERs) increases rapidly, distribution grids, as the most significant 'grid-edge' for DER integration, play a crucial role in bridging the grid backbone (i.e., transmission system) to the end-users. Resilient and stable distribution grids are urgently needed to modernize electric power grids with high penetration of inverter-based resources (IBRs) and ensure operational continuity.

Conventional grid-interactive power electronic converter design mainly focuses on satisfying the design constraints of individual converter units and the operational requirements at the single point of interconnection (POI). However, given the increasing penetration level of IBRs in modern power grids, *converter systems* should also be taken into account to meet the grid needs in a wider area. Furthermore, the concept of converter design has been tremendously advanced, considering the cross-domain and multi-disciplinary objectives. Particularly, on top of the conventional and legacy converter design constraints on power density, energy conversion efficiency, among others, additional considerations on the interactions among multiple converters (i.e., *converter systems*) should be highlighted, with special emphases on the coupling operation between converter hardware implementation (physical layer) and information exchange through communication interconnections (cyber layer), control design respecting the tradeoff between local control constraints satisfaction and interactive operation with neighboring converters, and fault-tolerant design and converter system resiliency enhancement coordinated with conventional protection schemes in a multi-timescale context. All these emerging design constraints call for a paradigm shift into a resiliency-oriented converter design framework.

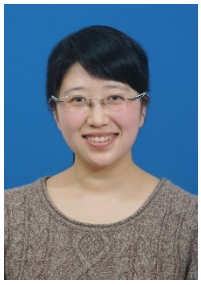
In this tutorial, the diversified and multi-disciplinary instructor team from academia, government national laboratories, and leading industry companies will introduce the resiliency-oriented modeling and control of grid-interactive converter, and the topics will range from fundamental concepts covering the necessary background knowledge to advanced applications and field deployment. The topics will echo the cutting-edge technologies and applications of grid-interactive converters, including hybrid and networked AC and DC microgrids, inverter-based renewable energy (e.g., photovoltaics) integration, resiliency enhancement, and protection coordination in inverter-dominated power grids, among others.

3. Presenter's Bio



Xiaonan Lu received his B.E. and Ph.D. degree in electrical engineering from Tsinghua University, Beijing, China, in 2008 and 2013, respectively. From September 2010 to August 2011, he was a guest Ph.D. student at the Department of Energy Technology, Aalborg University, Denmark. From October 2013 to December 2014, he was a Postdoc Research Associate at the Department of Electrical Engineering and Computer Science, University of Tennessee, Knoxville. From January 2015 to July 2018, he was with Argonne National Laboratory, first as a Postdoc Appointee and then an Energy Systems Scientist. In July 2018, he joined the College of Engineering at Temple University as an Assistant Professor.

His research interests include modeling and control of power electronic inverters, hybrid AC and DC microgrids, power electronics dominated power grids, and real-time hardware-in-the-loop simulation. Dr. Lu is the Associate Editor of IEEE Transactions on Industrial Electronics, the Associate Editor of IEEE Transactions on Industry Applications, the Editor of IEEE Transactions on Smart Grid, and the Editor of Power Engineering Letters. Dr. Lu received the IEEE Philadelphia Section Delaware Valley Young Electrical Engineer of the Year in 2020.



Jin Tan received the B.E. and Ph.D. degree in electrical engineering from Southwest Jiaotong University, Chengdu, China. She was a visiting Ph.D. student with the Department of Energy Technology, Aalborg University, Denmark. She was also a Postdoctoral Researcher with the Department of Electrical Engineering and Computer Science, University of Tennessee, Knoxville, TN, USA. She is currently a Research Engineer with the Power System Engineering Center, National Renewable Energy Laboratory, Golden, CO, USA. Her research interests include power system stability with large-scale renewable integration, dynamic modeling of various renewable generation, ancillary control of renewable integration, and energy storage for grid application.

Andy Hoke is a Senior Engineer in the Grid-connected Energy Systems Group of the National Renewable Energy Laboratory (NREL). His research interests include power electronics and controls for the integration of distributed and renewable energy with electric power systems. He is experienced in design, testing, modeling, simulation, and hardware-in-the-loop techniques for grid integration of power electronics. He is currently the Chair of the IEEE 1547.1 Working Group. He received the B.A. degree in engineering physics from Dartmouth College and the M.S. and Ph.D. degrees in electrical engineering from the University of Colorado, Boulder. Dr. Hoke received IEEE Power and Energy Society (PES) General Meeting Best Conference Paper Awards in 2015 and 2017.

Lisa Qi received the bachelor's degree from Xi'an Jiaotong University, Xi'an, China, the master's degree from Zhejiang University, Hangzhou, China, and the Ph.D. degree from Texas A&M University, College Station, TX, USA. All are in electrical engineering. Dr. Qi was a research faculty at Florida State University, Tallahassee, FL, USA, from 2004 to 2009. She joined ABB in Raleigh, NC, in 2009 and is currently a Senior Principal Scientist at U.S. Corporate Research Center. Dr. Qi's research interests mainly focus on the protection and operation of hybrid AC and DC grids.