

Power Distribution System Modernization with Solid State Transformer and Integrated Renewables

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Significant advances have been made in recent years to achieve low and medium voltage interconnection between utility and customers through wide bandgap power devices, innovative converter topologies, and controls. The integration of power electronic converters, local renewable generation, load, and/or storage is currently finding widespread applications in microgrids, electric ships, electric vehicle fast chargers, large scale data centers, and commercial/industrial buildings bringing the benefits of high efficiency, power quality, flexibility, stability, and reliability. Use of electronic loads such as electric vehicles, consumer electronics, and computing are also on the rise. Power electronics is the key technology that connects modern customers with utility by enabling distributed generation, microgrids and the integration of electronic loads. FREEDM systems Center have been pioneering many of the developments through its FREEDM concept which provides an architecture for a future electric power distribution system. The FREEDM concept envisions the “Energy Internet,” a system that enables flexible energy sharing for consumers in a residential distribution system. One of the core technologies for the FREEDM system is the power electronics based solid-state transformer (SST). The SST behave like a smart transformer with the advantage of power flow control, reactive power compensation capability, and potential fault current limitation. Additionally, to achieve high performance in networked power electronics systems, controls play a key role where they are implemented in a hierarchical manner starting from local power converter controls to primary to secondary, and to tertiary levels. The control challenges are immense both due to interaction among the power electronics converters and the intermittency of the renewables. The demand and desire is to make these intelligent power electronic converters plug-and-play type, and in a network, the control algorithms at different levels are to provide for automated and robust power, energy and fault management. The future customer is expected to interact with the provider or utility based on economic, social, environmental and security considerations.

This talk will present the modern power electronics based power distribution system addressing system architecture, stability issues, primary and secondary controls, grid synchronization techniques, and results aimed at demonstrating the FREEDM concept.

Prof. Iqbal Husain is the Director of the Future Renewable Electric Energy Delivery and Management (FREEDM) Engineering Research Center and the ABB Distinguished Professor at North Carolina State University where he joined in Fall 2011. Prior to coming to NC State he was serving as a faculty member at the University of Akron, Ohio was also a visiting Professor at Oregon State University. Prof. Husain also serves as the Director of the Advanced Transportation Energy Center (ATEC). He received the B.Sc. degree from Bangladesh University of Engineering and Technology, Bangladesh, and the M.S. and Ph.D. degrees from Texas A&M University, College Station, Texas.

Prof. Husain’s research interests are in the areas of control and modeling of electrical drives, design of electric machines, inverters for distributed power generation, inverter controls for grid synchronization, and modeling and control of electric and hybrid vehicle systems.

Prof. Husain is a Fellow of the IEEE, and also, is the Editor-in-Chief of the IEEE Electrification Magazine. He was the General Co-Chair for Energy Conversion Congress & Expo (ECCE) 2012 in Raleigh, NC, the chairman of the IEEE-IAS Transportation Systems Committee, and the chairman of the IEEE-IAS Electric Machines Committee. Prof. Husain received the 2006 SAE Vincent Bendix Automotive Electronics Engineering Award, the 2004 College of Engineering Outstanding Researcher Award, the 2000 IEEE Third Millennium Medal, the 1998 IEEE-IAS Outstanding Young Member award, and several IEEE-IAS prize paper awards.