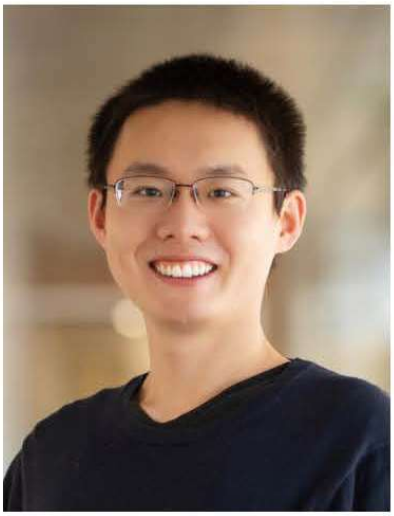
ECE SEMINAR



Dr. Xiaofan Cui

Postdoctoral Fellow,
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February 28th, 2:00 PM to 3:00 PM

Location: SEH 2000

Efficient Power Conversion for Multiscale Energy Systems

ABSTRACT

Fostered by the high controllability, speed, and power density of power electronics, future energy systems can be more agile in actuation and more heterogeneous in form. In the ultimate energy system, the right energy is delivered to the right place at the right time. However, conventional power-processing architectures remain inadequate for heterogeneous energy resources. Moreover, the bandwidth of energy delivery is bottlenecked by the speed of power converters. In this talk, I will present my work on addressing these challenges through new modeling, control, design, and results from hardware and simulations.

This talk follows two themes: (I) better power-processing architectures to equalize energy heterogeneity; (II) better power-control frameworks to accelerate energy delivery. In the first scheme, I will demonstrate a power-conversion architecture to repurpose retired electric vehicle batteries for stationary energy storage. The statistical distributions of second-life battery characteristics are mapped to a hierarchical partial-power-processing architecture; In several case studies, this architecture pushes the battery utilization-power converter tradeoff and decreases the thermal management cost by a factor of two compared to its conventional counterparts. In the second scheme, I will present two advances that overcome the speed limitations: (1) a sampled-data modeling and control framework for variable frequency dc-dc converters; the converter based on this framework shows a fast transient response that is within five switching cycles; (2) a control and design approach that guarantees the large-signal stability robustness of current-mode dc-dc converters; the resulting converters can operate in the frequency that is an order of magnitude higher than the existing current-mode dc-dc converters. These advances position power electronics to revolutionize what is possible for next-generation energy systems in energy storage, renewable energy, computing, sensing, and beyond.

BIOGRAPHY

Xiaofan Cui is currently a Postdoctoral Fellow with the Stanford Energy Control Laboratory at Stanford University. He received the B.E. degree in electrical engineering and automation from Tsinghua University, Beijing, China, in 2016. He received the M.S. degree in mathematics, the M.S. and Ph.D. degree in electrical and computer engineering from the University of Michigan, Ann Arbor, MI, USA in 2018 and 2022, respectively. His research interests include the modeling, control, and design of high-performance power electronics for energy systems. He is the winner of the Michigan Translational Research and Commercialization Award in 2021, the recipient of the Richard F. and Eleanor A. Towner Prize for Distinguished Academic Achievement at the University of Michigan in 2021, and the recipient of Rackham Graduate Student Research Grant in 2020.