Bai Cui

Postdoctoral Appointee
Energy Systems Division
Argonne National Laboratory

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Research Interests

My primary research interests are in the area of power system security and stability analysis and power system optimization. Topics of recent interests include:

1. Power flow solvability and its applications
2. Real-time monitoring of voltage stability
3. Convex relaxation of optimal power flow and its applications

Education

Georgia Institute of Technology

2018 Ph.D. Electrical and Computer Engineering (Electric Power Systems)
- Dissertation: *Distribution System Service Restoration Using Dynamic Programming Considering Switch Characteristics*
- Advisor: Drs. Sakis Meliopoulos and Andy Sun
- Minor: Mathematics

2014 M.S. Electrical and Computer Engineering

University of Michigan

2011 B.S. Computer Engineering

Shanghai Jiao Tong University

2011 B.S. Electrical Engineering
- Dual bachelor's degree

Internships

Eaton Corporation, Eden Prairie, MN

Su–Fa '15 **Corporate Research and Technology Intern**
- Designed hardware-in-the-loop testbed, integrated Simulink distribution system model, corporate feeder automation software, and real-time simulation tool (OPAL-RT).
- Implemented dynamic programming-based volt/var control optimization algorithm for online application of distribution feeder automation.

SpaceTime Insight, Atlanta, GA

Summer '14 **Advanced Application Development Intern**
- Developed smart meter anomaly detection algorithms using statistical and machine learning tools such as local outlier factor and self-organizing maps.
- Designed and maintained AMI relational database structure using PostgreSQL.

Experience

2018 – Postdoctoral Appointee, Argonne National Laboratory, Energy Systems Division

2015 – 2018 Research Assistant, Georgia Institute of Technology

2012 – 2014 Teaching Assistant (Electric Power Systems), Georgia Institute of Technology

Projects

Argonne National Laboratory

2018 – **Measurement-Based Hierarchical Framework for Time-Varying Stochastic Load Modeling**
- Derived composite load model state space representation.
- Applied novel data-driven approach for composite load model parameter reduction.

2018 – **Convex Relaxation of Optimal Power Flow**
- Proposed strengthened QC relaxation based on lift-and-project and bound tightening.
- Applied convex relaxation in system planning and operation.

Georgia Institute of Technology

2016 – 2018 **Solvability of Power Flow Equations**
- Derived sufficient conditions for existence and uniqueness of power flow solutions.
- Derived convex inner approximation of power flow solution space.
- Derived robust certificate of system security under uncertainty.

2016 – 2018 **Distribution System Reconfiguration and Service Restoration**
- Implemented distribution automation functions for Korea Electric Power Corporation.
- Developed meta-heuristic-based algorithms for distribution system reconfiguration.
- Developed dynamic programming-based algorithm for sequential service restoration.

2014 – 2015 **Distribution System Command Authentication for Cyber Security via Cyber-Physical Modeling**
- Implemented intrusion detection algorithm for system cyber-physical security.
- Developed C++ code for faster than real time dynamic state estimation for system protection and command authentication.
- Developed model reduction algorithm facilitating faster than real time simulation.

2012 – 2015 **Monitoring and Detection of Long-Term Voltage Instability**
- Derived voltage instability proximity index based on power flow Jacobian.
- Developed voltage stability-constrained optimal power flow model based on convex reformulation and relaxation.
- Developed voltage stability monitoring scheme for transmission corridors.

Publications

In Review (Journal Articles)

1. **B. Cui** and Z. Wang, "Counterexample to Equivalent Nodal Analysis for Voltage Stability Assessment," submitted to *IEEE Power Engineering Letters*.
2. Y. Li, Y. Zhen, D. Zhao, H. Lei, **B. Cui**, and S. Li, "Incorporating Energy Storage and User Experience in Isolated Microgrid Dispatch Using a Multi-objective Model," submitted to *IET Generation, Transmission, & Distribution*.

Journal Articles

2019 1. C. Wang, **B. Cui**, Z. Wang, and C. Gu, "SDP-based Optimal Power Flow with Steady-State Voltage Stability Constraints," *IEEE Transactions on Smart Grid*, to be published.

2018 2. C. Wang, **B. Cui**, and Z. Wang, "Analysis of Solvability Boundary for Droop-Controlled Microgrids," *IEEE Transactions on Power Systems (Letters)*, vol. 33, no. 5, pp. 5799–5802, September 2018.

3. **B. Cui** and X. A. Sun, "A New Voltage Stability-Constrained Optimal Power Flow Model: Sufficient Condition, SOCP Representation, and Relaxation," *IEEE Transactions on Power Systems*, vol. 33, no. 5, pp. 5092–5102, September 2018.

2017 4. **B. Cui** and Z. Wang, "Voltage Stability Assessment Based on Improved Coupled Single-Port Method," *IET Generation, Transmission & Distribution*, vol. 11, no. 10, pp. 2703–2711, July 2017.

5. Z. Wang, **B. Cui**, and J. Wang, "A Necessary Condition for Power Flow Insolvability in Power Systems with Distributed Generators," *IEEE Transactions on Power Systems*, vol. 32, no. 2, pp. 1440–1450, March 2017.

2016 6. D. Ding, D. Zhao, X. Zhang, X. Lan, C. Li, and **B. Cui**, "Investigation of Vibration Impacts on HVAC Transformer from HVDC System Under Monopole Operation," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 23, no. 3, pp. 1386–1392, June 2016.

Conference Proceedings

2016 1. S. Meliopoulos, G. Cokkinides, R. Fan, L. Sun, and **B. Cui**, "Command Authentication via Faster Than Real Time Simulation," *IEEE PES General Meeting*, Boston, MA, 2016.

2013 2. **B. Cui**, M. Begović, R. Nuqui, D. Sobajić, and Y. Song, "On Voltage Stability Monitoring with Voltage Instability Predictors," *Bulk Power System Dynamics and Control-IX Optimization, Security and Control of the Emerging Power Grid (IREP), 2013 IREP Symposium*, Rethymno, Greece, 2013.

Articles in Preparation

1. J. Liu, **B. Cui**, D. K. Molzahn, C. Chen, X. Lu, and J. Wang, "Optimal Power Flow for DC Networks with Robust Feasibility and Stability Guarantees."

2. **B. Cui** and X. A. Sun, "Solvability of Power Flow Equations Through Existence and Uniqueness of Complex Fixed Point."

3. Z. Tan, Y. Liu, H. Sun, and **B. Cui**, "Fault Diagnosis and Bad Data Detection of Power Transmission Network — A Time Domain Approach."

Conference and Workshop Presentations

2019 1. Strong Certificate for Solvability of Power Flow Equations, *LANL Grid Science Winter School and Conference*, Santa Fe, NM, January 2019.

2017 2. Distribution Service Restoration by Dynamic Programming Considering Switch Characteristics, *Georgia Tech Workshop on Electric Energy Systems and Optimization*, poster session, Atlanta, GA, November 2017.

3. Voltage Stability, Power Flow Solvability, and A New Voltage Stability-Constrained Optimal Power Flow (VSC-OPF) Model, *INFORMS Annual Meeting*, Houston, TX, October 2017.

4. Voltage Stability, Power Flow Solvability, and A New Voltage Stability-Constrained Optimal Power Flow (VSC-OPF) Model, *University of Bergamo/Georgia Institute of Technology Optimization Workshop*, Atlanta, GA, September 2017.

2016 5. Robust and Decentralized Operations for Managing Renewable Generation and Demand Response in Large-Scale Distribution Systems, *PSERC IAB Meeting*, poster session, Atlanta, GA, December 2016.

Professional Service

1. Journal reviewer for *IEEE Transactions on Power Systems*
2. Journal reviewer for *IEEE Transactions on Smart Grid*
3. Journal reviewer for *IEEE Transactions on Sustainable Energy*
4. Journal reviewer for *IEEE Access*
5. Journal reviewer for *IEEE Power and Energy Technology Systems Journal*
6. Journal reviewer for *IET Generation, Transmission & Distribution*
7. Journal reviewer for *IET Renewable Power Generation*
8. Journal reviewer for *International Transactions on Electrical Energy Systems*
9. Reviewer for *IEEE International Conference on Smart Grid Synchronized Measurements and Analytics*

Honors and Awards

2016 1. IEEE Transactions on Smart Grid Best Reviewer Award
2. PSERC IAB Meeting Best Poster Award