Daniel K. Molzahn

Computational Engineer
Argonne National Laboratory
Energy Systems Division

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Education

University of Michigan

2013 Dow Sustainability Fellow, Department of Electrical Engineering and Computer Science
- Supervisor: Dr. Ian Hiskens

University of Wisconsin–Madison

2013 Ph.D. Electrical Engineering (Electric Power Systems)
- Dissertation: *Application of Semidefinite Optimization Techniques to Problems in Electric Power Systems*
- 2014 Harold A. Peterson Best Dissertation Award, Second Place
- Advisor: Dr. Bernard Lesieutre

2012 M.P.A. La Follette School of Public Affairs

2010 M.S. Electrical Engineering
- Thesis: *Power System Models Formulated as Eigenvalue Problems and Properties of Their Solutions*
- Certificate in Energy Analysis and Policy

2008 B.S. Electrical Engineering, Mathematics
- Graduated with Highest Distinction Honors

Experience

2015 – Computational Engineer, Argonne National Laboratory, Energy Systems Division

2013 – 2015 Dow Sustainability Fellow, University of Michigan

2009 – 2013 Research Assistant, University of Wisconsin–Madison

2012 Teaching Assistant (Electric Power Systems), University of Wisconsin–Madison

2008 – 2012 Graduate Fellow, University of Wisconsin–Madison

2008 Ford Motor Company, Sustainable Mobility Technology (Internship)
- Created MATLAB/Simulink models of permanent magnet synchronous motors and control systems for hybrid electric vehicles.

2007 Wisconsin Public Service Corporation, Electric Distribution Engineering (Internship)
- Modeled distributed generators.
- Analyzed distribution systems using SynerGEE load flow software.
- Conducted stray voltage investigations.

2005 – 2007 Wisconsin Public Service Corporation, Information Technology (Internship)
- Developed code in VB.NET for engineering and business applications.
- Designed websites in Dreamweaver.
- Created, modified, and tested reports in Crystal XI and Business Objects XI.

Honors & Awards

2010, 2008 Grainger Power Engineering Award
2009 National Science Foundation Graduate Research Fellowship
2008 Electrical and Computer Engineering Distinguished Fellowship, UW–Madison

Publications

In Review (Monographs)

1. **D.K. Molzahn** and I.A. Hiskens, "A Survey of Relaxations and Approximations of the Power Flow Equations," invited submission to *Foundation and Trends in Electric Power Systems*.

In Review (Journal Articles)

1. M. Yao, **D.K. Molzahn**, and J.L. Mathieu, "A Multiperiod Optimal Power Flow Approach to Improve Power System Voltage Stability Using Demand Response," submitted.
2. **D.K. Molzahn** and J. Wang, "Detection and Characterization of Intrusions to Network Parameter Data in Electric Power System Operations," submitted.

In Review (Conference Proceedings)

1. C. Josz, **D.K. Molzahn**, and S. Sojoudi, "Transient Stability Analysis of Power Systems via Occupation Measures," submitted.

Journal Articles

2018
1. **D.K. Molzahn**, "Identifying and Characterizing Non-Convexities in the Feasible Spaces of Optimal Power Flow Problems," to appear in *IEEE Transactions on Circuits and Systems II: Express Briefs*, presented at *IEEE International Symposium on Circuits and Systems (ISCAS), special session on On-line Identification, Control, & Optimization of Electric Power Systems*, 27-30 May 2018.
2. C. Josz and **D.K. Molzahn**, "Lasserre Hierarchy for Large Scale Polynomial Optimization in Real and Complex Variables," *SIAM Journal on Optimization*, vol. 28, no. 2, pp. 1017-1048, 2018.
3. **D.K. Molzahn**, "Identifying Redundant Flow Limits on Parallel Lines," *IEEE Transactions on Power Systems (Letters)*, vol. 33, no. 3, pp. 1-3, May 2018.
4. O. Coss, J.D. Hauenstein, H. Hong, and **D.K. Molzahn**, "Locating and Counting Equilibria of the Kuramoto Model with Rank One Coupling," *SIAM Journal on Applied Algebra and Geometry*, vol. 2, no. 1, pp. 45-71, 2018.

5. D. Wu, **D.K. Molzahn**, B.C. Lesieutre, and K. Dvijotham, "A Deterministic Method to Identify Multiple Local Extrema for the AC Optimal Power Flow Problem," *IEEE Transactions on Power Systems*, vol. 33, no. 1, pp. 654-668, January 2018.

2017 6. J. Lavaei, S.H. Low, R. Baldick, B. Zhang, **D.K. Molzahn**, F. Dörfler, H. Sandberg, "Guest Editorial: Distributed Control and Efficient Optimization Methods for Smart Grid," *IEEE Transactions on Smart Grid, Special issue on Distributed Control and Efficient Optimization Methods for Smart Grid*, vol. 8, no. 6, pp. 2939-2940, November 2017.

7. **D.K. Molzahn**, F. Dörfler, H. Sandberg, S.H. Low, S. Chakrabarti, R. Baldick, and J. Lavaei, "A Survey of Distributed Optimization and Control Algorithms for Electric Power Systems," *IEEE Transactions on Smart Grid, Special issue on Distributed Control and Efficient Optimization Methods for Smart Grid*, vol. 8, no. 6, pp. 2941-2962, November 2017.

8. **D.K. Molzahn**, "Computing the Feasible Spaces of OPF Problems," *IEEE Transactions on Power Systems*, vol. 32, no. 6, pp. 4752-4763, November 2017.

9. **D.K. Molzahn**, "Incorporating Squirrel-Cage Induction Machine Models in Convex Relaxations of OPF Problems," *IEEE Transactions on Power Systems (Letters)*, vol. 32, no. 6, pp. 4972-4974, November 2017.

10. J.F. Marley, **D.K. Molzahn**, and I.A. Hiskens, "Solving Multiperiod OPF Problems using an AC-QP Algorithm Initialized with an SOCP Relaxation," *IEEE Transactions on Power Systems*, vol. 32, no. 5, pp. 3538-3548, September 2017.

11. **D.K. Molzahn**, C. Josz, I.A. Hiskens, and P. Panciatici, "A Laplacian-Based Approach for Finding Near Globally Optimal Solutions to OPF Problems," *IEEE Transactions on Power Systems*, vol. 32, no. 1, pp. 305-315, January 2017.

2016 12. **D.K. Molzahn** and I.A. Hiskens, "Convex Relaxations of Optimal Power Flow Problems: An Illustrative Example," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 63, no. 5, pp. 650-660, May 2016.

2015 13. **D.K. Molzahn** and I.A. Hiskens, "Sparsity-Exploiting Moment-Based Relaxations of the Optimal Power Flow Problem," *IEEE Transactions on Power Systems*, vol. 30, no. 6, pp. 3168-3180, November 2015.

2014 14. **D.K. Molzahn**, B.C. Lesieutre, and C.L. DeMarco, "Approximate Representation of ZIP Loads in a Semidefinite Relaxation of the OPF Problem," *IEEE Transactions on Power Systems, Letters*, vol. 29, no. 4, pp. 1864-1865, July 2014.

15. **D.K. Molzahn**, B.C. Lesieutre, and C.L. DeMarco, "A Sufficient Condition for Global Optimality of Solutions to the Optimal Power Flow Problem," *IEEE Transactions on Power Systems, Letters*, vol. 29, no. 2, pp. 978-979, March 2014.

2013 16. **D.K. Molzahn**, J.T. Holzer, B.C. Lesieutre, and C.L. DeMarco, "Implementation of a Large-Scale Optimal Power Flow Solver Based on Semidefinite Programming," *IEEE Transactions on Power Systems*, vol. 28, no. 4, pp. 3987-3998, November 2013.

17. **D.K. Molzahn**, B.C. Lesieutre, and C.L. DeMarco, "A Sufficient Condition for Power Flow Insolvability with Applications to Voltage Stability Margins," *IEEE Transactions on Power Systems*, vol. 28, no. 3, pp. 2592-2601, August 2013.

18. **D.K. Molzahn** and B.C. Lesieutre, "Initializing Dynamic Power System Simulations Using Eigenvalue Formulations of the Induction Machine and Power Flow Models," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 60, no. 3, pp. 690–702, March 2013.

19. **D.K. Molzahn**, B.C. Lesieutre, and H. Chen, "Counterexample to a Continuation-Based Algorithm for Finding All Power Flow Solutions," *IEEE Transactions on Power Systems, Letters*, vol. 28, no. 1, pp. 564–565, February 2013.

2011 20. **D.K. Molzahn** and C. Singletary, "An Empirical Investigation of Speculation in the MISO Financial Transmission Rights Auction Market," *The Electricity Journal*, vol. 24, issue 5, pp. 57–68, June 2011.

Conference Proceedings

2018 1. M.R. Narimani, **D.K. Molzahn**, D. Wu, and M.L. Crow, "Empirical Investigation of Non-Convexities in Optimal Power Flow Problems," to appear in *American Control Conference (ACC)*, 27-29 June 2018.

2. **D.K. Molzahn** and L.A. Roald, "Towards an AC Optimal Power Flow Algorithm with Robust Feasibility Guarantees," to appear in *20th Power Systems Computation Conference (PSCC)*, 11-15 June 2018.

3. M.R. Narimani, **D.K. Molzahn**, and M.L. Crow, "Improving QC Relaxations of OPF Problems via Voltage Magnitude Difference Constraints and Envelopes for Trilinear Monomials," to appear in *20th Power Systems Computation Conference (PSCC)*, 11-15 June 2018.

4. S. Misra, **D.K. Molzahn**, and K. Dvijotham, "Optimal Adaptive Approximations of the AC Power Flow Equations," to appear in *20th Power Systems Computation Conference (PSCC)*, 11-15 June 2018.

5. J.A. Kersulis, I.A. Hiskens, C. Coffrin, and **D.K. Molzahn**, "Topological Graph Metrics for Detecting Grid Anomalies and Improving Algorithms," to appear in *20th Power Systems Computation Conference (PSCC)*, 11-15 June 2018.

2017 6. M. Yao, **D.K. Molzahn**, and J.L. Mathieu, "The Impact of Load Models in an Algorithm for Improving Power System Voltage Stability via Demand Response," *55th Annual Allerton Conference on Communication, Control, and Computing*, October 4-6, 2017.

7. L.A. Roald, **D.K. Molzahn**, and A.F. Tobler, "Power System Optimization with Uncertainty and AC Power Flow: Analysis of an Iterative Algorithm," *IREP Symposium on Bulk Power System Dynamics and Control – X. The Power System of the Future: Global Dynamics arising from Distributed Actions*, August 27–September 1, 2017.

8. M. Yao, J.L. Mathieu, and **D.K. Molzahn**, "Using Demand Response to Improve Power System Voltage Stability Margins," *IEEE PowerTech Manchester*, 18-22 June 2017.
High-quality paper award.

2016 9. K. Dvijotham and **D.K. Molzahn**, "Error Bounds on the DC Power Flow Approximation: A Convex Relaxation Approach," *IEEE 55th Annual Conference on Decision and Control (CDC)*, 12-14 December 2016.

10. **D.K. Molzahn**, C. Josz, and I.A. Hiskens, "Moment Relaxations of Optimal Power Flow Problems: Beyond the Convex Hull," *IEEE Global Conference on Signal and Information Processing (GlobalSIP)*, 7-9 December 2016.

11. **D.K. Molzahn**, D. Mehta, and M. Niemerg, "Toward Topologically Based Upper Bounds on the Number of Power Flow Solutions," *American Control Conference (ACC)*, 6-8 July 2016.
Best presentation in session award.

12. D. Mehta, **D.K. Molzahn**, K. Turitsyn, "Recent Advances in Computational Methods for the Power Flow Equations," *American Control Conference (ACC)*, 6-8 July 2016.

13. **D.K. Molzahn**, C. Josz, I.A. Hiskens, and P. Panciatici, "Computational Advances for Sparsity-Exploiting Moment Relaxations of the OPF Problem," *19th Power Systems Computation Conference (PSCC)*, 20-24 June 2016.
14. **D.K. Molzahn**, I.A. Hiskens, and B.C. Lesieutre, "Calculation of Voltage Stability Margins and Certification of Power Flow Insolvability using Second-Order Cone Programming," *49th Hawaii International Conference on System Sciences (HICSS)*, 5-8 January 2016.

2015
15. **D.K. Molzahn**, C. Josz, I.A. Hiskens, and P. Panciatici, "Solution of Optimal Power Flow Problems using Moment Relaxations Augmented with Objective Function Penalization," *IEEE 54th Annual Conference on Decision and Control (CDC)*, 15-18 December 2015.
16. **D.K. Molzahn**, Z.B. Friedman, B.C. Lesieutre, C.L. DeMarco, and M.C. Ferris, "Estimation of Constraint Parameters in Optimal Power Flow Data Sets," *47th North American Power Symposium (NAPS)*, 4-6 October 2015.
17. **D.K. Molzahn** and I.A. Hiskens, "Mixed SDP/SOCP Moment Relaxations of the Optimal Power Flow Problem," *IEEE PowerTech Eindhoven*, 29 June–2 July, 2015.
18. **D.K. Molzahn**, S.S. Baghsorkhi, and I.A. Hiskens, "Semidefinite Relaxations of Equivalent Optimal Power Flow Problems: An Illustrative Example," *2015 IEEE International Symposium on Circuits and Systems (ISCAS)*, 24-27 May 2015.

2014
19. P. Panciatici, M.C. Campi, S. Garatti, S.H. Low, **D.K. Molzahn**, A.X. Sun, L. Wehenkel, "Advanced Optimization Methods for Power Systems," *18th Power Systems Computation Conference (PSCC)*, 18-22 August 2014.
20. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxation of the Optimal Power Flow Problem," *18th Power Systems Computation Conference (PSCC)*, 18-22 August 2014.
21. **D.K. Molzahn**, B.C. Lesieutre, and C.L. DeMarco, "Investigation of Non-Zero Duality Gap Solutions to a Semidefinite Relaxation of the Optimal Power Flow Problem," *47th Hawaii International Conference on System Sciences (HICSS), 2014*, 6-9 January 2014.

2013
22. A.R. Borden, **D.K. Molzahn**, B.C. Lesieutre, and P. Ramanathan, "Power System Structure and Confidentiality Preserving Transformation of Optimal Power Flow Model," *51st Annual Allerton Conference on Communication, Control, and Computing (Allerton), 2013*, 2-4 October 2013.
23. **D.K. Molzahn**, V. Dawar, B.C. Lesieutre, and C.L. DeMarco, "Sufficient Conditions for Power Flow Insolvability Considering Reactive Power Limited Generators with Applications to Voltage Stability Margins," *IREP Symposium on Bulk Power System Dynamics and Control – IX. Optimization, Security, and Control of the Emerging Power Grid*, 25-30 August 2013.

2012
24. A.R. Borden, **D.K. Molzahn**, P. Ramanathan, and B.C. Lesieutre, "Confidentiality-Preserving Optimal Power Flow for Cloud Computing," *50th Annual Allerton Conference on Communication, Control, and Computing (Allerton), 2012*, pp. 1300-1307, 1-5 October 2012.

2011
25. B.C. Lesieutre, **D.K. Molzahn**, A.R. Borden, and C.L. DeMarco, "Examining the Limits of the Application of Semidefinite Programming to Power Flow Problems," in *49th Annual Allerton Conference on Communication, Control, and Computing (Allerton), 2011*, pp. 1492-1499, 28-30 September 2011.
26. D.R. Schwarting, **D.K. Molzahn**, C.L. DeMarco, and B.C. Lesieutre, "Topological and Impedance Element Ranking (TIER) of the Bulk-Power System," *44th Hawaii International Conference on System Sciences (HICSS), 2011*, pp. 1-10, 4-7 January 2011.

2010 27. **D.K. Molzahn** and B.C. Lesieutre, "An Eigenvalue Formulation for Determining Initial Conditions of Induction Machines in Dynamic Power System Simulations," *2010 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 2311-2313, 30 May–2 June 2010.

Other Conference and Workshop Presentations

2018 1. **D.K. Molzahn**, H. Hijazi, and C. Josz, "Quickly Certifying Global Optimality of a Candidate Optimal Power Flow Solution using a Moment Relaxation Hierarchy," *Power Systems: Semi-Algebraic Techniques for Optimal Power Flow and Stability Assessment*, Paris, France, 16-17 January 2018.

2017 2. **D.K. Molzahn** and L.A. Roald, "AC Optimal Power Flow with Robust Feasibility Guarantees," *Georgia Tech Workshop on Electric Energy Systems and Operations Research*, Atlanta, GA, 9-10 November 2017.

3. **D.K. Molzahn** and K. Dvijotham, "Error Bounds on Power Flow Linearizations: A Convex Relaxation Approach," *INFORMS Annual Meeting 2017*, Houston, TX, 22-25 October 2017.

4. **D.K. Molzahn**, M. Yao, and J.L. Mathieu, "A Multi-Period OPF Approach to Improve Voltage Stability using Demand Response," *INFORMS Annual Meeting 2017*, Houston, TX, 22-25 October 2017.

5. **D.K. Molzahn**, "Characterizing Non-Convexities in the Feasible Spaces of AC OPF Problems," *INFORMS Annual Meeting 2017*, Houston, TX, 22-25 October 2017.

6. O. Coss, J.D. Hauenstein, H. Hong, and **D.K. Molzahn**, "Finding & Counting Equilibria of the Kuramoto Model for Coupled Oscillators," *SIAM Conference on Applied Algebraic Geometry*, Atlanta, GA, 31 July–4 August, 2017.

7. **D.K. Molzahn**, C. Josz, I.A. Hiskens, and P. Panciatici, "A Laplacian-Based Approach for Finding Near Globally Optimal Solutions to OPF Problems," *IEEE Power and Energy Society General Meeting, Transactions Paper Session*, Chicago, IL, 19 July 2017.

8. **D.K. Molzahn**, J.L. Mathieu, and M. Yao, "Power System Voltage Stability using Demand Response," *Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software (Docket No. AD10-12-008)*, Federal Energy Regulatory Commission, Washington, DC, 26-28 June 2017.

9. **D.K. Molzahn** and K. Dvijotham, "Error Bounds on Power Flow Linearizations: A Convex Relaxation Approach," *Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software (Docket No. AD10-12-007)*, Federal Energy Regulatory Commission, Washington, DC, 26-28 June 2017.

10. **D.K. Molzahn**, "A Tutorial on Convex Relaxations of the Power Flow Equations," *Modern Challenges in Power System Operation and Electricity Market: An Optimization Perspective*, DTU Summer School, Copenhagen, Denmark, 12-16 June, 2017.

11. **D.K. Molzahn** and K. Dvijotham, "Error Bounds on Power Flow Linearizations: A Convex Relaxation Approach," *Banff International Research Station, Workshop on Optimization and Inference for Physical Flows on Networks (17w5165)*, 7 March 2017.

12. **D.K. Molzahn**, D. Wu, B.C. Lesieutre, and K. Dvijotham, "Computing Multiple Local Optima for OPF Problems using an Elliptical Tracing Algorithm," *INFORMS Computing Society Conference (ICS)*, Austin, TX, 15-17 January 2017.

13. **D.K. Molzahn** and K. Dvijotham, "Error Bounds on Power Flow Linearizations: A Convex Relaxation Approach," *Los Alamos National Laboratory Center for Nonlinear Studies, Grid Science Winter School and Conference*, Santa Fe, NM, 12-13 January 2017.

2016 14. **D.K. Molzahn**, "Visualizing The Feasible Spaces of Optimal Power Flow Problems and Their Convex Relaxations," *INFORMS Annual Meeting 2016*, Nashville, TN, 13-16 November 2016.

15. J.-C. Gilbert, C. Josz, and **D.K. Molzahn**, "Plea for a Semidefinite Optimization Solver in Complex Numbers," *14th EUROPT Workshop on Advances in Continuous Optimization*, Warsaw, Poland, 1-2 July 2016.

16. **D.K. Molzahn**, "Visualizing the Feasible Spaces of Challenging OPF Problems," *Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software (Docket No. AD10-12-007)*, Federal Energy Regulatory Commission, Washington, DC, 27-29 June 2016.

17. C. Josz and **D.K. Molzahn**, "Moment/Sum-of-Squares Hierarchy for Complex Polynomial Optimization," *INFORMS International*, Waikoloa Village, HI, 12-15 June 2016.

18. **D.K. Molzahn**, F. Qiu, and J. Wang, "Optimization of Electric Power Systems: Considering Uncertainty and Non-Convexity," Poster presentation at *Argonne National Laboratory Grid Day*, Lemont, IL, 18 April 2016.

2015 19. **D.K. Molzahn** and I.A. Hiskens, "Computational Advances for Moment Relaxations of Optimal Power Flow Problems," *INFORMS Annual Meeting 2015*, Philadelphia, PA, 1-4 November 2015.

20. **D.K. Molzahn**, I.A. Hiskens, and B.C. Lesieutre, "Calculation of Voltage Stability Margins and Certification of Power Flow Insolvability using Convex Relaxations," *INFORMS Annual Meeting 2015*, Philadelphia, PA, 1-4 November 2015.

21. **D.K. Molzahn** and I.A. Hiskens, "Sparsity-Exploiting Moment Relaxations of Optimal Power Flow Problems," *22nd International Symposium on Mathematical Programming*, Pittsburgh, PA, 12-17 July 2015.

22. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of the Optimal Power Flow Problem," *SIAM Conference on Computational Science and Engineering*, Salt Lake City, UT, 14-18 March 2015.

2014 23. **D.K. Molzahn** and I.A. Hiskens, "Convex Optimization of Electric Power Systems," *Dow Sustainability Fellows Symposium*, poster session, Ann Arbor, MI, 15 November 2014.

24. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of Optimal Power Flow Problems," *INFORMS Annual Meeting 2014*, San Francisco, CA, 9-12 November 2014.

25. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of Optimal Power Flow Problems," *Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software (Docket No. AD10-12-005)*, Federal Energy Regulatory Commission, Washington, DC, 23-25 June 2014.

26. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxation of the Optimal Power Flow Problem," *IBM and RTE Workshop on Convexification of the AC Optimal Power Flow Problem*, Dublin, Ireland, 23 April 2014.

2013 27. **D.K. Molzahn**, B.C. Lesieutre, C.L. DeMarco, and M.C. Ferris, "Application of Semidefinite Programming to Large-Scale Optimal Power Flow Problems," *Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software (Docket No. AD10-12-004)*, Federal Energy Regulatory Commission, Washington, DC, 24-26 June 2013.

28. M.C. Ferris, Z.B. Friedman, **D.K. Molzahn**, C.L. DeMarco, and B.C. Lesieutre, "ACOPF Models: Extending Data, Formulations, and Solution Methodology," *Staff Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software (Docket No. AD10-12-004)*, Federal Energy Regulatory Commission, Washington, DC, 24-26 June 2013.
29. B.C. Lesieutre, **D.K. Molzahn**, and C.L. DeMarco, "Advanced Optimization Tools for OPF Formulations in Power Markets," *Power Systems Engineering Research Center (PSERC) Industry-University Meeting, 2013*, Madison, WI, 29-31 May 2013.

Technical Reports

2016 1. **D.K. Molzahn**, "A Survey of Distributed Optimization Algorithms for Optimal Power Flow Problems," Grid Modernization Initiative, Grid Architecture Project, November 2016.
2. S. Backhaus, K. Kalsi, S. Misra, **D.K. Molzahn**, J. Lian, E. Dall'Anese, M. Vuffray, S. Kundu, and K. Baker, "Grid Modernization Initiative Project 1.4.10 Control Theory Project Road Map," October 2016.
3. **D.K. Molzahn**, M. Niemerg, D. Mehta, and J.D. Hauenstein, "Investigating the Maximum Number of Real Solutions to the Power Flow Equations: Analysis of Lossless Four-Bus Systems," *arXiv:1603.05908*, March 2016.

2014 4. B.C. Lesieutre and **D.K. Molzahn**, "Optimization and Control of Electric Power Systems," *Final Technical Report, DOE Grant #DE-SC0002319*, 17 October 2014.

2012 5. B.C. Lesieutre, C.L. DeMarco, and **D.K. Molzahn**, "Power System Deliverability Ranking of Critical Elements to Support Select Facilities," *Report to the Federal Energy Regulatory Commission (not publicly available)*, January 2012.
6. B.C. Lesieutre, C.L. DeMarco, and **D.K. Molzahn**, "Power System Ranking of Nodal Locations," *Report to the Federal Energy Regulatory Commission (not publicly available)*, January 2012.

2010 7. **D.K. Molzahn**, S.P. Williams, and R. Srinivasan, "Plug-In Vehicles in Madison, WI: Consumer Preferences, Charging Stations, and Distribution System Impacts," *Energy Analysis and Policy Capstone Project Report to Madison Gas and Electric (not publicly available)*, 2010.

Invited Seminars

2018 1. **D.K. Molzahn**, "Optimal Power Flow with Robust Feasibility Guarantees," *Argonne National Laboratory, Laboratory Directed Research and Development (LDRD) Seminar*, 17 April 2018.
2. **D.K. Molzahn**, "Characterizing Non-Convexities in the Feasible Spaces of OPF Problems and an Algorithm for Finding Multiple Local Optima," *Los Alamos National Laboratory, Center for Nonlinear Studies*, 26 March 2018.
3. **D.K. Molzahn**, "Recent Research in Power System Optimization: Feasible Space Computation and Approximation Error Quantification," *Boston University, Center for Information and Systems Engineering*, 23 February 2018.
4. **D.K. Molzahn**, "Recent Research in Power System Optimization: Feasible Space Computation and Approximation Error Quantification," *Massachusetts Institute of Technology*, 22 February 2018.

2017 5. **D.K. Molzahn**, "Recent Research in Power System Optimization: Approximation Error Quantification, Feasible Space Computation, and Convex Relaxations," *Northwestern University*, 30 November 2017.

6. **D.K. Molzahn** and L.A. Roald, "Recent Progress in Optimal Power Flow: A Survey of Convex Relaxations and an Algorithm for Robust Feasibility," *Argonne National Laboratory, Mathematics and Computer Science Division*, 16 November 2017.
7. **D.K. Molzahn**, "Recent Research in Power System Optimization: Approximation Error Quantification, Feasible Space Computation, and Convex Relaxations," *Purdue University*, 19 October 2017.
8. **D.K. Molzahn**, "Recent Research in Power System Optimization: Approximation Error Quantification, Feasible Space Computation, and Convex Relaxations," *University of Aalborg*, 16 June 2017.
9. **D.K. Molzahn**, "Recent Research in Power System Optimization: Approximation Error Quantification, Feasible Space Computation, and Convex Relaxations," *University of California, Berkeley*, 3 May 2017.
10. **D.K. Molzahn**, "Recent Research in Optimization of Electric Power Systems and Implications for Electricity Markets," *Energy Policy Institute at the University of Chicago (EPIC)*, 21 February 2017.

2016 11. **D.K. Molzahn**, "Moment Relaxations of Optimal Power Flow Problems," *Seminar at the Missouri University of Science and Technology*, 4 October 2016.

12. **D.K. Molzahn**, "Recent Developments in Moment Relaxations of Optimal Power Flow Problems," *Seminar at Columbia University*, 9 May 2016.
13. **D.K. Molzahn**, "Moment Relaxations of Optimal Power Flow Problems," *Seminar at Argonne National Laboratory*, 22 January 2016.

2015 14. **D.K. Molzahn**, "Computational Advances for Moment Relaxations of Optimal Power Flow Problems," *Seminar at the University of Wisconsin–Madison*, 18 September 2015.

15. **D.K. Molzahn** and I.A. Hiskens, "Computational Advances for Moment Relaxations of Optimal Power Flow Problems," *Seminar at Réseau de transport d'électricité (RTE)*, 23 June 2015.
16. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of the Optimal Power Flow Problem," *Seminar at ETH Zürich*, 8 June 2015.
17. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of the Optimal Power Flow Problem," *Seminar at the University of Notre Dame*, 16 April 2015.
18. **D.K. Molzahn** and I.A. Hiskens, "Optimization of Electric Power Systems," *University of Michigan Dow Sustainability Seminar*, 26 February 2015.
19. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of the Optimal Power Flow Problem," *Seminar at the University of Illinois at Urbana-Champaign*, 2 February 2015.

2014 20. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxations of the Optimal Power Flow Problem," *Seminar at the University of California, Berkeley*, 6 November 2014.

21. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxation of the Optimal Power Flow Problem," *Seminar at Argonne National Laboratory*, 12 May 2014.
22. **D.K. Molzahn** and I.A. Hiskens, "Moment-Based Relaxation of the Optimal Power Flow Problem," *Seminar at the University of Wisconsin–Madison*, 10 April 2014.
23. **D.K. Molzahn**, I.A. Hiskens, B.C. Lesieutre, and C.L. DeMarco, "Optimization and Other Research Topics in Electric Power Systems," *University of Michigan Dow Sustainability Seminar*, 17 February 2014.

24. **D.K. Molzahn**, I.A. Hiskens, B.C. Lesieutre, and C.L. DeMarco, "Application of Semidefinite Optimization Techniques to the Optimal Power Flow Problem," *Seminar at Texas A&M*, 20 January 2014.

2013 25. **D.K. Molzahn**, I.A. Hiskens, B.C. Lesieutre, and C.L. DeMarco, "Application of Semidefinite Optimization Techniques to the Optimal Power Flow Problem," *Seminar at Los Alamos National Laboratory*, 30 October 2013.

26. B.C. Lesieutre and **D.K. Molzahn**, "A New Method for Estimating Maximum Power Transfer and Voltage Stability Margins to Mitigate the Risk of Voltage Collapse," *PSERC Webinar*, 15 October 2013.

27. **D.K. Molzahn**, "Research Topics in Electric Power Systems Engineering," *University of Michigan Undergraduate Research Opportunity Program (UROP) Seminar*, 8 October 2013.

28. **D.K. Molzahn**, B.C. Lesieutre, and C.L. DeMarco, "Training on the TIER Methods for Ranking Transmission System Facilities," *Federal Energy Regulatory Commission Training Session*, 18-20 June 2013.

Software Packages

2013 1. **D.K. Molzahn**, "`SDP_PF`: Implementation of Applications for a Semidefinite Programming Relaxation of the Power Flow Equations."

A package of MATLAB code integrated with MATPOWER that implements the semidefinite programming relaxation of the optimal power flow problem for large-scale systems, a sufficient condition for global optimality of an optimal power flow solution, a power flow insolvability condition (including the possibility of generator reactive power limits), and voltage stability margins. *Available in the current version of the* MATPOWER *distribution:* http://www.pserc.cornell.edu/matpower/

Research Grants

2016 1. Department of Energy, Grid Modernization Laboratory Consortium (GMLC), "Control Theory Enabling the Deployment of Huge Numbers of Distributed Energy Resources," Co-I and Argonne Lead (Argonne portion: $585,000 over three years)

2. Department of Energy, Advanced Research Projects Agency–Energy (ARPA-E), "EPIGRIDS: Electric Power Infrastructure & Grid Representation in Interoperable Data Sets," Co-I and Argonne Lead (Argonne portion: $324,900 over two years)

3. Laboratory Directed Research and Development (LDRD) SEED Project, "Enhancing Computational Tools for Polynomial Optimization Problems Relevant to Networked Systems," PI ($25,000 for one year)

Professional Service

1. Vice-chair of the Technical Program Committee for the *Power Systems Computation Conference* (2020). Previously served as a member of the technical program committee (2016, 2018), reviewer, and session chair for this conference.

2. Panel member for review of National Science Foundation grant proposals

3. Member of *IEEE Task Force on Benchmarks for Emerging Power System Algorithms*

4. Guest associate editor (special issue on distributed control and optimization) and reviewer for *IEEE Transactions on Smart Grid*. Included on list of "Best Reviewers" in 2017.

5. Technical Program Committee member for *IEEE Global Conference on Signal and Information Processing*
6. Technical Program Committee member for *Intelligent System Applications to Power Systems*
7. Tutorial session co-organizer and reviewer for *American Control Conference*
8. Session organizer for *Modeling and Optimization: Theory and Applications (MOPTA)*
9. Session chair and reviewer for *IEEE PowerTech Conference*
10. Session chair for *North American Power Symposium*
11. Poster judge for *Postdoctoral Research and Career Symposium, Argonne National Laboratory*
12. Journal reviewer for *IEEE Transactions on Power Systems*
13. Journal reviewer for *IEEE Transactions on Automatic Control*
14. Journal reviewer for *IEEE Transactions on Control of Network Systems*
15. Journal reviewer for *IEEE Transactions on Network Science and Engineering*
16. Journal reviewer for *International Journal of Electrical Power and Energy Systems*
17. Journal reviewer for *IET Generation, Transmission & Distribution*
18. Journal reviewer for *Journal of Modern Power Systems and Clean Energy*
19. Journal reviewer for *Sustainable Energy, Grids and Networks*
20. Journal reviewer for *Electric Power Systems Research*
21. Journal reviewer for *Electric Power Components and Systems*
22. Journal reviewer for *Mathematical Programming*
23. Journal reviewer for *Optimization Methods and Software*
24. Journal reviewer for *Automatica*
25. Journal reviewer for *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*
26. Journal reviewer for *EURASIP Journal on Advances in Signal Processing*
27. Reviewer for *IEEE Conference on Decision and Control*
28. Reviewer for *IEEE Multiconference on Systems and Control*
29. Reviewer for *IEEE Power and Energy Society General Meeting*
30. Reviewer for *IEEE International Symposium on Circuits and Systems*
31. Reviewer for *Mediterranean Conference on Control and Automation*
32. Reviewer for *Intelligent System Applications to Power Systems Conference*
33. Reviewer for *Mediterranean Conference on Control and Automation*

Advised / Co-Advised Students

2017 1. Wesley Chan, Northwestern University, undergraduate student

2016 2. Alireza Barzegar, Nanyang Technological University, doctoral student with Prof. Su Rong
3. Mohammad Rasoul Narimani, Missouri University of Science and Technology, doctoral student with Prof. Mariesa Crow
4. Aldo Tobler, ETH Zürich, masters student with Dr. Line Roald

Joint Appointments

1. Adjunct Professor, Missouri University of Science and Technology, Electrical and Computer Engineering Department

Memberships in Professional Organizations

1. Institute of Electrical and Electronics Engineers
2. INFORMS (Optimization Society)
3. Tau Beta Pi Engineering Honor Society
4. Eta Kappa Nu Electrical and Computer Engineering Honor Society