

**IAN DOBSON**

Professor

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US citizen

- Education**
- PhD in Electrical Engineering 1989, Cornell University, Ithaca, NY.
  - Bachelor of Arts in Mathematics 1978, Cambridge University, England.
- Work**
- Professor  
Electrical and Computer Engineering Department,  
Iowa State University.
  - Faculty (Assistant Prof. 1989, Associate Prof. 1994, Professor 1999)  
Electrical and Computer Engineering Department,  
University of Wisconsin-Madison 1989-2011.
  - Graduate Research Assistant, Cornell University, 1984-1989.  
PhD thesis: Describing fractal basin boundaries in a forced oscillator.
  - Consultant to Transonic Systems Inc., Ithaca NY, 1987-1988.  
Advised on theory of a laser doppler blood flow meter.
  - Systems analyst EASAMS Ltd., Frimley, Surrey, England, 1978-1983.  
Simulation and modeling of airborne weapon systems.  
Devised and implemented an original and general switching circuit simulation to analyse transients in transformer-rectifier and other high voltage switching power supplies. This work was done at Culham Laboratory on contract to the United Kingdom Atomic Energy Authority. Planning, technical control and marketing of contracts.  
Promoted to Intermediate and Senior 2 positions.
- Awards**
- NSF Initiation Grant
  - NSF Presidential Young Investigator
  - Fellow IEEE, 2006
  - Sandbulte Professor 2011-2021

### Some research highlights

- Explaining how voltages fall in voltage collapse blackouts using nonlinear dynamics.
- Inventing algorithms to find the closest voltage collapse blackout, and select controls to avoid blackouts. These algorithms appear in textbooks and commercial software used to operate power grids. More generally in nonlinear science, the same algorithms apply to closeness to bifurcation instabilities, and have been applied by others to a variety of problems in chemical engineering, mechanical engineering and biology.
- Data shows heavy tails in the probability of large blackouts. I worked with physicists to explain this as the power grid self-organizing itself to near a critical point. Our simulations of power grid upgrade and failure can reproduce the observed data. This is an advance in complex systems science and engineering.
- I devised several high-level probabilistic models of cascading failure that can help explain complicated series of failures in large blackouts. So far, the models match observed data. This is an advance in a challenging problem in risk analysis.
- I devised new ways to extract statistics from detailed electric utility outage data. These statistics describe how much cascading outages propagate in the grid and disentangle outage and restore processes in blackouts caused by extreme weather.
- New instrumentation called synchrophasors is being deployed to monitor power grids. I had a breakthrough in circuit theory that allows synchrophasor measurements to be easily combined to monitor events in specific regions of the power grid.
- Co-inventing a modulator for a soft switching power electronic convertor. This is a patented, licensed, and manufactured invention that generalizes to power electronics work in communication systems on one dimensional sigma-delta modulators. We analyzed the spectrum (noise performance) using ergodic theory from nonlinear dynamics. (I was happy to apply this theory to engineering since it is a fun fact that my academic great-great-grandfather is the mathematician G.D. Birkhoff who invented ergodic theory!)
- Analyzing resonances and jumps of switching times in high power switching devices using nonlinear dynamics.
- Citations: h index of 64 and total citations 16400 (Google Scholar)

**Journal publications: Phasor measurements for smart grid**

- [1] I. Dobson, Voltages across an area of a network, *IEEE Transactions on Power Systems*, vol. 27, no. 2, May 2012, pp. 993-1002.
- [2] H. Sehwal, I. Dobson, Applying synchrophasor computations to a specific area, *IEEE Transactions on Power Systems*, vol. 28, no. 3, August 2013, pp. 3503-3504.
- [3] A. Darvishi, I. Dobson, Threshold-based monitoring of multiple outages with PMU measurements of area angle, *IEEE Transactions on Power Systems*, vol. 31, no. 3, May 2016, pp. 2116-2124.
- [4] C.D. Vournas, L. Ramirez, I. Dobson, On two-bus equivalents of transmission corridors, *IEEE Transactions on Power Systems*, vol. 31, no. 3, May 2016, pp. 2497-2498.
- [5] S. Mendoza-Armenta, I. Dobson, Applying a formula for generator redispatch to damp interarea oscillations using synchrophasors, *IEEE Transactions on Power Systems*, vol. 31, no. 4, July 2016, pp. 3119-3128.
- [6] W. Ju, I. Dobson, K. Martin, K. Sun, N. Nayak, I. Singh, H. Silva-Saravia, A. Faris, L. Zhang, Y. Wang, Real-time area angle monitoring using synchrophasors: a practical framework and utility deployment, *IEEE Transactions on Smart Grid*, vol. 12, no. 1, January 2021, pp. 859-870.

**Journal publications: Complex Systems and Risk of Blackouts**

- [7] B.A. Carreras, V.E. Lynch, I. Dobson, D.E. Newman, Critical points and transitions in an electric power transmission model for cascading failure blackouts, *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 12, no. 4, December 2002, pp. 985-994.  
*Discovery of critical loading phenomena in which blackout risk sharply increases in a power system model of cascading line overloads.*  
>480 citations in google scholar
- [8] B.A. Carreras, D.E. Newman, I. Dobson, A.B. Poole, Evidence for self-organized criticality in a time series of electric power system blackouts, *IEEE Transactions on Circuits and Systems, Part 1*, vol. 51, no. 9, September 2004, pp. 1733-1740.  
*Analyzes historical North American blackout distribution and suggests complex system explanation for this observed data.*  
>400 citations in google scholar
- [9] B.A. Carreras, V.E. Lynch, I. Dobson, D.E. Newman, Complex dynamics of blackouts in power transmission systems, *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 14, no. 3, September 2004, pp. 643-652.  
*Opposing forces of increasing load and the engineering upgrades in response to blackouts can self-organize the network to near a critical point. Uses a power system model of cascading line overloads on a slowly evolving network.*
- [10] D.P. Nedic, I. Dobson, D.S. Kirschen, B.A. Carreras, V.E. Lynch, Criticality in a cascading failure blackout model, *International Journal of Electrical Power and Energy Systems*, vol 28, 2006, pp 627-633.
- [11] I. Dobson, B.A. Carreras, V.E. Lynch, D.E. Newman, Complex systems analysis of series of blackouts: cascading failure, critical points, and self-organization, *Chaos:*

*An Interdisciplinary Journal of Nonlinear Science*, vol. 17, 026103, June 2007  
>700 citations in google scholar

- [12] H. Ren, I. Dobson, B.A. Carreras, Long-term effect of the n-1 criterion on cascading line outages in an evolving power transmission grid, *IEEE Transactions on Power Systems*, vol. 23, no. 3, August 2008, pp. 1217 - 1225.
- [13] B. A. Carreras, D. E. Newman, I. Dobson, M. Zeidenberg, The impact of risk-averse operation on the likelihood of extreme events in a simple model of infrastructure, *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 19, no. 4, 043107, October 2009 (8 pages).
- [14] D.E. Newman, B.A. Carreras, V.E. Lynch, I. Dobson, Exploring complex systems aspects of blackout risk and mitigation, *IEEE Transactions on Reliability*, vol. 60, no. 1, March 2011, pp. 134-143.
- [15] C.D. Brummitt, P.D.H. Hines, I. Dobson, C. Moore, R.M. D'Souza, Transdisciplinary electric power grid science, opinion piece, Proceedings of the National Academy of Sciences, vol 110, no. 30, July 2013, p. 12159.
- [16] B.A. Carreras, D.E. Newman, I. Dobson, Does size matter?, *Chaos, An Interdisciplinary Journal of Nonlinear Science*, vol. 24, 023104, 2014.
- [17] J. M. Reynolds-Barredo, D.E. Newman, B.A. Carreras, I. Dobson, The interplay of network structure and dispatch solutions in power grid cascading failures, *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 26, no. 11, 113111, 2016
- [18] B.A. Carreras, J. M. Reynolds-Barredo, I. Dobson, D.E. Newman, Critical behavior of power transmission network complex dynamics in the OPA model, *Chaos: An Interdisciplinary Journal of Nonlinear Science*, vol. 29, 033103, March 2019

### Journal publications: Cascading Failure and Risk of Blackouts

- [19] I. Dobson, B.A. Carreras, D.E. Newman, A loading-dependent model of probabilistic cascading failure, *Probability in the Engineering and Informational Sciences*, vol. 19, no. 1, January 2005, pp. 15-32.  
*An analytically solvable model for cascading failure.*
- [20] J. Chen, J.S. Thorp, I. Dobson, Cascading dynamics and mitigation assessment in power system disturbances via a hidden failure model, *International Journal of Electrical Power and Energy Systems*, vol. 27, no. 4, May 2005, pp. 318-326.  
>500 citations in google scholar
- [21] I. Dobson, B.A. Carreras, V.E. Lynch, B. Nkei, D.E. Newman, Estimating failure propagation in models of cascading blackouts, *Probability in the Engineering and Informational Sciences*, vol 19, no 4, October 2005, pp 475-488.
- [22] M. Begovic, J-M. Gagnon, P. Gomes, W. Lachs, C-C. Liu, V. Madani, D. Novosel, G. Trudel, M. Amin, H. Clark, I. Dobson, P. Donalek, P. Grondin, L. Wehenkel, Defense Plan Against Extreme Contingencies - CIGRE Task Force C2.02.24, Summary of Technical Brochure No. 316, *Electra*, vol. 231, April 2007.

- [23] H. Ren, I. Dobson, Using transmission line outage data to estimate cascading failure propagation in an electric power system, *IEEE Transactions on Circuits and Systems Part II*, vol. 55, no. 9, Sept. 2008, pp. 927-931.
- [24] D.L. Turcotte, S.G. Abaimov, I. Dobson, J.B. Rundle, Implications of an inverse branching aftershock sequence model, *Physical Review E*, vol. 79, no. 1, 016101, 2009 (8 pages).
- [25] I. Dobson, J. Kim, K.R. Wierzbicki, Testing branching process estimators of cascading failure with data from a simulation of transmission line outages, *Risk Analysis*, vol. 30, no. 4, April 2010, pp. 650-662.
- [26] J. Kim, I. Dobson, Approximating a loading-dependent cascading failure model with a branching process, *IEEE Transactions on Reliability*, vol. 59, no. 4, December 2010, pp. 691-699.
- [27] N. Romero, N. Xu, L. K. Nozick, I. Dobson, D. Jones, Investment planning for electric power systems under terrorist threat, *IEEE Transactions on Power Systems*, vol. 27, no. 1, February 2012, pp. 108-116.
- [28] M. Vaiman, K. Bell, Y. Chen, B. Chowdhury, I. Dobson, P. Hines, M. Papic, S. Miller, P. Zhang, Risk assessment of cascading outages: methodologies and challenges, *IEEE Transactions on Power Systems*, vol. 27, no. 2, May 2012, pp. 631-641.
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- [30] H. Wu, I. Dobson, Cascading stall of many induction motors in a simple system, *IEEE Transactions on Power Systems*, vol. 27, no. 4, Nov. 2012, pp. 2116-2126.
- [31] I. Dobson, Estimating the propagation and extent of cascading line outages from utility data with a branching process, *IEEE Transactions on Power Systems*, vol. 27, no. 4, November 2012, pp. 2146-2155.
- [32] J. Kim, J.A. Bucklew, I. Dobson, Splitting method for speedy simulation of cascading blackouts, *IEEE Transactions on Power Systems*, vol. 28, no. 3, August 2013, pp. 3010-3017.
- [33] I. Dobson, B.A. Carreras, D.E. Newman, How many occurrences of rare blackout events are needed to estimate event probability?, *IEEE Transactions on Power Systems*, vol. 28, no. 3, August 2013, pp. 3509-3510.
- [34] J. Qi, I. Dobson, S. Mei, Towards estimating the statistics of simulated cascades of outages with branching processes, *IEEE Transactions on Power Systems*, vol. 28, no. 3, August 2013, pp. 3410-3419.
- [35] H. Wu, I. Dobson, Analysis of induction motor cascading stall in a simple system based on the CASCADE model, *IEEE Transactions on Power Systems*, vol. 28, no. 3, August 2013, pp. 3184-3193.
- [36] N. Romero, L.K. Nozick, I. Dobson, N. Xu, D.A. Jones, Transmission and generation expansion to mitigate seismic risk, *IEEE Transactions on Power Systems*, vol. 28, no. 4, November 2013, pp. 3692-3701.

- [37] N. Romero, L.K. Nozick, I. Dobson, N. Xu, D.A. Jones, Seismic retrofit for electric power systems, *Earthquake Spectra*, vol. 31, no. 2, May 2015, pp. 1157-1176.
- [38] B.A. Carreras, D.E. Newman, I. Dobson, North American blackout time series statistics and implications for blackout risk, *IEEE Transactions on Power Systems*, vol. 31, no. 6, November 2016, pp. 4406-4414.
- [39] IEEE Working Group on understanding, prediction, mitigation and restoration of cascading failures, Benchmarking and validation of cascading failure analysis tools, *IEEE Transactions on Power Systems*, vol. 31, no. 6, November 2016, pp. 4887 - 4900.
- [40] I. Dobson, B.A. Carreras, D.E. Newman, J.M. Reynolds-Barredo, Obtaining statistics of cascading line outages spreading in an electric transmission network from standard utility data, *IEEE Transactions on Power Systems*, vol. 31, no. 6, November 2016, pp. 4831-4841.
- [41] I. Dobson, Electricity grid: When the lights go out, New and Views article in *Nature Energy*, no. 16059, April 2016.
- [42] P.D.H. Hines, I. Dobson, P. Rezaei, Cascading power outages propagate locally in an influence graph that is not the actual grid topology, *IEEE Transactions on Power Systems*, vol. 32, no. 2, March 2017, pp. 958-967.
- [43] I. Dobson, D.E. Newman, Cascading blackout overall structure and some implications for sampling and mitigation, *International Journal of Electrical Power and Energy Systems*, vol. 86, March 2017, pp. 29-32.
- [44] K. Zhou, I. Dobson, Z. Wang, A. Roitershtein, A. P. Ghosh, A Markovian influence graph formed from utility line outage data to mitigate large cascades, *IEEE Transactions on Power Systems*, vol. 35, no. 4, July 2020, pp. 3224-3235.
- [45] K. Zhou, J.R. Cruise, C.J. Dent, I. Dobson, L. Wehenkel, Z. Wang, A.L. Wilson, Bayesian estimates of transmission line outage rates that consider line dependencies, *IEEE Transactions on Power Systems*, vol. 36, no. 2, March 2021, pp. 1095-1106. DOI 10.1109/TPWRS.2020.3012840.
- [46] M. Noebels, I. Dobson, M. Panteli, Observed acceleration of cascading outages, *IEEE Transactions on Power Systems*, vol. 36, no. 4, July 2021, pp. 3821-3823.

### Journal publications: Resilience

- [47] S. Kancherla, I. Dobson, Heavy-tailed transmission line restoration times observed in utility data, *IEEE Transactions on Power Systems*, vol. 33, no. 1, January 2018, pp. 1145-1147.
- [48] M. R. Kelly-Gorham, P.D.H. Hines, K. Zhou, I. Dobson, Using utility outage statistics to quantify improvements in bulk power system resilience, 21st Power Systems Computation Conference, Porto Portugal, July 2020, and *Electric Power Systems Research*, vol. 189, 106676, December 2020.
- [49] N.K. Carrington I. Dobson, Z. Wang, Extracting resilience metrics from distribution utility data using outage and restore process statistics, *IEEE Transactions on Power Systems*, vol. 36, no. 2, November 2021, pp. 5814-5823.

- [50] S. Skarvelis-Kazakos, M. Van Harte, M. Panteli, E. Ciapessoni, D. Cirio, A. Pitto, R. Moreno, C. Kumar, C. Mak, I. Dobson, C. Challen, M. Papic, C. Rieger, Resilience of electric utilities during the COVID-19 pandemic in the framework of the CIGRE definition of power system resilience, *International Journal of Electrical Power and Energy Systems*, vol. 136, 107703, March 2022.

### Journal publications: Electric Power System Stability

- [51] I. Dobson, H.-D. Chiang, Towards a Theory of Voltage Collapse in Electric Power Systems, *Systems and Control Letters*, Vol. 13, 1989, pp. 253-262.  
*Explains using nonlinear dynamics how voltages fall along a center manifold in a voltage collapse blackout when an operating equilibrium disappears in a saddle-node bifurcation. Introduces popular voltage collapse model with load dynamics.*  
>430 citations in google scholar
- [52] H.-D. Chiang, I. Dobson, R.J. Thomas, J.S. Thorp, L. Fekih-Ahmed, On voltage collapse in electric power systems, *IEEE Transactions on Power Systems*, Vol. 5, No. 2, May 1990, pp. 601-611.
- [53] I. Dobson, Observations on the geometry of saddle node bifurcation and voltage collapse in electric power systems, *IEEE Transactions on Circuits and Systems, Part 1: Fundamental Theory and Applications*, Vol. 39, No. 3, March 1992, pp. 240-243.
- [54] C.A. Canizares, F.L. Alvarado, C.L. DeMarco, I. Dobson, W.F. Long, Point of collapse methods applied to AC/DC power systems, *IEEE Transactions on Power Systems*, Vol. 7., No. 2, May 1992, pp. 673-683.
- [55] I. Dobson, H. Glavitsch, C.C. Liu, Y. Tamura, K. Vu, Voltage collapse in power systems, *IEEE Circuits and Devices Magazine*, vol. 8, no. 3, May 1992, pp. 40-45.
- [56] I. Dobson, L. Lu, Computing an optimum direction in control space to avoid saddle node bifurcation and voltage collapse in electric power systems, *IEEE Transactions on Automatic Control*, vol 37, no. 10, October 1992, pp. 1616-1620.
- [57] I. Dobson, L. Lu, Voltage collapse precipitated by the immediate change in stability when generator reactive power limits are encountered, *IEEE Transactions on Circuits and Systems, Part 1*, vol. 39, no. 9, Sept. 1992, pp. 762-766.
- [58] I. Dobson, L. Lu, New methods for computing a closest saddle node bifurcation and worst case load power margin for voltage collapse, *IEEE Transactions on Power Systems*, vol. 8, no. 3, August 1993, pp. 905-913.
- [59] T.J. Overbye, I. Dobson, C.L. DeMarco, Q-V Curve interpretations of energy measures for voltage security, *IEEE Transactions on Power Systems*, vol. 9, no. 1, Feb. 1994, pp. 331-340.
- [60] F.L. Alvarado, I. Dobson, Y. Hu, Computation of closest bifurcations in power systems, *IEEE Transactions Power Systems*, vol. 9, no. 2, May 1994, pp. 918-928.
- [61] S. Greene, I. Dobson, F.L. Alvarado, Sensitivity of the loading margin to voltage collapse with respect to arbitrary parameters, *IEEE Transactions on Power Systems*, vol. 12, no. 1, February 1997, pp. 262-272.  
>470 citations in Google scholar

- [62] S. Greene, I. Dobson, F.L. Alvarado, Contingency ranking for voltage collapse via sensitivities from a single nose curve, *IEEE Transactions on Power Systems*, vol. 14, no. 1, February 1999, pp. 232-240.
- [63] I. Dobson, J. Zhang, S. Greene, H. Engdahl, P.W. Sauer, Is strong modal resonance a precursor to power system oscillations?, *IEEE Transactions on Circuits and Systems, Part 1*, vol. 48, no. 3, March 2001, pp. 340-349.
- [64] S. Greene, I. Dobson, F.L. Alvarado, Sensitivity of transfer capability margins with a fast formula, *IEEE Transactions on Power Systems*, vol. 17, no. 1, February 2002, pp. 34-40.
- [65] I. Dobson, E. Barocio, Scaling of normal form analysis coefficients under coordinate change, *IEEE Transactions on Power Systems*, vol. 19, no. 3, August 2004, pp. 1438-1444.
- [66] J. Zhang, I. Dobson, F.L. Alvarado, Quantifying transmission reliability margin, *International Journal of Electric Energy and Power Systems*, vol. 26, no. 9, 2004, pp. 697-702.
- [67] I. Dobson, E. Barocio, Perturbations of weakly resonant power system electromechanical modes, *IEEE Transactions on Power Systems*, vol. 20, no. 1, Feb. 2005, pp. 330-337.
- [68] J. Arroyo, I. Dobson, Counterexamples to a method for identifying Hopf bifurcations without eigenvalue calculation, *IEEE Transactions on Circuits and Systems-II*, vol. 54, no. 5, May 2007, pp. 432-434.
- [69] I. Dobson, The irrelevance of electric power system dynamics for the loading margin to voltage collapse and its sensitivities, *Nonlinear Theory and Its Applications*, IEICE, vol. 2, no. 3, July 2011, pp. 263-280.
- [70] I. Dobson, Synchrony and your morning coffee, News and Views article in *Nature Physics*, vol. 9, no. 3, March 2013, pp. 133-134.
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### Journal publications: Nonlinear Dynamics

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- [73] J.H. Booske, R.F. Cooper, I. Dobson, Mechanisms for nonthermal effects on ionic mobility during microwave processing of crystalline solids, *Journal of Materials Research*, vol. 7, no. 2, February 1992, pp. 495-501.
- [74] I. Dobson, Computing a closest bifurcation instability in multidimensional parameter space, *Journal of Nonlinear Science*, vol. 3, no. 3, 1993, pp. 307-327.  
*Finds smallest pattern of parameter changes that destabilize an engineering system with many parameters*



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#### **Journal publications: Power Electronics (mainly high power)**

- [83] I. Dobson, Representation and simulation of AC/DC convertor systems using fixed and varying electrical axes, *IEE Proceedings, Part A*, Vol. 134, No. 1, pp. 67-83, January 1987.
- [84] I. Dobson, Geometric description of bridge rectifier operational modes using regular polygons, *IEE Proceedings, Part A*, Vol. 134, No. 1, pp. 85-88, January 1987.
- [85] S.G. Jalali, R.H. Lasseter, I. Dobson, Dynamic response of a thyristor controlled switched capacitor, *IEEE Transactions on Power Delivery*, vol. 9, no. 3, July 1994, pp.1609-1615.
- [86] I. Dobson, Stability of ideal thyristor and diode switching circuits, *IEEE Transactions on Circuits and Systems, Part 1*, vol. 42, no. 9, September 1995, pp. 517-529.
- [87] S.G. Jalali, I. Dobson, R.H. Lasseter, G. Venkataramanan, Switching time bifurcations in a thyristor controlled reactor, *IEEE Transactions on Circuits and Systems, Part 1*, vol. 43, no. 3, March 1996, pp. 209-218.
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- [89] R. Rajaraman, I. Dobson, Damping estimates of subsynchronous and power swing oscillations in power systems with thyristor switching devices, *IEEE Transactions on Power Systems*, vol. 11, no. 4, November 1996, pp. 1926-1930.
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*Analytic derivation of device spectrum and switching rate using ergodic theory and Fourier theory on lattices.*
- [93] G.A. Luckjiff, I. Dobson, Hexagonal sigma delta modulators in power electronics, *IEEE Transactions on Power Electronics*, vol. 20, no. 5, September 2005, pp. 1075-1083.

#### **Journal publications: Climate change**

- [94] L.M. Beard, J.B. Cardell, I. Dobson, F. Galvan, D. Hawkins, W. Jewell, M. Kezunovic, T.J. Overbye, P.K. Sen, D.J. Tylavsky, Key technical challenges for the electric power industry and climate change, *IEEE Transactions on Energy Conversion*, vol. 25, no. 2, June 2010, pp. 465–473.

#### **Patent**

- [95] D.M. Divan, I. Dobson, G.A. Luckjiff, Modulator for resonant link converters, US patent 5,619,406, April 1997.  
*Generalization of one-dimensional sigma-delta modulator principle to hexagonal quantizer. Licensed and manufactured invention.*

#### **Book chapters**

- [96] I. Dobson, S.G. Jalali, R. Rajaraman, Damping and resonance in a high power switching circuit, chapter in *Systems and Control Theory for Power Systems* (eds. J.H. Chow, P.V. Kokotovic, R.J. Thomas), IMA volume 64 in mathematics and its applications, Springer Verlag, pp. 137-156, 1995.
- [97] I. Dobson, Stability and nonlinear dynamics in thyristor and diode circuits, chapter in *Nonlinear Phenomena in Power Electronics: Attractors, Bifurcations, Chaos, and Nonlinear Control* (eds. S. Banerjee, G.C. Verghese), IEEE Press 2001, ISBN 0780353838.
- [98] I. Dobson, T. Van Cutsem, C. Vournas, C. DeMarco, M. Venkatasubramanian, T. Overbye, C. Canizares, Chapter 2: Basic Theoretical Concepts in *Voltage Stability Assessment: Concepts, Practices and Tools*, IEEE Power Engineering Society

Power System Stability Subcommittee Special Publication, IEEE product number SP101PSS, ISBN 0780378695, 2002.

- [99] I. Dobson, Distance to bifurcation in multidimensional parameter space: margin sensitivity and closest bifurcations, chapter 3, pp. 49-66 in *Bifurcation Control, Theory and Applications*, editors G. Chen, D.J. Hill, X. Yu, Lecture Notes in Control and Information Sciences. Vol. 293, ISBN 3-540-40341-8, Springer Verlag 2003
- [100] I. Dobson, Analysis of cascading infrastructure failures, chapter for Wiley Handbook of Science and Technology for Homeland Security, edited by J. G. Voeller, Wiley-Interscience, April 2010.
- [101] I. Dobson, sections on “Systems aspects of large blackouts” and “Steady-state stress” in *Power System Stability and Control*, Third Edition, editor L.L. Grigsby, CRC Press May 2012 ISBN 9781439883204.
- [102] B. A. Carreras, D. E. Newman, I. Dobson, V. E. Lynch, P. Gradney, Thresholds and complex dynamics of interdependent cascading infrastructure systems, Chapter 5, pp. 95-114, in G. D’Agostino and A. Scala (eds.), *Networks of Networks: The Last Frontier of Complexity*, Springer Switzerland 2014, doi:10.1007/978-3-319-03518-5\_5
- [103] I. Dobson, Cascading network failure in power grid blackouts, article for *Encyclopedia of Systems and Control*, edited by T. Samad and J. Baillieul, Springer London, available online in 2014, print version 2015, ISBN 978-1-4471-5059-6.  
Revised version for 2nd edition, 2021 [https://doi.org/10.1007/978-3-030-44184-5\\_26](https://doi.org/10.1007/978-3-030-44184-5_26)
- [104] I. Singh, K. Martin, N. Nayak, I. Dobson, A. Faris, A. Darvishi, Voltage stability assessment using synchrophasor technology, Chapter 20 in *Use of voltage stability assessment and transient stability assessment tools in grid operations*, Power electronics and power systems series, Editor S. (NDR) Nuthalapati, Springer Nature Switzerland AG, 2021 [https://doi.org/10.1007/978-3-030-67482-3\\_20](https://doi.org/10.1007/978-3-030-67482-3_20)

### Web site

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### Selected Conference Papers

particularly those not reworked or republished as journal papers

- I. Dobson, A first analysis of stability when a constraint on the system state is encountered, *International Symposium on Circuits and Systems*, Singapore, June 1991, pp. 1224-1227.
- I. Dobson, F.L. Alvarado, C.L. DeMarco, Sensitivity of Hopf bifurcations to power system parameters, *invited paper, 31st IEEE Conference on Decision and Control* Tucson, AZ, December 1992, pp. 2928-2933.

- R. Rajaraman, I. Dobson, Damping and incremental energy in thyristor switching circuits, *invited paper, IEEE International Symposium on Circuits and Systems*, Seattle, Washington, May 1995, pp. 291-294.
- I. Dobson, Strong resonance effects in normal form analysis and subsynchronous resonance, *Bulk Power System Dynamics and Control V*, August 2001, Onomichi, Japan.
- I. Dobson, B.A. Carreras, D.E. Newman, A branching process approximation to cascading load-dependent system failure, *Thirty-seventh Hawaii International Conference on System Sciences*, Hawaii, January 2004.
- B.A. Carreras, V.E. Lynch, D.E. Newman, I. Dobson, Dynamical and probabilistic approaches to the study of blackout vulnerability of the power transmission grid, *Thirty-seventh Hawaii International Conference on System Sciences*, Hawaii, Jan. 2004.
- V. Auvray, I. Dobson, L. Wehenkel, Modifying eigenvalue interactions near weak resonance, *IEEE International Symposium on Circuits and Systems*, Vancouver Canada, May 2004.
- I. Dobson, B.A. Carreras, D.E. Newman, Probabilistic load-dependent cascading failure with limited component interactions, *IEEE International Symposium on Circuits and System*, Vancouver Canada, May 2004.
- I. Dobson, B.A. Carreras, D.E. Newman, A criticality approach to monitoring cascading failure risk and failure propagation in transmission systems, *Electricity Transmission in Deregulated Markets: Challenges, Opportunities and Necessary R&D Agenda*, Carnegie-Mellon University, Pittsburgh PA, December 2004.
- D.E. Newman, B.A. Carreras, V.E. Lynch, I. Dobson, The impact of various upgrade strategies on the long-term dynamics and robustness of the transmission grid, *Electricity Transmission in Deregulated Markets: Challenges, Opportunities and Necessary R&D Agenda*, Carnegie-Mellon University, Pittsburgh PA, December 2004.
- I. Dobson, B.A. Carreras, D.E. Newman, Branching process models for the exponentially increasing portions of cascading failure blackouts, *Thirty-eighth Hawaii International Conference on System Sciences*, Hawaii, January 2005.
- D.E. Newman, B. Nkei, B.A. Carreras, I. Dobson, V.E. Lynch, P. Gradney, Risk assessment in complex interacting infrastructure systems, *Thirty-eighth Hawaii International Conference on System Sciences*, Hawaii, January 2005.
- U. Bhatt, D.E. Newman, B.A. Carreras, I. Dobson, Understanding the effect of risk aversion on risk, *Thirty-eighth Hawaii International Conference on System Sciences*, Hawaii, January 2005.
- I. Dobson, K.R. Wierzbicki, B.A. Carreras, V.E. Lynch, D.E. Newman, An estimator of propagation of cascading failure, *Thirty-ninth Hawaii International Conference on System Sciences*, Kauai, Hawaii, January 2006.
- B.A. Carreras, D.E. Newman, P. Gradney, V.E. Lynch, I. Dobson, Interdependent risk in interacting infrastructure systems, *Fortieth Hawaii International Conference on System Sciences*, Hawaii, January 2007.
- I. Dobson, Where is the edge for cascading failure?: challenges and opportunities for quantifying blackout risk, *IEEE Power Engineering Society General Meeting*, Tampa FL USA, June 2007.

- I. Dobson, K.R. Wierzbicki, J. Kim, H. Ren, Towards quantifying cascading blackout risk, Bulk Power System Dynamics and Control-VII, Charleston SC, August 2007.
- D.E. Newman, B.A. Carreras, V.E. Lynch, I. Dobson, Evaluating the effect of upgrade, control and development strategies on robustness and failure risk of the power transmission grid, Forty-first Hawaii International Conference on System Sciences, Hawaii, January 2008
- IEEE PES CAMS Task Force on Cascading Failure, Initial review of methods for cascading failure analysis in electric power transmission systems, IEEE Power and Energy Society General Meeting, Pittsburgh PA USA, July 2008 (Dobson was task lead for this paper).
- B. A. Carreras, D. E. Newman, I. Dobson, M. Zeidenberg, A simple model for the reliability of an infrastructure system controlled by agents, Forty-second Hawaii International Conference on System Sciences, Hawaii, January 2009.
- IEEE PES CAMS Task Force on Cascading Failure, Vulnerability assessment for cascading failures in electric power systems, IEEE PES Power Systems Conference and Exposition, Seattle WA USA, March 2009.
- B. A. Carreras, D. E. Newman, M. Zeidenberg, I. Dobson, Dynamics of an economics model for generation coupled to the OPA power transmission model, Forty-third Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2010.
- I. Dobson, M. Parashar, C. Carter, Combining phasor measurements to monitor cutset angles, Forty-third Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2010. Best Paper Award.
- I. Dobson, M. Parashar, A cutset area concept for phasor monitoring, IEEE Power and Energy Society General Meeting, Minneapolis, MN USA, July 2010.
- I. Dobson, New angles for monitoring areas, IREP Symposium, Bulk Power System Dynamics and Control - VIII, Buzios, Rio de Janeiro, Brazil, August 2010.
- I. Dobson, B.A. Carreras, Number and propagation of line outages in cascading events in electric power transmission systems, 48th Annual Allerton Conference on Communication, Control and Computing, Monticello IL USA, September 2010.
- D.E. Newman, B.A. Carreras, M. Kirchner, I. Dobson, The impact of distributed generation on power transmission grid dynamics, Forty-fourth Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2011.
- I. Dobson, Estimating the extent of cascading transmission line outages using standard utility data and a branching process, summary for panel session at IEEE Power and Energy Society General Meeting, Detroit MI USA, July 2011.
- M. Papic, K. Bell, Y. Chen, I. Dobson, L. Fonte, E. Haq, P. Hines, D.Kirschen, X. Luo, S.S. Miller, N. Samaan, M. Vaiman, M. Varghese, P. Zhang, Survey of tools for risk assessment of cascading outages, IEEE Power and Energy Society General Meeting, Detroit MI USA, July 2011.
- B.A. Carreras, D.E. Newman, I. Dobson, Determining the vulnerabilities of the power transmission system, Forty-fifth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2012.

- D.E. Newman, B.A. Carreras, N.S. Degala, I. Dobson, Risk metrics for dynamic complex infrastructure systems such as the power transmission grid, Forty-fifth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2012.
- H. Sehwal, I. Dobson, Locating line outages in a specific area of a power system with synchrophasors, North American Power Symposium, University of Illinois, Urbana-Champaign IL, September 2012.
- B.A. Carreras, D.E. Newman, I. Dobson, N.S. Degala, Validating OPA with WECC data, Forty-sixth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2013.
- P.D.H. Hines, I. Dobson, E. Cotilla-Sanchez, M. Eppstein, “Dual graph” and “random chemistry” methods for cascading failure analysis, Forty-sixth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2013.
- S. Mendoza-Armenta, I. Dobson, A formula for damping interarea oscillations with generator redispatch, IREP Symposium: Bulk Power System Dynamics and Control-IX, Rethymon, Greece, August 2013.
- A. Darvishi, I. Dobson, A. Oi, C. Nakazawa, Area angles monitor area stress by responding to line outages, NAPS North American Power Symposium, Manhattan KS USA, September 2013.
- I. Dobson, Actionable information from electric transmission grids to ensure their reliability and resilience, position paper, NSF 2013 National Workshop on Energy Cyber Physical Systems, Arlington VA USA, December 2013.
- B.A. Carreras, D.E. Newman, I. Dobson, The impact of size and inhomogeneity on power transmission network complex system dynamics, Forty-seventh Hawaii International Conference on System Sciences, Big Island, Hawaii, January 2014.
- L. Ramirez, I. Dobson, Monitoring voltage collapse margin by measuring the area voltage across several transmission lines with synchrophasors, IEEE Power Engineering Society General Meeting, National Harbor MD USA, July 2014.
- A. Darvishi, I. Dobson, Synchrophasor monitoring of single line outages via area angle and susceptance, NAPS North American Power Symposium, September 2014, Pullman WA USA
- B.A. Carreras, D.E. Newman, I. Dobson, Lambda-gaga: toward a new metric for the complex system state of the electrical grid, Forty-eighth Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2015.
- A. Darvishi, I. Dobson, Area angle can monitor cascading outages with synchrophasors, Innovative Smart Grid Technologies Conference, Washington DC, February 2015.
- I. Dobson, Statement to the Federal Energy Regulatory Commission, Reliability Technical Conference Docket No. AD14-9-000, Washington DC, June 4 2015.
- L. Ramirez, I. Dobson, Monitoring voltage collapse margin with synchrophasors across transmission corridors with multiple lines and multiple contingencies, IEEE Power and Energy Society General Meeting, Denver CO, July 2015.

- B.A. Carreras, D.E. Newman, I. Dobson, J.M. Reynolds-Barredo, The impact of local power balance and link reliability on blackout risk in heterogeneous power transmission grids, Forty-ninth Hawaii International Conference on System Sciences, January 2016, Kauai, HI USA.
- M. Papic, I. Dobson, Comparing a transmission planning study of cascading with historical line outage data, International Conference on Probability Methods Applied to Power Systems (PMAPS), Beijing China, October 2016.
- I. Dobson, N.K. Carrington, K. Zhou, Z. Wang, B.A. Carreras, J.M. Reynolds-Barredo, Exploring cascading outages and weather via processing historic data, Fifty-first Hawaii International Conference on System Sciences, January 2018, Big Island, Hawaii.
- I. Dobson, A. Flueck, S. Aquiles-Perez, S. Abhyankar, J. Qi, Towards incorporating protection and uncertainty into cascading failure simulation and analysis, Probability Methods Applied to Power Systems, Boise, Idaho, USA June 2018.
- K. Zhou, I. Dobson, P.D.H. Hines, Z. Wang, Can an influence graph driven by outage data determine transmission line upgrades that mitigate cascading blackouts? Probability Methods Applied to Power Systems, Boise, Idaho, USA June 2018.
- P. Henneaux, E. Ciapessoni, D. Cirio, E. Cotilla-Sanchez, R. Diao, I. Dobson, A. Gaikwad, S. Miller, M. Papic, A. Pitto, J. Qi, N. Samaan, G. Sansavini, S. Uppalapati, R. Yao, Benchmarking quasi-steady state cascading outage analysis methodologies, Probability Methods Applied to Power Systems, Boise, Idaho, USA June 2018.
- N. Nayak, L. Zhang, K. Martin, I. Dobson, A. Bose, D. Sobajic, Practical implementation of synchrophasor based real-time contingency analysis, North American Power Symposium, Fargo ND, September 2018.
- B.A. Carreras, J. M. Reynolds Barredo, I. Dobson, D.E. Newman, Validating the OPA cascading blackout model on a 19402 bus transmission network with both mesh and tree structures, Fifty-second Hawaii International Conference on System Sciences, Maui, HI January 2019 Best paper award
- L. Zhang, K. Martin, N. Nayak, I. Singh, I. Dobson, A. Bose, D. Sobajic, Real-time synchrophasor applications to support power system operations, PAC World Americas Conference, Raleigh NC, August 2019.
- M.R. Kelly-Gorham, P. Hines, I. Dobson, Using historical utility outage data to compute overall transmission grid resilience, Modern Electric Power Systems Conference, Wrocław Poland, September 2019.
- A.J. Flueck, I. Dobson, Z. Huang, N.E. Wu, R. Yao, G. Zweigle, Dynamics and protection in cascading outages, IEEE Power and Energy Society General Meeting, Montreal CA, August 2020.
- K. Zhou, I. Dobson, Z. Wang, Can the Markovian influence graph simulate cascading resilience from historical outage data?, Probability Methods Applied to Power Systems, Liege, Belgium, August 2020.
- K. Zhou, J.R. Cruise, C.J. Dent, I. Dobson, L. Wehenkel, Z. Wang, A.L. Wilson, Applying Bayesian estimates of individual transmission line outage rates, Probability Methods Applied to Power Systems, Liege, Belgium, August 2020.

- A.L. Bowker, D.E. Newman, B.A. Carreras, D. Huang, I. Dobson, C. Koplin, Characteristics and risk of microgrid outages from a complex systems point of view, Fifty-fourth Hawaii International Conference on System Sciences, January 2021.
- S. Ekisheva, R. Rieder, J. Norris, M. Lauby, I. Dobson, Impact of extreme weather on North American transmission system outages, IEEE Power and Energy Society General Meeting, Washington DC USA, July 2021.
- Nichelle'Le K. Carrington, I. Dobson, Z. Wang, Transmission grid outage statistics extracted from a web page logging outages in Northeast America, North American Power Symposium, College Station TX USA, November 2021. Best paper award.



### Courses taught at Iowa State University

EE303 Energy systems and power electronics	2013,2014,2014,2015
EE455 Introduction to energy distribution systems	2015
EE456 Power systems analysis I	2017,2018,2020,2021
EE554 Power system dynamics	2014,2016
EE577 Linear systems (also MATH/AERE/ME)	2020,2021
EE578 Nonlinear systems	2018
EE653 Phasor measurements in power system networks	2012
EE653 Reliability, risk, and resilience in power systems	2017
EE653 Resilient network analysis	2018

### Courses taught at University of Wisconsin

ECE220 Electrodynamics I	1995
ECE330 Signals and systems	1990,1994,1999
ECE331 Probability & random processes	2002,2003,2004,2006,2009
ECE332 Feedback control systems	1996,2002,2002,2003,2004
ECE342 Electronic circuits II	1998,1999
ECE355 Electromech. energy conversion	1999,2000
ECE334 State space systems analysis	1992,1993,1995,1998,2007,2010
ECE427 Electric power systems	1989,1991,1992,1996
ECE730 Probability & stochastic processes	2006
ECE731 Advanced power system analysis	1993
ECE717 Linear systems	1991,1997,2001,2003,2005,2008
ECE/ChE/Math 777 Chaos & bifurcations	1997,2001,2005,2010
ECE817 Nonlinear systems	1991,2011
ECE903 Special topics in control	1990,1994
ECE905 Special topics in power	2004

### Conference Proceedings Edited

- [106] A.B. Kumar, A. Ipakchi, F.L. Alvarado, I. Dobson, S. Mukherjee, W.H. Esselman (eds.), Proceedings: EPRI/NSF Workshop on Application of advanced mathematics to power systems, Electric Power Research Institute, TR101795, April 1993.

### Reports

- [107] I. Dobson, 6 Culham Laboratory (United Kingdom Atomic Energy Authority) reports on the CONNIE switching circuit simulation, including Technical Description (CLM-PDN2/88), Users Guide (CLM-PDN1/88), and modelling of transformer rectifier systems using CONNIE (EDD/ESG/83/N10, N11, N12, N13), Culham Laboratory, Abingdon, Oxon OX14 3DB, England, Nov. 1983.
- [108] R.H. Lasseter, I. Dobson, S.G. Jalali, *Harmonics and instabilities in switching circuits*, (Electric Power Research Institute Report), EPRI TR-102317, May 1993.
- [109] I. Dobson, *Loading margin methods for avoiding voltage collapse*, (Electric Power Research Institute Report), EPRI, Palo Alto CA and National Science Foundation, Arlington VA, EPRI TR-111275, September 1998.
- [110] I. Dobson, *Stability, damping, nonlinear dynamics and SSR in thyristor switching circuits*, (Electric Power Research Institute Report), EPRI, Palo Alto CA and National Science Foundation, Arlington VA, EPRI TR-111276, September 1998.
- [111] I. Dobson, F.L. Alvarado, C.L. DeMarco, P. Sauer, S. Greene, H. Engdahl, J. Zhang, Avoiding and suppressing oscillations, PSerc publication 00-01, December 1999, available from <http://www.pserc.wisc.edu/>.
- [112] I. Dobson, S. Greene, R. Rajaraman, C.L. DeMarco, F.L. Alvarado, M. Glavic, J. Zhang, R. Zimmerman, Electric power transfer capability: Concepts, applications, sensitivity, uncertainty, PSerc publication 01-34, November 2001, available from <http://www.pserc.wisc.edu/>.
- [113] M. Begovic, J-M. Gagnon, P. Gomes, W. Lachs, C-C. Liu, V. Madani, D. Novosel, G. Trudel, M. Amin, H. Clark, I. Dobson, P. Donalek, P. Grondin, L. Wehenkel, Defense Plan Against Extreme Contingencies - CIGRE Task Force C2.02.24, CIGRE Technical Brochure No. 316, April 2007.
- [114] Task Force on Blackout Experience, Mitigation, and Role of New Technologies, of the IEEE PES Power System Dynamic Performance Committee, Blackout experiences and lessons, best practices for system dynamic performance, and the role of new technologies, IEEE Special Publication 07TP190, July 2007.
- [115] M. Parashar, A. Agarwal, Y. Makarov, I. Dobson, Real-time voltage security assessment (RTVSA) Functional specifications for commercial grade application, Consortium for Electric Reliability Technology Solutions (CERTS) report for California Independent System Operator (CAISO), April 2007. Available from <http://certs.lbl.gov/>
- [116] M. Parashar, A. Agarwal, Y. Makarov, I. Dobson, Real-time voltage security assessment (RTVSA) Report on algorithms and framework, Consortium for Electric Reliability Technology Solutions (CERTS) report for California Independent System Operator (CAISO), December 2007. Available from <http://certs.lbl.gov/>
- [117] J. McCalley, S. Khaitan, I. Dobson, K.R. Wierzbicki, J. Kim, H. Ren, Risk of cascading outages (final project report), PSERC publication 08-04, February 2008. Available from <http://www.pserc.wisc.edu/>.

- [118] J. Guckenheimer, J. Ottino, A. Bertozzi, I. Couzin, I. Dobson, S. Glotzer, M. Golubitsky, J. Hudson, C. Jacobson, I. Kevrekidis, E. Klavins, J. Lega, I. Mezic, M. Newman, J. Sethna, M. Shelley, A. Vespignani, L.S. Young, Foundations for Complex Systems Research in the Physical Sciences and Engineering, Report from an NSF Workshop in September 2008.
- [119] M. Morgan, I. Dobson, et al., Extreme Events Phase 1, California Energy Commission Publication.
- [120] M. Morgan, I. Dobson, et al., Extreme Events Phase 2, California Energy Commission Publication number CEC-MR- 08-03, 2011.
- [121] M. Kezunovic, A. Annaswamy, I. Dobson, S. Grijalva, D. Kirschen, J. Mitra, L. Xie, Energy Cyber-Physical Systems Research Challenges and Opportunities Report from NSF Workshop held Dec 15-16, 2013, June 2014
- [122] Q. Zhang, X. Guo, A. Ramapuram-Matavalam, P. Sharma, V. Chiluka, J. McCalley, V. Ajjarapu, S. Khaitan, I. Dobson, Final Report to Southern California Edison from Iowa State University; Analysis of and Response to Extreme Events in the Bulk Electric System, December 2017.

### Grants

- I. Dobson, *NSF Initiation Grant*. The main causes of voltage collapse in electric power systems, \$60,750, 1990-1992.
- I. Dobson, *NSF Presidential Young Investigators Award*. \$125,000, 1991-1998.
- I. Dobson, Avoiding bifurcation instabilities in electric power systems, \$188,800 PYI Industrial matching funds from Electric Power Research Institute plus \$187,500 NSF matching funds, 1992-1998.
- R.H. Lasseter, I. Dobson, Harmonic interactions between FACTS systems, \$287,620 over 3 years from Electric Power Research Institute 1992 -1995.
- P. Sauer, I. Dobson, R.J. Thomas, M.A. Pai, F.L. Alvarado, H.-D. Chiang, Real time control of oscillations of electric power systems, Empire State Electric Energy Research Corporation and New York State Electric and Gas, \$75,000, Wisconsin share is \$24,000, 1996.
- R.H. Lasseter, F.L. Alvarado, C.L. DeMarco, I. Dobson, D. Ray, NSF Industry-University Cooperative Research Center PSerc (Power Systems engineering research center), \$237,500, 1996-01.
- I. Dobson, Modulator for a soft switching power supply, Industrial and Economic Development Research Program, Wisconsin \$15,000 for one year, 1998-99.
- I. Dobson, F.L. Alvarado, C.L. DeMarco, P. Sauer, Avoiding and suppressing oscillations in electric power systems, PSerc project. \$60,000 1997-1999,
- H.-D. Chiang, P. Sauer, I. Dobson, Voltage collapse monitor. PSerc Industry project. \$10,000 Dobson share. 1997-2000.
- I. Dobson, F.L. Alvarado, C.L. DeMarco, Limitations and interactions of bulk power transfers in large scale electric power systems, NSF funding for Research Centers and Small Firm Collaborative Research and Development, \$190,000, 1998-2000. \$73,000 of the \$190,000 is subcontracted to Christensen Associates, Madison, WI.
- C.L. DeMarco, M.A. Pai, I.A. Hiskens, I. Dobson, New System Control Methodologies. PSerc Industry project. \$10,000 Dobson share. 1999-2002.
- I. Dobson, Towards real time control of oscillations in electric power systems, NSF \$220,000 for 4 years starting 7/1/00.
- I. Dobson, Self-organized criticality, blackouts and disruptions in power, and communication systems, NSF grant ECS0085711 \$64,800 for one year starting 9/1/00.
- I. Dobson, B.A. Carreras, B. Kirby, J.S. Thorp, Self-organized criticality, blackouts and disruptions in power and communication systems, DOE CERTS grant, \$80,000 Dobson share. 2001-2002.
- I. Dobson, Collaborative research: Complex dynamics, criticality and cascading events in power system blackouts and communication networks, NSF grant ECS02143691, \$60,000 for 3 years starting 9/1/02.
- C.L. DeMarco, I. Dobson, I.A. Hiskens, D.J. Ray, F.L. Alvarado, NSF IUCRC PSerc site award, 2004-2006, \$75,000 plus supplements exceeding 300K.

- I. Dobson, B.A. Carreras, Risk, Criticality and Self-Organization in Large Blackouts involving Cascading Failure, DOE/CERTS, \$250,000 for 2003-2004. Dobson share is \$125,000.
- S. Talukdar, J.D. McCalley, I Dobson, Risk analysis of critical loading and blackouts with cascading events, PSerc, \$160,000 for 2 years starting summer 2005. Dobson share is \$53,334.
- I. Dobson, Support for CAISO Voltage Security Assessment and Oscillation Monitoring Projects, **DOE CERTS**, \$30,000. 2005-2006.
- I. Dobson, Support for CAISO Voltage Security Assessment and Oscillation Monitoring Projects, **DOE CERTS**, \$21,000. 2006-2007.
- J. Cardell, I. Dobson, and many others, PSerc, The Electric Power Industry and Climate Change Discussion Paper, PSerc, \$21,000 for 6 months in 2007. Dobson share is \$3,000.
- I. Dobson, Cyber Systems: collaborative research: Complex Systems Dynamics of Blackouts and Transmission System Upgrades **NSF**, \$73,000 for 3 years starting in June 2006. This is the Wisconsin portion of collaborative research with University of Alaska and Oak Ridge National Lab/BACV solutions.
- I. Dobson, M. Zeidenberg, HSD Collaborative research: Human decision making and its effect on infrastructure system dynamics, **NSF**, \$210,000 for 4 years starting in November 2006. This is the Wisconsin portion of collaborative research with University of Alaska and Oak Ridge National Lab/BACV solutions.
- I. Dobson, J.D. McCalley, C-C. Liu, Risk analysis of critical loading and blackouts with cascading events, PSerc, \$190,000 for 3 years starting summer 2007. Dobson share is \$56,000.
- I. Dobson, M. Morgan, M. Kumbale, D.E. Newman, B.A. Carreras, Y. Makarov, B.C. Lesieutre, S. Varadan, R. Adapa, Extreme Event Research, **California Energy Commission CIEE/PIER** program, \$1,140,000 for about 2.25 years starting in March 2009. This is a collaboration between University of Wisconsin, EPRI, PNNL, BACV solutions, Southern Company, KEMA consulting, and University of Alaska. Dobson is the technical lead in this proposal and UW share is \$215,000.
- I. Dobson, Exploring approaches to suppressing oscillations, **California Energy Commission/PIER via DOE CERTS**, \$123,000(+\$38,000??) 2009-2011.
- D. Bienstock, S.J. Wright, I. Dobson, I. Hiskens, J. Linderoth, Reconfiguring power systems to minimize cascading failures– models and algorithms, **DOE ASCR**, 1.5 M\$ for 3 years starting in September 2009. Collaborative grant with Columbia U. and U. Michigan.
- I. Dobson, New angles for monitoring areas of electric power systems, University of Wisconsin graduate school, \$38,400 for one year starting July 2011.
- V. Vittal, C.L. Demarco, B.C. Lesieutre, I. Dobson, and many others, PSERC Collaborative Proposal for a Phase III Industry University Cooperative Research Center Program, **NSF**, \$135K for 1 year starting March 2010.
- V. Vittal, T. Overbye, I. Dobson, J.D. McCalley, V. Ajjarapu, C.L. Demarco, and many others, The future grid to enable sustainable energy systems, an initiative of

PSERC, funds from **DOE** via supplement to preceding NSF grant. Dobson share of funding is \$210,000 for 3 years starting in 2011.

- I. Dobson, F. Bullo, B. Sinopoli, CPS Collaborative Research: The cyberphysical challenges of transient stability and security in power grids, **NSF**, 1.125M\$ for 4 years starting in 2011. Collaborative grant with University of California Santa Barbara and Carnegie-Mellon University. Dobson share of funding is \$375,000.
- I. Dobson, Applications of area angles, LBNL \$16,000, 2012.
- I. Dobson, SSR research, anonymous donor \$16,625.
- I. Dobson, Arendt J. and Verna V. Sandbulte professorship funds, 2012-present
- I. Dobson, Measuring stress across an area of a power system with area angles, EPRC project, \$68,364, 2 years starting 2013.
- J.D. McCalley, I. Dobson, D.C. Aliprantis, Transmission planning and defense plans, EPRC project, \$69,864, 2 years starting 2013
- I. Dobson, Sponsored Project Agreement, Fuji Electric Co., \$37,500, 2013.
- M.L. Crow, P. Sauer, B. Lesieutre, J.D. McCalley, R. Smith, B. McKinney, P. Muhoro, J.F. Kelly, I. Dobson and many others in Midwest Power schools, GEARED Grid Engineering for Accelerated Renewable Energy Deployment, DOE, Dobson share is \$30,098, 9/1/2013-8/31/2018.
- I. Dobson, Fast monitoring of voltage collapse and cascading outages with synchrophasors, EPRC project, \$70,000, 2 years starting 2014.
- I. Dobson, M. Ilic, Monitoring and maintaining limits of area transfers with synchrophasors, PSERC Power Systems Engineering Research Center, \$150K , 07/01/15 - 08/31/17. Dobson share is 80K.
- J.D. McCalley, V. Ajjarapu, I. Dobson, S. Khaitan, New Network Designs & Control Strategies: Defending Against Extreme Contingencies, Southern California Edison. Dobson share is \$35,559, 7/1/14-6/30/16
- I. Dobson, EAGER: Renewables: Fundamental allometric scalings for distribution networks with renewables, NSF, \$92,481, 4 years starting September 2015.
- S. Abhyankar, E. Constantinescu, J. Qi, D. Koch, A. Flueck, I. Dobson, J. Quada, P. McCoy, Protection and dynamic modeling, simulation, and analysis of cascading failures, DOE Grid Modernization Project, \$300K, Lead is Argonne National Lab., Dobson share is 38K, including 6K matching from Iowa Energy Center, 1 year starting April 2016.
- Z. Wang, I. Dobson, Data-driven modeling, monitoring and mitigation of cascading outages in transmission and distribution systems, NSF, \$347,938, 3 years starting June 2016.
- I. Dobson, Real time applications using linear state estimation project (RTA/LSE), \$80,000, subcontract from Electric Power Group LLC for DOE grant, 3 years starting January 2017.
- I. Dobson, CRISP Type 2: Collaborative research: Understanding the benefits and mitigating the risks of interdependence in critical infrastructure systems, NSF, \$400,000,

5 years starting January 2018. Collaborative grant with University of Vermont (P. Hines, M. Eppstein) and MIT (E. Modiano, K. Turitsyn, A. Glasmeier).

- I. Dobson, Resilience constrained optimization for energy systems, Argonne National Lab \$64,905, 1.5 years starting August 2018.
- Z. Wang, I. Dobson, A data-driven multi-timescale predictive, proactive, and recovery optimization framework for solar energy integrated resilient distribution grid, DOE via Argonne National Lab, 2 years starting November 2018, \$83,000.
- Z. Wang, C. Hegde, I. Dobson, V. Ajjarapu (with EPG, Google Brain, IBM), Robust learning of dynamic interactions for enhancing power system resilience, DOE, 1M\$, 6/01/19- 12/30/2020.
- I. Dobson, Cascading risk and mitigation, Argonne National Laboratory, \$39,764, one year starting July 2020.
- H. Villegas Pico, I. Dobson, Deep reinforcement learning for power system resilience, National Renewable Energy Laboratory, \$17,976, 2 months starting August 2020.
- H. Villegas Pico, I. Dobson, Deep reinforcement learning approaches to resilience of power systems, National Renewable Energy Laboratory, \$35,000, 11/17/20-09/30/21.

### Media reporting about our blackout research

- Why the lights went out. Jonathan Kay, National Post, August 16 2003
- How a butterfly's wing can bring down Goliath. Chaos theories calculate the vulnerability of megasystems. Keay Davidson, San Francisco Chronicle, August 15 2003
- L'energia ha un punto critico. Donata Allegri, Ecplanet
- Black-out: cause e mezzi per prevenirli. Carlo Alberto Nucci e Alberto Borghetti, Rivista ENERGIA, n. 3, pp. 20-29, 2003
- This was a first world blackout. Chris Suellentrop, Slate magazine, August 15 2003
- Energy scientist studies blackout triggers. Pat Daukantas, Government Computer News, August 22 2003
- The Power Grid as Complex System. Sara Robinson, **SIAM News**, Volume 36, Number 10, December 2003  
Headline story with extensive coverage of our work.
- The unruly power grid, Peter Fairley, **IEEE Spectrum** August 2004.  
This lead article quoted Dobson and Carreras and summarized our complex systems research on blackouts.
- The items above discussed our research results. Our team was also widely quoted for general background on the August 2003 blackout, including appearances on ABC Nightline, NPR radio and quotes in about a dozen newspapers.
- Blackouts ahead on our unruly power grids, Peter Fairley, Carbon Nation, August 2013.
- Blackout threat unmitigated a decade after the Northeast went dark, Peter Fairley, IEEE Spectrum Energywise blog, August 2013.
- Blackout of the century, Peter Fairley, **Discover Magazine**, March 2016.  
This article described the collaboration between Dobson, Carreras, and Newman and our results in analyzing blackouts



### Professional Society Activities

- **Fellow IEEE** “for contributions to understanding and analysis of voltage collapse”, 2006.
- Paper reviewer, including IEEE Power Engineering Society journals and conferences and a large variety of other journals in power systems and complex and nonlinear systems.
- Member of Technical Committee on Power Systems and Power Electronics Circuits, IEEE Circuits and Systems Society, in the 1990s.
- Member of IEEE Power Engineering Society Power System Stability Subcommittee, 1995-2002. Coordinator, editor and coauthor of a 96 page chapter of a working group publication on voltage collapse. This publication received an IEEE Power engineering Society Working Group Recognition Award for an outstanding technical report in 2005.
- Member of IEEE Power Engineering Society Power System Dynamic Performance Committee, 1998-present
- Member of IEEE Power Engineering Society Power System Analysis, Computing, and Economics Committee, 2009-present
- **Chair** of Technical Committee on Power Systems and Power Electronic Circuits, IEEE Circuits and Systems Society, 1998-99.
- Member of IEEE Circuits and Systems Society review committee for ISCAS, 2000-04, 2008, and 2010.
- Member of IEEE Power Engineering Society Task Force on the Need to Assess Higher Order Terms for Small Signal (Modal) Analysis, 2001-2005.
- Member of IEEE Power Engineering Society Task Force on Blackout Experience, Mitigation, and Role of New Technologies, 2005-2007.
- Member (also Task 1 leader) of IEEE Power Engineering Society Task Force on Understanding, Prediction, Prevention and Restoration of Cascading Failures. 2007-present
- External Member, a project review committee, Center for Nonlinear Sciences, Los Alamos National Lab, August 2010.
- Member of SIAM Mathematics Awareness Month 2011 Advisory Committee.
- Member of IEEE Power Engineering Society Task Force and then Working group for Understanding, Predicting, Mitigation, and Restoration of Cascading Failures. 2007-present. The working group was awarded a IEEE Power Engineering Society Technical committee Working Group recognition award in 2015
- Member of IEEE Power Engineering Society Probability Applications for Common Mode Events Working group 2013-present.
- Member of Cigre Working group 2020-present.

**Selected talks presented by Dobson that are not in list of conference papers**

- Cascading failure, Talk at the University of Liege, Belgium March 2003
- Cascading failure and catastrophic risk in complex systems, Invited talk at Institute for Asset Management Workshop, Birmingham, England, September 2003
- Cascading failure analysis, Lecture at EEI Market Design & Transmission Pricing School Madison, Wisconsin, July 2004
- Avoiding bifurcations in high-dimensional parameter spaces, invited talk in Minisymposium on Theory and Numerical Analysis of Bifurcations in Piecewise Smooth Dynamical Systems, SIAM Conference on Applications of Dynamical Systems, Snowbird UT, May 2005.
- Monitoring risk of cascading failure blackouts, Presentation at Oak Ridge National Lab to representatives from Nuclear Regulatory Commission, Federal Energy Regulatory Commission, and North American Electric Reliability Council, July 2005
- Monitoring risk of cascading failure blackouts, Invited presentation at NSF/EPRI workshop, Denver CO October 2005.
- **Plenary speaker**, Cascading Failure and Complex Dynamics in Large Blackouts, at SIAM Conference on Applications of Dynamical Systems, Snowbird UT, May 2005.
- Plenary Speaker, Criticality, Self-organization and Cascading Failure in Blackouts of Evolving Electric Power Networks, 6th Understanding Complex Networks Symposium, University of Illinois at Urbana-Champaign, May 2006.
- Plenary Speaker, Cascading Failure and Complex Dynamics in Large Blackouts, Los Alamos National Laboratory Center for Nonlinear Studies Workshop on Optimization in Complex Networks, June 2006.
- Panelist, PIER TRP Policy Advisory Committee Meeting, San Ramon, CA June 2006.
- Criticality, Self-organization and Cascading Failure in Electric Power System Blackouts, University of California-Davis, June 2006, Rice University, October 2006, and Princeton Plasma Physics National Lab, September 2007.
- Risk of Large Cascading Blackouts, EUCI Transmission Reliability Conference, Washington DC, October 2006.
- Understanding Cascading failure, EPRI Workshop, Palo Alto CA December 2007.
- Cascading failure analysis, Lecture at EEI Transmission & Wholesale Markets School Madison, Wisconsin, August 2008.
- Modeling cascading failure, Presentation at workshop: Vulnerability assessment of critical infrastructure, with case studies on power transmission networks and dams, Madison WI, January 2009
- Can we quantify the risk of cascading failure blackouts with branching processes? Center for Nonlinear Studies seminar, Los Alamos National Lab, April 2009.
- How can complex system feedbacks shape cascading failure blackout risk towards criticality?, Center for Control, Dynamical Systems, and Computation seminar, University of California at Santa Barbara, April 2009.

- Modeling engineered and sustainable systems with complex system feedbacks, First international conference on computational sustainability CompSust09, Cornell University, Ithaca NY, June 2009.
- Extreme event research, California Energy Commission Transmission Research Program Colloquium, Costa Mesa CA, September 2009.
- Models of cascading failure in blackouts of electric power transmission systems, Electronic Power Grid Resilience Workshop. Organized by the Naval Postgraduate School. Monterey CA May 2010.
- Monitoring stress and reliability for a smarter grid, University of Washington-Seattle, May 2010.
- Modeling cascading failure with branching processes, Mini-Workshop on Optimization and Control Theory for Smart Grids, Center for Nonlinear Sciences, Los Alamos National Lab, August 2010.
- New angles for monitoring power system area stress with synchrophasors, Webinar, Power systems engineering research center, September 2010.
- New angles across power system areas to monitor stress, North American SynchroPhasor Initiative NASPI meeting, Arlington VA, October 2010.
- Propagation of cascading line outages as a reliability metric, talk at Federal Energy Regulatory Commission FERC, Washington DC, October 2010.
- Cascading failure and complex systems dynamics in large blackouts, invited talk at Energy and Emergence, public workshop sponsored by Institute for Complex Adaptive Matter and Center for the Study of Complex Systems, University of Michigan, Ann Arbor MI, November 2010.
- Cascading failure in widespread blackouts, invited talk at session on Mathematics and Our Energy Future, AAAS (American Association for the Advancement of Science) Annual Meeting, Washington DC, February 2011.
- Estimating propagation and the statistics of blackout extent from electric power grid cascading failure data, keynote speaker, Network Frontier Workshop, Northwestern University, Evanston IL, December 2011.
- Locating line outages in a specific area of a power system from area PMUs, North American Synchrophasor Initiative NASPI meeting, Orlando FL, March 2012.
- How can we model power systems for cascading blackouts? considerable complications, cutting corners, and validation with data, invited talk, Santa Fe Institute, NM, May 2012.
- Voltages across an area of a network and synchrophasor monitoring of power systems, UC Santa Barbara, January 2012 and LANL CNLS Conference Santa Fe NM, May 2012.
- Voltages across an area of a network, poster presentation, IEEE PES General meeting, San Diego, CA July 2012.
- Combining PMU measurements to get angles across areas, PSerc meeting Big Sky, Montana, July 2012

- Cyberphysical challenges of transient stability and security in power grids, poster presentation, NSF CPS PI meeting, National Harbor MD, October 2012
- Alarming with Area Phase Angles? presentation to industry at WECC JSIS (Western Electricity Coordinating Council Joint Synchronized Information Subcommittee) meeting Tempe AZ, January 2013
- How can complex system feedbacks shape cascading failure blackout risk towards criticality?, University of Vermont, November 2012
- Sampling and speed for cascading failure simulations, DIMACS workshop, Rutgers University, Piscataway NJ, February 2013
- Models and data for cascading outages in power transmission networks, **keynote presentation**, Net-o-Nets conference, Berkeley CA June 2014
- Damping interarea oscillations with generator redispatch using synchrophasors, invited speaker, LANL Grid Science Conference, Santa Fe NM January 2015
- Quantifying cascading failure propagation in blackouts of electrical transmission networks, MIT, Boston MA, February 2015
- Outage risk and complexity of the grid, joint Committee on Regional Electric Power Cooperation and Western Interconnection Regional Advisory Body meeting, Salt Lake UT, April 2016
- Panelist for Western Interstate Energy Board Webinar on Critical Energy/Electric Infrastructure Information, July 2016
- Large blackout risk in a complex and evolving grid, special invited session for 50th anniversary HICSS conference, January 2017
- Complex systems approaches to series of blackouts, NSF webinar on complex systems, April 2017
- Challenges and opportunities from historical WECC blackout data, invited panel on Identifying and Assessing Emerging Risks at Western Reliability Summit, Portland OR, May 2017
- New statistics from detailed outage data, talk at Bonneville Power Administration, Vancouver WA USA May 2017
- Data-driven models of cascading blackouts in electric power transmission networks, talk at University of Washington, Seattle, April 2018.

### **Summary of university service at Iowa State**

- Chair, ECpE Awards Committee
- Chair, Elections and Oversight Committee
- Member, Search committee for Engineering College Dean
- Member, ECpE Strategic planning committee
- Member, ECpE Promotion and Tenure committee
- Member, ECpE Curriculum Revision task force
- Member, ECpE Graduate committee
- ECpE Power area chair
- Member, Junkins chair selection committee
- Member, College chair renewal committees

### **Summary of university service at Wisconsin**

- Chair and member, tenure and promotion committee
- Chair and member, awards committee
- Chair and member, MS exam committee
- Member, promotion and recruiting committee
- Member, salary committee
- Member, graduate award committee
- Member, graduate recruiting and fellowship committee
- Member, graduate committee
- Member, budget committee
- Member, undergraduate curriculum committee
- Member, undergraduate advising and scholarships (in charge of scholarships)
- Member, teaching peer review committee
- Member, undergraduate scholarship committee
- Member, ad hoc committees on workload
- Member, steering committee for UW-Madison Chaos and Complex Systems Seminar
- Faculty senator

**Conference Papers (complete list)**

- [123] Mace, T.A., J.W. Gray, R.C. McLachlan, I. Dobson, CONNIE— A general AC-DC convertor and transient circuit analysis program, *Proceedings of the 18th IEEE Power Modulator Symposium*, June 1988.
- [124] I. Dobson, H.-D. Chiang, J.S. Thorp, L. Fekih-Ahmed, A model of voltage collapse in electric power systems, *invited paper, Proceedings of the 27th IEEE Conference on Decision and Control*, Austin, Texas, pp. 2104-2109, December 1988.
- [125] I. Dobson, D.F. Delchamps, Basin boundaries in the pendulum with nonperiodic forcing, *Proceedings of the 1989 Conference on Information Sciences and Systems*, The Johns Hopkins University, Baltimore, MD, pp. 374-379, March 1989.
- [126] H.-D. Chiang, I. Dobson, R.J. Thomas, J.S. Thorp, L. Fekih-Ahmed, On voltage collapse in electric power systems, *IEEE Power Industry Computer Application Conference*, Seattle, WA, May 1989.
- [127] I. Dobson, Approximate decoupling of a condition for voltage collapse, *Proceedings of the 28th IEEE Conference on Decision and Control, invited paper*, Tampa, Florida, vol. 1, December, 1989, pp. 336-337.
- [128] I. Dobson, A first analysis of stability when a constraint on the system state is encountered, *International Symposium on Circuits and Systems*, Singapore, June 1991, pp. 1224-1227.
- [129] I. Dobson, L. Lu, Y. Hu, A direct method for computing a closest saddle node bifurcation in the load power parameter space of an electric power system, *International Symposium on Circuits and Systems*, Singapore, June 1991, pp. 3019-3022.
- [130] C.A. Canizares, F.L. Alvarado, C.L. DeMarco, I. Dobson, W.F. Long, Point of collapse methods applied to AC/DC power systems, paper 91 SM 491-1-PWRS, IEEE Power Engineering Society 1991 Summer Meeting, San Diego, CA, July 1991.
- [131] I. Dobson, L. Lu, Computing an optimum direction in control space to avoid saddle node bifurcation and voltage collapse in electric power systems, L.H. Fink ed., *Proceedings: Bulk power system voltage phenomena, voltage stability and security ECC/NSF workshop*, Deep Creek Lake, MD, August 1991, pp. 163-168.
- [132] J.H. Booske, R.F. Cooper, I. Dobson, L. McCaughan, Models of nonthermal effects on ionic mobility during microwave processing of crystalline solids, *Ceramic Transactions*, vol. 21, *Microwaves: Theory and applications in materials processing*, ISBN 0-944904-43-2 (American Ceramic Society, Westerville, OH, 1991), pp. 185-192.
- [133] I. Dobson, L. Lu, Immediate change in stability and voltage collapse when generator reactive power limits are encountered, L.H. Fink ed., *Proceedings: Bulk power system voltage phenomena, voltage stability and security ECC/NSF workshop*, Deep Creek Lake, MD, August 1991, pp. 65-73.
- [134] I. Dobson, L. Lu, Using an iterative method to compute a closest saddle node bifurcation in the load power parameter space of an electric power system, L.H. Fink ed., *Proceedings: Bulk power system voltage phenomena, voltage stability and security ECC/NSF workshop*, Deep Creek Lake, MD, August 1991, pp. 157-161.

- [135] I. Dobson, Power system instabilities, bifurcations and parameter space geometry, *EPRI/NSF Workshop on application of advanced mathematics to power systems, invited paper*, Redwood City, CA, Sept. 1991; appears in EPRI proceedings TR-101795, April 1993, pp 3-20–3-29.
- [136] G. Gray, D.C. Kammer, I. Dobson, Chaos in an attitude maneuver of a damped satellite due to time-periodic perturbations, AAS 92-171, AAS/AIAA Space Flight Mechanics Meeting, Colorado Springs, CO, February 1992.
- [137] I. Dobson, An iterative method to compute the closest saddle node or Hopf bifurcation instability in multidimensional parameter space, *invited paper, International Symposium on Circuits and Systems*, San Diego, CA, May 1992, pp. 2513-2516.
- [138] S.G. Jalali, I. Dobson, R.H. Lasseter, Instabilities due to bifurcation of switching times in a thyristor controlled reactor, *Power Electronics Specialists Conference*, Toledo, Spain, July 1992, pp. 546-552.
- [139] I. Dobson, L. Lu, New methods for computing a closest saddle node bifurcation and worst case load power margin for voltage collapse, 92 SM 587-6 PWRs, *IEEE PES Summer meeting*, Seattle, WA, July 1992.
- [140] I. Dobson, F.L. Alvarado, C.L. DeMarco, Sensitivity of Hopf bifurcations to power system parameters, *invited paper, 31st IEEE Conference on Decision and Control* Tucson, AZ, December 1992, pp. 2928-2933.
- [141] I. Dobson, S.G. Jalali, R. Rajaraman, Damping and resonance in a high power switching circuit, Institute for Math and its Applications workshop paper, Univ. of Minnesota, Minneapolis MN, March 1993.
- [142] T.J. Overbye, I. Dobson, C.L. DeMarco, Q-V Curve interpretations of energy measures for voltage security, 93 WM 184-2 PWRs, *IEEE PES Winter meeting*, Columbus OH, February 1993.
- [143] A. Mazzoleni, I. Dobson, Analytic methods for determining exact stability boundaries for flexible structures, *34th Structures, Structural Dynamics and Materials Conference*, La Jolla, CA, April 1993.
- [144] A. Mazzoleni, I. Dobson, Closest bifurcation analysis applied to design of flexible satellites, AAS/AIAA Space Flight Mechanics Conference, Pasadena, CA, Feb. 1993 (Paper AAS 93-123).
- [145] A. Mazzoleni, I. Dobson, A method for determining exact stability boundaries for flexible satellites with arbitrary position independent damping, AAS/AIAA Space Flight Mechanics Conference Pasadena, CA, Feb. 1993.
- [146] G. Gray, I. Dobson, D.C. Kammer, Detection of chaotic saddles in an attitude maneuver of a spacecraft containing a viscous damper, AAS/AIAA Space Flight Mechanics Conference Feb. 1993, Pasadena, CA.
- [147] R. Rajaraman, I. Dobson, S.G. Jalali, Nonlinear dynamics and switching time bifurcations of a thyristor controlled reactor, *IEEE International Symposium on Circuits and Systems*, Chicago, IL, May 1993, pp. 2180-2183.
- [148] I. Dobson, S.G. Jalali, Surprising simplification of the Jacobian of a switching circuit, *IEEE International Symposium on Circuits and Systems*, Chicago, IL, May 1993, pp. 2652-2655.

- [149] F.L. Alvarado, I. Dobson, Y. Hu, Computation of closest bifurcations in power systems, *IEEE PES Summer meeting*, Vancouver, Canada, July 1993.
- [150] S.G. Jalali, R.H. Lasseter, I. Dobson, Dynamic response of a thyristor controlled switched capacitor, *IEEE PES Winter meeting*, New York, February 1994.
- [151] I. Dobson, The irrelevance of load dynamics for the loading margin to voltage collapse and its sensitivities, Bulk power system voltage phenomena III, Voltage stability, security & control, ECC/NSF workshop, Davos, Switzerland, August 1994, pp. 509-518.
- [152] R. Rajaraman, I. Dobson, Damping and incremental energy in thyristor switching circuits, *invited paper, IEEE International Symposium on Circuits and Systems*, Seattle, Washington, May 1995, pp. 291-294.
- [153] G.A. Luckjiff, I. Dobson, D. Divan, Interpolative sigma delta modulators for high frequency power electronic applications, *Power Electronics Specialists Conference*, Atlanta, Georgia, June 1995, pp. 444-449.
- [154] R. Rajaraman, I. Dobson, R.H. Lasseter, Y. Shern, Computing the damping of subsynchronous oscillations due to a thyristor controlled series capacitor, paper 95SM403-6PWRD, *IEEE PES Summer meeting*, Portland, Oregon, July 1995.
- [155] R. Rajaraman, I. Dobson, Damping estimates of subsynchronous and power swing oscillations in power systems with thyristor switching devices, paper 96WM255-0-PWRS, *IEEE PES Winter meeting*, Baltimore, MD, January 1996.
- [156] S. Greene, I. Dobson, F.L. Alvarado, Sensitivity of the loading margin to voltage collapse with respect to arbitrary parameters, paper 96WM278-2-PWRS, *IEEE PES Winter meeting*, Baltimore, MD, January 1996.
- [157] S. Greene, I. Dobson, F.L. Alvarado, P.W. Sauer, Initial concepts for applying sensitivity to transfer capability, NSF Workshop on Available Transfer Capability, Urbana IL USA, June 1997.
- [158] S. Greene, I. Dobson, F.L. Alvarado, Contingency ranking for voltage collapse via sensitivities from a single nose curve, paper PE-707-PWRS-2-06-1997, *IEEE PES Summer meeting*, Berlin, Germany, July 1997.
- [159] I. Dobson, J. Zhang, S. Greene, H. Engdahl, P.W. Sauer, Is modal resonance a precursor to power system oscillations?, International symposium on Bulk power System Dynamics and Control-IV Restructuring, Santorini, Greece, August 1998, , pp. 659-673.
- [160] G.A. Luckjiff, I. Dobson, Power spectrum of a sigma-delta modulator with hexagonal vector quantization and constant input, *invited paper, IEEE International Symposium on Circuits and Systems*, Orlando, Florida, May 1999, vol. V, pp. 270-273.
- [161] B.A. Carreras, D.E. Newman, I. Dobson, A.B. Poole, Initial evidence for self-organized criticality in electric power system blackouts, *Thirty-third Hawaii International Conference on System Sciences, Maui, Hawaii, January 2000*
- [162] B.A. Carreras, D.E. Newman, I. Dobson, A.B. Poole, Evidence for self-organized criticality in electric power system blackouts, *Thirty-fourth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2001*



- [163] I. Dobson, B.A. Carreras, V. Lynch, D.E. Newman, An initial model for complex dynamics in electric power system blackouts, *Thirty-fourth Hawaii International Conference on System Sciences*, Maui, Hawaii, January 2001
- [164] B.A. Carreras, V.E. Lynch, M.L. Sachtjen, I. Dobson, D.E. Newman, Modeling blackout dynamics in power transmission networks with simple structure, *Thirty-fourth Hawaii International Conference on System Sciences*, Maui, Hawaii, January 2001
- [165] J.G. Wohlbier, J.H. Booske, I. Dobson, New nonlinear multifrequency TWT model, 2nd IEEE International Vacuum Electronics Conference, Huis ter Duin, Noordwijk, Netherlands, April 2001.
- [166] I. Dobson, Strong resonance effects in normal form analysis and subsynchronous resonance, *Bulk Power System Dynamics and Control V*, August 2001, Onomichi, Japan.
- [167] I. Dobson, J. Chen, J.S. Thorp, B.A. Carreras, D.E. Newman, Examining criticality of blackouts in power system models with cascading events, *Thirty-fifth Hawaii International Conference on System Sciences*, Hawaii, January 2002.
- [168] B.A. Carreras, V.E. Lynch, I. Dobson, D.E. Newman, Dynamics, criticality and self-organization in a model for blackouts in power transmission systems, *Thirty-fifth Hawaii International Conference on System Sciences*, Hawaii, January 2002.
- [169] I. Dobson, D.E. Newman, B.A. Carreras, V. Lynch, An initial complex systems analysis of the risks of blackouts in power transmission systems, *Power Systems and Communications Infrastructures for the future*, Beijing, September 2002.
- [170] I. Dobson, B.A. Carreras, D.E. Newman, A probabilistic loading-dependent model of cascading failure and possible implications for blackouts, *Thirty-sixth Hawaii International Conference on System Sciences*, Hawaii, January 2003.
- [171] B.A. Carreras, V.E. Lynch, D.E. Newman, I. Dobson, Blackout mitigation assessment in power transmission systems, *Thirty-sixth Hawaii International Conference on System Sciences*, Hawaii, January 2003.
- [172] I. Dobson, E. Barocio, Perturbations of weakly resonant power system electromechanical modes, *IEEE Bologna Power Tech Conference*, Italy, June 2003.
- [173] J.G. Wohlbier, J.H. Booske, I. Dobson, A new view of phase distortion in a traveling wave tube, *4th IEEE International Conference on Vacuum Electronics*, pp.328-329, May 2003.
- [174] I. Dobson, B.A. Carreras, D.E. Newman, A branching process approximation to cascading load-dependent system failure, *Thirty-seventh Hawaii International Conference on System Sciences*, Hawaii, January 2004.
- [175] B.A. Carreras, V.E. Lynch, D.E. Newman, I. Dobson, Dynamical and probabilistic approaches to the study of blackout vulnerability of the power transmission grid, *Thirty-seventh Hawaii International Conference on System Sciences*, Hawaii, January 2004.
- [176] V. Auvray, I. Dobson, L. Wehenkel, Modifying eigenvalue interactions near weak resonance, *IEEE International Symposium on Circuits and Systems*, Vancouver Canada, May 2004.

- [177] I. Dobson, B.A. Carreras, D.E. Newman, Probabilistic load-dependent cascading failure with limited component interactions, IEEE International Symposium on Circuits and System, Vancouver Canada, May 2004.
- [178] I. Dobson, B.A. Carreras, V. Lynch, D.E. Newman, Complex systems analysis of series of blackouts: cascading failure, criticality, and self-organization Bulk Power System Dynamics and Control - VI, Cortina dAmpezzo, Italy, August 2004.
- [179] I. Dobson, B.A. Carreras, V.E. Lynch, B. Nkei, D.E. Newman, Estimating failure propagation in models of cascading blackouts, Eighth International Conference on Probability Methods Applied to Power Systems, Ames Iowa, Sept. 2004.
- [180] I. Dobson, B.A. Carreras, D.E. Newman, A criticality approach to monitoring cascading failure risk and failure propagation in transmission systems, Electricity Transmission in Deregulated Markets: Challenges, Opportunities and Necessary R&D Agenda, Carnegie-Mellon University, Pittsburgh PA, December 2004.
- [181] D.E. Newman, B.A. Carreras, V.E. Lynch, I. Dobson, The impact of various upgrade strategies on the long-term dynamics and robustness of the transmission grid, Electricity Transmission in Deregulated Markets: Challenges, Opportunities and Necessary R&D Agenda, Carnegie-Mellon University, Pittsburgh PA, December 2004.
- [182] I. Dobson, B.A. Carreras, D.E. Newman, Branching process models for the exponentially increasing portions of cascading failure blackouts, Thirty-eighth Hawaii International Conference on System Sciences, Hawaii, January 2005.
- [183] D.E. Newman, B. Nkei, B.A. Carreras, I. Dobson, V.E. Lynch, P. Gradney, Risk assessment in complex interacting infrastructure systems, Thirty-eighth Hawaii International Conference on System Sciences, Hawaii, January 2005.
- [184] U. Bhatt, D.E. Newman, B.A. Carreras, I. Dobson, Understanding the effect of risk aversion on risk, Thirty-eighth Hawaii International Conference on System Sciences, Hawaii, January 2005.
- [185] D.P. Nedic, I. Dobson, D.S. Kirschen, B.A. Carreras, V.E. Lynch, Criticality in a cascading failure blackout model, Fifteenth Power Systems Computation Conference, Liege Belgium, August 2005.
- [186] I. Dobson, K.R. Wierzbicki, B.A. Carreras, V.E. Lynch, D.E. Newman, An estimator of propagation of cascading failure, Thirty-ninth Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2006.
- [187] K.R. Wierzbicki, I. Dobson, An approach to statistical estimation of cascading failure propagation in blackouts, CRIS, Third International Conference on Critical Infrastructures, Alexandria VA, Sept. 2006.
- [188] B.A. Carreras, D.E. Newman, P. Gradney, V.E. Lynch, I. Dobson, Interdependent risk in interacting infrastructure systems, Fortieth Hawaii International Conference on System Sciences, Hawaii, January 2007.
- [189] I. Dobson, Where is the edge for cascading failure?: challenges and opportunities for quantifying blackout risk, IEEE Power Engineering Society General Meeting, Tampa FL USA, June 2007.

- [190] I. Dobson, K.R. Wierzbicki, J. Kim, H. Ren, Towards quantifying cascading blackout risk, Bulk Power System Dynamics and Control-VII, Charleston, SC, USA, August 2007.
- [191] D.E. Newman, B.A. Carreras, V.E. Lynch, I. Dobson, Evaluating the effect of upgrade, control and development strategies on robustness and failure risk of the power transmission grid, Forty-first Hawaii International Conference on System Sciences, Hawaii, January 2008.
- [192] IEEE PES CAMS Task Force on Cascading Failure, Initial review of methods for cascading failure analysis in electric power transmission systems, IEEE Power and Energy Society General Meeting, Pittsburgh PA USA, July 2008. (Dobson was task lead for this paper)
- [193] J. Cardell, I. Dobson, W. Jewell, M. Kezunovic, T. Overbye, P. K. Sen, D. Tylavsky, L. Beard, F. Galvan, D. Hawkins, The electric power industry and climate change: U.S. research needs, IEEE Power and Energy Society General Meeting, Pittsburgh PA USA, July 2008.
- [194] M. Kezunovic, I. Dobson, Y. Dong, Impact of extreme weather on power system blackouts and forced outages: new challenges, Balkan Power Conference, Sibenik Croatia, September 2008.
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- [203] I. Dobson, Estimating cascading blackout extent using utility data and a branching process, presentation at INFORMS (Institute for operations research and the management sciences) annual meeting, Austin TX, November 2010.

- [204] D.E. Newman, B.A. Carreras, M. Kirchner, I. Dobson, The impact of distributed generation on power transmission grid dynamics, Forty-fourth Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2011.
- [205] I. Dobson, Estimating the extent of cascading transmission line outages using standard utility data and a branching process, summary for panel session at IEEE Power and Energy Society General Meeting, Detroit MI USA, July 2011.
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- [208] D.E. Newman, B.A. Carreras, N.S. Degala, I. Dobson, Risk metrics for dynamic complex infrastructure systems such as the power transmission grid, Forty-fifth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2012.
- [209] H. Sehwal, I. Dobson, Locating line outages in a specific area of a power system with synchrophasors, North American Power Symposium, University of Illinois, Urbana-Champaign IL, September 2012.
- [210] B.A. Carreras, D.E. Newman, I. Dobson, N.S. Degala, Validating OPA with WECC data, Forty-sixth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2013.
- [211] P. Hines, I. Dobson, E. Cotilla-Sanchez, M. Eppstein, “Dual graph” and “random chemistry” methods for cascading failure analysis, Forty-sixth Hawaii International Conference on System Sciences, Maui, Hawaii, January 2013.
- [212] S. Mendoza-Armenta, I. Dobson, A formula for damping interarea oscillations with generator redispatch, IREP Symposium: Bulk Power System Dynamics and Control-IX, Rethymon, Greece, August 2013.
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- [214] I. Dobson, Actionable information from electric transmission grids to ensure their reliability and resilience, position paper, NSF 2013 National Workshop on Energy Cyber Physical Systems, Arlington VA USA, December 2013.
- [215] B.A. Carreras, D.E. Newman, I. Dobson, The impact of size and inhomogeneity on power transmission network complex system dynamics, Forty-seventh Hawaii International Conference on System Sciences, Big Island, Hawaii, January 2014.
- [216] L. Ramirez, I. Dobson, Monitoring voltage collapse margin by measuring the area voltage across several transmission lines with synchrophasors, IEEE Power and Energy Society General Meeting, July 2014, National Harbor MD USA
- [217] PACME working group of the IEEE PES Reliability, risk and probability applications subcommittee, Effects of dependent and common mode outages on the reliability of

bulk electric system – Part I: Basic concepts, IEEE Power and Energy Society General Meeting, July 2014, National Harbor MD USA

- [218] PACME working group of the IEEE PES Reliability, risk and probability applications subcommittee, Effects of dependent and common mode outages on the reliability of bulk electric system – Part II: Outage data analysis, IEEE Power and Energy Society General Meeting, July 2014, National Harbor MD USA
- [219] A. Darvishi, I. Dobson, Synchrophasor monitoring of single line outages via area angle and susceptance, NAPS North American Power Symposium, September 2014, Pullman WA USA
- [220] Reviewer and panelist for DOE Quadrennial Technology Review, December 2014
- [221] B.A. Carreras, D.E. Newman, I. Dobson, Lambda-gaga: toward a new metric for the complex system state of the electrical grid, Forty-eighth Hawaii International Conference on System Sciences, Kauai, Hawaii, January 2015.
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- [223] I. Dobson, Statement to the Federal Energy Regulatory Commission, Reliability Technical Conference Docket No. AD14-9-000, Washington DC, June 4 2015.
- [224] L. Ramirez, I. Dobson, Monitoring voltage collapse margin with synchrophasors across transmission corridors with multiple lines and multiple contingencies, IEEE Power and Energy Society General Meeting, Denver CO, July 2015.
- [225] B. A. Carreras, D. E. Newman, I. Dobson, J. M. Reynolds Barredo, The impact of local power balance and link reliability on blackout risk in heterogeneous power transmission grids, Forty-ninth Hawaii International Conference on System Sciences, January 2016, Kauai, HI USA.
- [226] M. Papic, I. Dobson, Comparing a transmission planning study of cascading with historical line outage data, International Conference on Probability Methods Applied to Power Systems (PMAPS), Beijing China, October 2016.
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- [228] I. Dobson, A. Flueck, S. Aquiles-Perez, S. Abhyankar, J. Qi, Towards incorporating protection and uncertainty into cascading failure simulation and analysis, Probability Methods Applied to Power Systems, Boise, Idaho, USA June 2018.
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- [230] P. Henneaux, E. Ciapessoni, D. Cirio, E. Cotilla-Sanchez, R. Diao, I. Dobson, A. Gaikwad, S. Miller, M. Papic, A. Pitto, J. Qi, N. Samaan, G. Sansavini, S. Uppalapati, R. Yao, Benchmarking quasi-steady state cascading outage analysis methodologies, Probability Methods Applied to Power Systems, Boise, Idaho, USA June 2018.

- [231] N. Nayak, L. Zhang, K. Martin, I. Dobson, A. Bose, D.J. Sobajic, Practical implementation of synchrophasor based real-time contingency analysis, North American Power Symposium, Fargo ND, September 2018.
- [232] B.A. Carreras, J. M. Reynolds Barredo, I. Dobson, D.E. Newman, Validating the OPA cascading blackout model on a 19402 bus transmission network with both mesh and tree structures, Fifty-second Hawaii International Conference on System Sciences, Maui, HI January 2019  
Best paper award
- [233] L. Zhang, K. Martin, N. Nayak, I. Singh, I. Dobson, A. Bose, D. Sobajic, Real-time synchrophasor applications to support power system operations, PAC World Americas Conference, Raleigh NC, August 2019.
- [234] M.R. Kelly-Gorham, P. Hines, I. Dobson, Using historical utility outage data to compute overall transmission grid resilience, Modern Electric Power Systems Conference, Wrocław Poland, September 2019.
- [235] A.J. Flueck, I. Dobson, Z. Huang, N.E. Wu, R. Yao, G. Zweigle, Dynamics and protection in cascading outages, IEEE Power and Energy Society General Meeting, Montreal CA, August 2020.
- [236] N. K. Carrington, S. Ma, I. Dobson, Z. Wang, Extracting resilience statistics from utility data in distribution grids, IEEE Power and Energy Society General Meeting, Montreal CA, August 2020.
- [237] M.R. Kelly-Gorham, P. Hines, K. Zhou, I. Dobson, Using utility outage statistics to quantify improvements in bulk power system resilience, Power Systems Computation Conference, Porto, Portugal, 2020.
- [238] K. Zhou, I. Dobson, Z. Wang, Can the Markovian influence graph simulate cascading resilience from historical outage data?, Probability Methods Applied to Power Systems, Liege, Belgium, August 2020.
- [239] K. Zhou, J.R. Cruise, C.J. Dent, I. Dobson, L. Wehenkel, Z. Wang, A.L. Wilson, Applying Bayesian estimates of individual transmission line outage rates, Probability Methods Applied to Power Systems, Liege, Belgium, August 2020.
- [240] A.L. Bowker, D.E. Newman, B.A. Carreras, D. Huang, I. Dobson, C. Koplin, Characteristics and risk of microgrid outages from a complex systems point of view, Fifty-fourth Hawaii International Conference on System Sciences, January 2021.
- [241] S. Ekisheva, R. Rieder, J. Norris, M. Lauby, I. Dobson, Impact of extreme weather on North American transmission system outages, IEEE Power and Energy Society General Meeting, Washington DC USA, July 2021.
- Nichelle'Le K. Carrington, I. Dobson, Z. Wang, Transmission grid outage statistics extracted from a web page logging outages in Northeast America, North American Power Symposium, College Station TX USA, November 2021. Best paper award.

### Students

(all degrees are in Electrical and Computer Engineering unless noted.)

- Liming Lu, MS 1991, Immediate change in stability and voltage collapse when power system limits are encountered.

- Andre Mazzoleni, PhD in Engineering Mechanics 1992, Comparative study of stability of flexible satellites with and without guy-wire constraints. (joint supervision with A.L. Schlack, Engineering Mechanics).  
Associate Professor at North Carolina State University in Mechanical & Aerospace Engineering.
- Sasan Jalali, PhD 1993, Harmonics and instabilities in thyristor based switching circuits. (joint supervision with R.H. Lasseter, ECE).  
Federal Energy Regulatory Commission, Washington DC
- Gary L. Gray, PhD in Engineering Mechanics, 1993, Chaos in the attitude dynamics of an internally damped satellite due to nonautonomous perturbations. (joint supervision with D. Kammer, Engineering Mechanics).  
Associate Professor at Penn State in Engineering Science and Mechanics.
- Rajesh Rajaraman, PhD 1996, Dynamics, damping & resonance in switching circuits.  
Vice president at L.R. Christensen Associates, Madison WI.
- Scott Greene, MS 1993, Constraint at a saddle node bifurcation.
- Scott Greene, PhD 1998, Margin & sensitivity methods for power system security  
University of Wisconsin-Madison
- John Wohlbier, MS 2000 Modeling and analysis of a traveling wave tube under multitone excitation. (joint supervision with J.H. Booske, ECE)
- John Wohlbier, PhD 2003 Nonlinear distortion and suppression in traveling wave tubes: insights and methods (joint supervision with J.H. Booske, ECE).  
computational scientist, Ci Software Associates/Engility Copr. Washington DC
- Glen Luckjiff, PhD 2003, Sigma delta modulators with hexagonal quantization  
Finance industry
- Kevin Wierzbicki, MS 2006, Predicting blackout size distribution by estimating branching process parameters.  
Federal Energy Regulatory Commission, Washington DC.
- JangHoon Kim, MS 2008, Properties of the branching model and the cascading model of the failure propagation of the power network.
- JangHoon Kim, PhD 2011, Quantifying failure propagation in electric power transmission systems.  
Samsung Corporation, South Korea.
- Hussam Sehwal, MS 2012, Initial applications of synchrophasors using area angles.  
International Transmission Company, Novi MI.
- Lingyun Ding, MS 2014, An initial exploration of spatial spreading of cascading failure in an electric power system.
- Atena Darvishi, PhD 2015, Monitoring of single and multiple line outages with synchrophasors in areas of the power system  
New York Power Authority, White Plains, NY.
- Lina M. Ramirez-Arbalaez, PhD 2016, Monitoring voltage stability margin across several transmission lines using synchrophasor measurements  
XM Colombia.

- Sameera Kancherla, MS 2017, Data analysis of transmission line restoration times. PPL Electric Utilities–EASi LLC, PA
- Vikram Chiluka, MS 2017, New areas for fast synchrophasor monitoring of multiple overloads with area angles  
Electric Power Group, Pasadena CA.
- Joe Eilers, MS 2020, Testing the robustness of electric transmission expansion plans of an independent system operator,  
MISO (Midcontinent Independent System Operator).
- Shikha Sharma, PhD 2020 Planning the electric power grid with centralized and distributed technologies (joint supervision with J.D. McCalley),  
Hitachi ABB Power Grids, San Jose CA
- Kai Zhou, PhD in progress (joint supervision with Z. Wang)
- Nichelle'Le K. Carrington, PhD in progress (joint supervision with Z. Wang)

### Visiting Scholars

- Henrik Engdahl (visiting from KTH Sweden) 1997-1998  
Computations for power system oscillations
- Emilio Barocio (visiting from CINVESTAV Mexico), 2001-2002  
Normal form analysis of power systems and resonant power system oscillations
- Vincent Auvray (visiting from University of Liège, Belgium), 2003-2004  
Interaction of eigenvalues near resonance
- Jaime Arroyo (visiting from CINVESTAV Mexico), 2005-2006  
Finding power system resonances and counterexamples
- Hui Ren (visiting from North China Electric Power University) 2006-2007  
Assessment of security criteria as self-organizing complex systems feedbacks
- Prof. Hao Wu (visiting from Zhejiang University, China) 2009-2011  
Cascading stall in induction motors
- Junjian Qi (visiting from Tsinghua University, China) 2012  
Applying branching processes to cascading failure
- Dr. Sarai Mendoza-Armenta (visiting from University of Michagoan, Mexico)  
Visitor 2012-2013  
Postdoctoral scholar 2014-2015  
Suppressing inter-area oscillations