Manish K. Singh

Assistant Professor, Electrical & Computer Engineering, Univ. of Wisconsin–Madison

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Education

June 2021 **Ph.D. Electrical Engineering**, *Virginia Tech.*
Advisor: Vassilis Kekatos
Thesis: Optimization, Learning, and Control for Energy Networks

May 2020 **Graduate Certificate in Data Analytics**, *Virginia Tech.*

Dec 2018 **M.S., Electrical Engineering**, *Virginia Tech.*
Advisor: Vassilis Kekatos
Thesis: Optimal operation of water and power distribution networks

May 2013 **B.Tech., Electrical Engineering**, *Indian Institute of Technology (BHU), Varanasi.*

Research Interests

My research interests are focused on optimization, control, and learning techniques to develop algorithmic solutions for the operation and analysis of electric power systems. Recently, I have been revisiting classical modeling assumptions in power systems and developing rigorous methods to accommodate the paradigm change due to integration of renewable energy technologies, grid edge devices and large power-system loads.

Keywords: Power system optimization and control, stability analysis, grid resilience, model reduction, convex and mixed-integer programming, deep learning, graph theory, network flows, power system modeling, stochastic optimization

Academic/Research Appointments

Nov 2023-present **Assistant Professor**, *ECE Department, UW-Madison.*

Jul 2021-Nov 2023 **Postdoctoral Associate**, *Univ. of Minnesota, with G. Giannakis and S. Dhople.*

Jun 2017-Jun 2021 **Graduate Research Associate**, *Virginia Tech, with Vassilis Kekatos.*

May 2020-Aug 2020 **Postgraduate Intern**, *National Renewable Energy Laboratory, Denver, CO.*

Publications

(Google Scholar profile)

Journal Articles

[1] V. Kekatos, R. Annin, **M. K. Singh**, and J. Qin, "Solving optimal power flow on a data budget: Feature selection on smart meter data," *IEEE Transactions on Power Systems*, vol. 41, no. 3, pp. 1978–1991, May 2026.

[2] ——, "Scheduling distributed energy resources under limited observability of distribution grids," *Sustainable Energy, Grids and Networks*, vol. 43, p. 101866, 2025, presented at the 12th Bulk Power Systems Dynamics and Control Symposium (IREP), Sorrento, Italy, Jul. 2025.

[3] Z. Yuan, G. Cavraro, **M. K. Singh**, and J. Cortés, "Learning provably stable local Volt/Var controllers for efficient network operation," *IEEE Transactions on Power Systems*, vol. 39, no. 1, pp. 2066–2079, Jan. 2024.

[4] M. Jalali, **M. K. Singh**, V. Kekatos, G. B. Giannakis, and C.-C. Liu, "Fast inverter control by learning the OPF mapping using sensitivity-informed Gaussian processes," *IEEE Transactions on Smart Grid*, vol. 14, no. 3, pp. 2432–2445, May 2023.

[5] **M. K. Singh** and V. Kekatos, "Optimal power flow schedules with reduced low-frequency oscillations," *Electric Power Systems Research*, vol. 212, p. 108301, Nov. 2022, presented at the Power Systems Computation Conference (PSCC), Porto, Portugal, Jun. 2022.

[6] **M. K. Singh**, V. Kekatos, and G. B. Giannakis, "Learning to solve the AC-OPF using sensitivity-informed deep neural networks," *IEEE Transactions on Power Systems*, vol. 37, no. 4, pp. 2833–2846, Jul. 2022.

[7] **M. K. Singh**, S. Dhople, F. Dörfler, and G. B. Giannakis, "Time-domain generalization of Kron reduction," *IEEE Control Systems Letters*, vol. 7, pp. 259–264, Jun. 2022.

[8] S. Biswas, **M. K. Singh**, and V. Centeno, "Chance-constrained optimal distribution network partitioning to enhance power grid resilience," *IEEE Access*, vol. 9, pp. 42 169–42 181, Mar. 2021.

[9] **M. K. Singh** and V. Kekatos, "On the flow problem in water distribution networks: Uniqueness and solvers," *IEEE Transactions on Control of Network Systems*, vol. 8, no. 1, pp. 462–474, Mar. 2021.

[10] ——, "Natural gas flow solvers using convex relaxation," *IEEE Transactions on Control of Network Systems*, vol. 7, no. 3, pp. 1283–1295, Sep. 2020.

[11] ——, "Optimal scheduling of water distribution systems," *IEEE Transactions on Control of Network Systems*, vol. 7, no. 2, pp. 711–723, Jun. 2020.

Conference Papers

[12] P. Zhang, L. Roald, and **M. K. Singh**, "Optimal measurement selection for certifiable voltage monitoring in power distribution systems," in *Proc. Hawaii International Conference on System Sciences (HICSS)*, Jan. 2027, accepted.

[13] E. Haag, Y. Chen, G. Venkataramanan, and **M. K. Singh**, "Assessing power flow controllability via variable line reactance," in *Proc. IEEE PES General Meeting*, Montreal, Canada, Jul. 2026.

[14] Y. Huang, D. B. Sapkota, and **M. K. Singh**, "Optimal singular perturbation-based model reduction for heterogeneous power systems," in *Proc. IEEE PES General Meeting*, Montreal, Canada, Jul. 2026.

[15] Y. Chen and **M. K. Singh**, "Optimally linearizing power flow equations for improved power system dispatch," in *Proc. IEEE Conference on Decision and Control (CDC)*, Rio de Janeiro, Brazil, Dec. 2025.

[16] B. C. Lesieutre and **M. K. Singh**, "Model expansion to realize preferred topologies," in *Proc. Allerton Conference on Communication, Control, and Computing*, Allerton, IL, Sep. 2025, invited paper.

[17] A. Gupta, **M. K. Singh**, and V. Kekatos, "Incorporating power system stability metrics into the optimal power flow," in *Proc. American Control Conference (ACC)*, Denver, CO, Jul. 2025, pp. 723–728.

[18] V. Kekatos, R. Annin, **M. K. Singh**, and J. Qin, "Scheduling distributed energy resources under limited observability of distribution grids," in *Proc. 12th Bulk Power Systems Dynamics and Control Symposium (IREP)*, Sorrento, Italy, Jul. 2025, journal version: Sustainable Energy, Grids and Networks, 2025.

[19] K. D. Polyzos, P. A. Traganitis, **M. K. Singh**, and G. B. Giannakis, "Ensembles of informative representations for self-supervised learning," in *Proc. IEEE International Workshop on Machine Learning for Signal Processing (MLSP)*, London, UK, Sep. 2024, best paper award, second place.

[20] H. T. Jung, S. Helman, **M. K. Singh**, and S. Dhople, "Inferences from numerical model reduction and aggregation of power-system dynamics featuring primary and secondary control," in *Proc. IEEE PES General Meeting*, Seattle, WA, Jul. 2024.

[21] H. T. Jung, D. Venkatramanan, **M. K. Singh**, and S. Dhople, "Per-unit dynamic models for grid-following photovoltaic inverters," in *Proc. IEEE Photovoltaic Specialists Conference (PVSC)*, San Juan, PR, Dec. 2023.

[22] **M. K. Singh**, K. D. Polyzos, P. A. Traganitis, S. Dhople, and G. B. Giannakis, "Physics-informed transfer learning for voltage stability margin prediction," in *Proc. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Rhodes, Greece, Jun. 2023.

[23] G. Cavraro, Z. Yuan, **M. K. Singh**, and J. Cortés, "Learning local Volt/Var controllers towards efficient network operation with stability guarantees," in *Proc. IEEE Conference on Decision and Control (CDC)*, Cancún, Mexico, Dec. 2022.

[24] **M. K. Singh**, D. Venkatramanan, and S. Dhople, "Towards optimal primary- and secondary-control design for networks with generators and inverters," in *Proc. 53rd Annual Allerton Conference on Communication, Control, and Computing*, Allerton, IL, Sep. 2022, invited paper.

[25] D. Venkatramanan, **M. K. Singh**, O. Ajala, A. Dominguez-Garcia, and S. Dhople, "Integrated system models for networks with generators and inverters," in *Proc. 11th Bulk Power Systems Dynamics and Control Symposium (IREP)*, Banff, Canada, Jul. 2022, first two authors contributed equally.

[26] **M. K. Singh**, S. Taheri, V. Kekatos, K. P. Schneider, and C.-C. Liu, "Joint grid topology reconfiguration and design of Watt-VAR curves for DERs," in *Proc. IEEE PES General Meeting*, Denver, CO, Jul. 2022.

[27] **M. K. Singh**, D. Venkatramanan, S. Dhople, B. Kroposki, and G. B. Giannakis, "Unifying energy-management problems for inverter-based power networks," in *Proc. IFAC Conference on Networked Systems (NecSys)*, Zurich, Switzerland, Jul. 2022.

[28] G. Cavraro, **M. K. Singh**, and A. Bernstein, "Emergency voltage regulation in power systems via ripple-type control," in *Proc. Mediterranean Conference on Control and Automation (MED)*, Bari, Italy, Jun. 2021.

[29] **M. K. Singh**, G. Cavraro, A. Bernstein, and V. Kekatos, "Ripple-type control for enhancing resilience of networked physical systems," in *Proc. American Control Conference (ACC)*, New Orleans, LA, May 2021.

[30] **M. K. Singh**, S. Gupta, V. Kekatos, G. Cavraro, and A. Bernstein, "Learning to optimize power distribution grids using sensitivity-informed deep neural networks," in *Proc. IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm)*, Tempe, AZ, Nov. 2020.

[31] N. Sahani, **M. K. Singh**, and C.-C. Liu, "Moving horizon-based optimal scheduling of EV charging: A power system-cognizant approach," in *Proc. IEEE PES General Meeting*, Montreal, Canada, Aug. 2020, best paper session.

[32] **M. K. Singh** and V. Kekatos, "Natural gas flow equations: Uniqueness and an MI-SOCP solver," in *Proc. American Control Conference (ACC)*, Philadelphia, PA, Jul. 2019.

[33] **M. K. Singh**, V. Kekatos, and C.-C. Liu, "Optimal distribution system restoration with microgrids and distributed generators," in *Proc. IEEE PES General Meeting*, Atlanta, GA, Aug. 2019.

[34] I. S. Jha, S. Sen, M. Tiwari, and **M. K. Singh**, "Control strategy for frequency regulation using battery energy storage with optimal utilization," in *Proc. IEEE 6th India International Conference on Power Electronics (IICPE)*, Kurukshetra, India, 2014, pp. 1–4.

[35] **M. K. Singh** and P. N. Reddy, "A fast adaptive protection scheme for distributed generation connected networks with necessary relay coordination," in *Proc. Students Conference on Engineering and Systems (SCES)*, Allahabad, India, Apr. 2013, pp. 1–5.

Theses

[36] **M. K. Singh**, "Optimization, learning, and control for energy networks," Ph.D. dissertation, Virginia Tech, 2021, advisor: Vassilis Kekatos.

[37] ——, "Optimal operation of water and power distribution networks," Master's thesis, Virginia Tech, 2018, advisor: Vassilis Kekatos.

Patents

[38] G. Cavraro, A. Bernstein, and **M. K. Singh**, "Ripple-type control of networked physical systems," U.S. Patent US11,982,979, issued May 14, 2024; application 17/501,743 filed Apr. 2022, 2024.

[39] G. Cavraro and **M. K. Singh**, "Local Volt/Var controllers with stability guarantees," U.S. Patent Application 18/337,578, filed Jan. 2024, 2024.

Book Chapters

[40] V. Kekatos and **M. K. Singh**, "Deep learning techniques for solving optimal power flow problems," in *Smart Cyber-Physical Power Systems: Solutions from Emerging Technologies, Volume 2*,

A. Parizad, H. R. Baghaee, and S. Rahman, Eds. John Wiley & Sons, Feb. 2025, ch. 17, pp. 471–500, refereed.

Refereed Abstracts and Posters

[41] D. B. Sapkota, Y. Huang, and **M. K. Singh**, "Optimal state transformations for singular perturbation-based model reduction of heterogeneous power systems," in *PowerUp Conference*, Boulder, CO, Sep. 2026, refereed abstract, presented as a poster.

[42] Y. Chen and **M. K. Singh**, "How many phase-shifting transformers are enough? Quantifying flow flexibility in meshed networks," in *PowerUp Conference*, Boulder, CO, Sep. 2026, refereed abstract, presented as a poster.

[43] P. Zhang, L. Roald, and **M. K. Singh**, "Optimal measurement selection for certifiable voltage monitoring in distribution grids," in *PowerUp Conference*, Boulder, CO, Sep. 2026, refereed abstract, presented as a poster.

[44] **M. K. Singh**, S. Gupta, and V. Kekatos, "Machine learning for optimal inverter operation in distribution grids," in *Proc. 55th Annual Conference on Information Sciences and Systems (CISS)*, Baltimore, MD, 2021, p. 1, published abstract, invited talk.

Technical Reports

[45] D. Venkatramanan, R. Henriquez-Auba, M. R. Rachi, J. T. Bui, **M. K. Singh**, D. Ramasubramanian, A. Hoke, B. Kroposki, and S. Dhople, "Grid-forming inverter technology specifications: A review of research reports and roadmaps," Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium, Tech. Rep. UNIFI-2022-1-1, Nov. 2022, non-refereed.

[46] **M. K. Singh**, V. Kekatos, S. Taheri, K. P. Schneider, and C.-C. Liu, "Enforcing radiality constraints for DER-aided power distribution grid reconfiguration," arXiv, Tech. Rep. arXiv:1910.03020, 2019.

Funded Research

2026–2028 **Improving grid strength and flexibility using grid-enhancing technologies**, *Power Systems Engineering Research Center (PSERC), Project S-117.*
Role: Project Leader (PI). Total award $220,000; UW–Madison share $80,000. With Prof. Bai Cui and Prof. Venkataramana Ajjarapu, Iowa State University.

2025–2028 **Use-Inspired Power Flow Modeling for Optimization and Dynamics Applications**, *National Science Foundation, Award ECCS-2453151.*
Role: Sole PI. Total award $425,288.

Industry Experience

Jul 2013-Jul 2016 **Engineer**, *Smart Grid Department, Power Grid Corp. of India Ltd., Gurgaon, India.*
The broad job responsibilities included feasibility studies and project report preparation for smart cities and transmission systems, smart grid project management, load flow analysis and simulation studies for proposed grid infrastructure. I was also involved in technology development with academic institutions, providing inputs to government organization in drafting policies and roadmap for energy storage, renewable generation, rooftop solar, ancillary services etc.

May 2012-Jul 2012 **Project Intern**, *Tata Steel, West Bokaro, India.*
Carried out a project on reduction of specific energy consumption of coal washeries and made recommendations with total reduction potential of 0.927kWh/tonne of coal treated. The financial impact was an annual Saving of INR 12.3 Million with capital investment of around INR 2.8 Million.

May 2011-Jun 2011 **Summer Intern**, *National Thermal Power Corporation, Kaniha, India.*
Studied the processes, structure and organization of the 6 X 500 MW coal-based thermal power plant, and associated switchyard.

Dec 2011 **Vocational Trainee**, *Bharat Heavy Electricals Ltd., Bhopal, India.*
Studied the processes involved in designing, manufacturing and testing of transformers up to 800 MVA.

Teaching Experience

Spring 2026 **Course Instructor**, *Advanced Power Systems*, Univ. of Wisconsin–Madison.
Teaching a graduate course, ECE 723, on power systems optimization and control.

Fall 2024, 2025 **Course Instructor**, *Electric Power Systems*, Univ. of Wisconsin–Madison.
Teaching a senior undergraduate course, ECE 427, on power systems.

Spring 2024, 2025 **Course Instructor**, *Signals & Systems*, Univ. of Wisconsin–Madison.
Teaching a foundational undergraduate course, ECE 330, for sophomores/juniors.

Fall 2022 **Mentor**, *Senior Design Project*, Univ. of Minnesota.
Mentored a group of five undergraduates for their senior design project on "Learning-based electric load disaggregation at varying timescales".

Fall 2020 **Guest Lecturer**, *Power Distribution System Analysis*, Virginia Tech.
Delivered lectures on mixed-integer optimization models for distribution grids. Focused on contemporary modeling and algorithmic solutions for network restoration and reconfiguration problems.

Spring 2017 **Course Instructor**, *Power Engineering Laboratory*, Virginia Tech.
Instructed three sections of the power laboratory course meant for junior undergraduate students in electrical engineering. The course included experiments on transformers, AC and DC machines, transmission lines, and power electronic circuits.

Fall 2016 **Teaching Assistant**, *Signals and Systems*, Virginia Tech.
Served as a teaching assistant for the sophomore-level signals and systems course. The course introduced students to various continuous and discrete transforms, solving differential equations, stability criteria, and system design.

Invited Talks

Apr 2026 "Improving grid strength and flexibility using grid-enhancing technologies" - Wisconsin Energy Institute Sustainable Energy Seminar, Madison

Dec 2025 "Improving grid strength and flexibility using grid-enhancing technologies" - PSERC Annual Meeting, Arlington

Aug 2025 "Optimal Power Flow Sensitivities: Analysis & Applications" - IEEE PES Lecture, Orange County Section, CA (virtual)

Sep 2024 "Optimal Power Flow Sensitivities: Analysis & Applications" - National Renewable Energy Laboratory, Golden

Jul 2024 "Advancing analysis and design of energy systems: A tale of monotonicity and sensitivity" - IEEE PES General Meeting, Seattle

Jul 2024 "DER Upsurge: Challenges and Opportunities" - PSERC Summer Workshop, Seattle

Mar 2024 "Optimal Power Flow Sensitivities: Analysis & Applications" - Iowa State University, Ames

Dec 2023 "Data-driven optimization and control for power systems" - PSERC Annual Meeting, Georgia Tech, Atlanta

Jul 2023 "Data-driven optimization and control for power distribution systems" - IEEE PES General Meeting, Orlando

Apr 2023 "Modeling and Analysis of Energy Networks: System-theoretic Solutions to Fundamental Challenges" - Washington State University, Pullman

Mar 2023 "Modeling and Analysis of Energy Networks: System-theoretic Solutions to Fundamental Challenges" - University at Buffalo (SUNY), Buffalo

Feb 2023 "Modeling and Analysis of Energy Networks: System-theoretic Solutions to Fundamental Challenges" - Carnegie Mellon University, Pittsburgh

Feb 2023 "Modeling and Analysis of Energy Networks: System-theoretic Solutions to Fundamental Challenges" - UW-Madison, Madison

Nov 2020 "Ripple-Type Control for Enhancing Resilience of Networked Physical Systems" - INFORMS Annual Meeting, Virtual

Oct 2019 "Flow Solvers for Natural Gas and Water Distribution Networks" - INFORMS Annual Meeting, Seattle

Mar 2019 "Solvers of Natural Gas and Water Flow Problems" - Conference on Information Sciences and Systems, Johns Hopkins University, Baltimore

Honors, Awards, and Professional Development

2024 IEEE Power & Energy Society Outstanding Doctoral Dissertation Award

2024 Elevated to the grade of IEEE Senior Member

2024 Best paper award (second place) at IEEE International Workshop on Machine Learning for Signal Processing

2022 Second prize, Bill and LaRue Blackwell Graduate Research Award for best dissertation

2022 Shortlisted among the top five finalists globally for ABB Research Award

2019-21 Prasad Scholarship, Dept. of Electrical and Computer Engineering, Virginia Tech

2019-20 Planning Officer, Indian Students Association, Virginia Tech

2019 Winner, 'Frame that Problem', INFORMS Annual Meeting, Seattle

2012-13 General Secretary of the Electrical Engineering Society, IIT (BHU), Varanasi

2007 Received the prestigious Kishore Vaigyanik Protsahan Yojana (KVPY) fellowship by Government of India

2006 Gold medal for Junior Science Olympiad and honorary mentioned in Junior Mathematics Olympiad, Atomic Energy Education Society, India

Service

Grant Proposal Reviewer

Feb 2026 National Science Foundation; Engineering Directorate.

June 2025 National Science Foundation; Social, Behavioral, and Economic Sciences Directorate.

April 2025 National Science Foundation; Engineering Directorate.

April 2024 National Science Foundation; Engineering Directorate.

Nov 2023 National Science Foundation; Engineering Directorate.

Jan 2023 National Science Foundation; Engineering Directorate.

Conference and Session Organization

2026 Technical Program Committee member, PowerUp Conference, Boulder, CO

2026 Session co-chair, "Electricity markets", PowerUp Conference, Boulder, CO

2025 Session co-chair, "Modern power and energy systems I", IEEE Conference on Decision and Control, Rio de Janeiro, Brazil

2023–25 Technical Program Committee member, IEEE Int. Conf. Comm., Contr., & Comp. Tech. for Smart Grids (SmartGridComm)

Departmental and University Service

2024–27 Faculty Senator, UW–Madison
2026– Director, Alvarado Sustainability Scholars program
2025– Graduate Admissions and Fellowships (GRAF) committee, ECE
2024–25 Accelerated MS steering committee, ECE
2023–24 Diversity, Equity, and Inclusion committee, ECE

Conference Reviewer

IEEE Power & Energy Society General Meeting (PES GM)
Power Systems Computation Conference (PSCC)
IEEE American Control Conference (ACC)
IEEE Conference on Decision and Control (CDC)
Learning for Dynamics & Control (L4DC)
IEEE Int. Conf. Comm., Contr., & Comp. Tech. for Smart Grids (SmartGridComm)
Hawaii International Conference on System Sciences (HICSS)
North American Power Symposium (NAPS)
IEEE Conference on Innovative Smart Grid Technologies, North America (ISGT NA)
PowerUp Conference
National Power Systems Conference (NPSC)
Indian Control Conference (ICC)

Journal Reviewer

IEEE Transactions on Power Systems
IEEE Transactions on Smart Grid
IEEE Transactions on Energy Markets, Policy and Regulation
IEEE Transactions on Control of Network Systems
IEEE Transactions on Automatic Control
IEEE Transactions on Energy Conversion
IEEE Control Systems Letters
IEEE Power Engineering Letters
IET Generation, Transmission & Distribution