Yifan Zhou

Personal Information

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Research Interests

Artificial Intelligence Driven Smart Grid, Microgrid and Networked Microgrids, Formal Analysis, Quantum Computing

Education and Visiting Experience

Ph.D. of Electrical Engineering, Tsinghua University Sep. 2014 – Jul. 2019
Beijing, China

- Supervisor: Yong Min, Professor
- Thesis: Integrated Power and Heat Dispatch Methodology Based on Operational Flexibility
- GPA: 92.0/100, Rank: **5/58**

Visiting Graduate at SEAS, Harvard University May. 2018 – Oct. 2018
Boston, MA, USA

- Supervisor: Na Li, Gordon McKay Professor

Visiting Graduate at School of EESE, University of Birmingham Apr. 2016 – Jul. 2016
Birmingham, UK

- Supervisor: Xiao-Ping Zhang, Professor

B. Sc. of Electrical Engineering, Tsinghua University Sep. 2010 – Jul. 2014
Beijing, China

- GPA: 93.1/100, Rank: **1/132**
- **Outstanding Graduate of Tsinghua University (1.5%)**, Outstanding Graduate of Beijing, Outstanding Thesis Award

Publications

Highlights: **10 first-author** papers in top-tier journals and conferences including TPWRS, TSTE, EGY, PESGM.

Books

[B1] Peng Zhang, Walter O. Krawec, Zefan Tang, **Yifan Zhou**, "Quantum Grids", Cambridge University Press, to be published in 2022.

[B2] **Yifan Zhou**, Peng Zhang, "Power System Reachability Analytics", Cambridge University Press, under preparation.

Journal Publications

[J1] Fei Feng, Peng Zhang, **Yifan Zhou**, " *Authentic microgrid state estimation*", IEEE Transactions on Power Systems (**TPWRS**), accepted, Jan. 2022.

[J2] Fei Feng, Peng Zhang, **Yifan Zhou**, Zefan Tang" *Quantum Microgrid State Estimation*", Electric Power Systems Research, accepted, Jan. 2022.

[J3] **Yifan Zhou**, Peng Zhang, " *Neuro-Reachability of Networked Microgrids*", IEEE Transactions on Power Systems (**TPWRS**), vol. 37, no. 1, pp. 142-152, Jan. 2022.

[J4] Lizhi Wang, **Yifan Zhou**, Wenfeng Wan, Peng Zhang, " *Eigenanalysis of Delayed Networked Microgrids*", IEEE Transactions on Power Systems (**TPWRS**), vol. 36, no. 5, pp. 4860-4863, Sept. 2021.

[J5] **Yifan Zhou**, Fei Feng, Peng Zhang, " *Quantum Electromagnetic Transient Program*", IEEE Transactions on Power Systems (**TPWRS**), vol. 36, no. 4, pp. 3813-3816, Jul. 2021.

[J6] Fei Feng, **Yifan Zhou**, Peng Zhang, " *Quantum Power Flow*", IEEE Transactions on Power Systems (**TPWRS**), vol. 36, no. 4, pp. 3810-3812, Jul. 2021.

[J7] **Yifan Zhou**, Peng Zhang, " *Reachable Dynamics of Networked Microgrids with Large Disturbances*", IEEE Transactions on Power Systems (**TPWRS**), vol. 36, no. 3, pp. 2416-2427, May. 2021.

[J8] **Yifan Zhou**, Peng Zhang, " *Reachable Power Flow: Theory to Practice*", IEEE Transactions on Power Systems (**TPWRS**), vol. 36, no. 3, pp. 2532-2541, May. 2021.

[J9] **Yifan Zhou**, Peng Zhang, " *Reachable Eigenanalysis*", IEEE Transactions on Power Systems (**TPWRS**), vol. 35, no. 6, pp. 4936-4939, Nov. 2020.

[J10] **Yifan Zhou**, Peng Zhang, " *Reachable Power Flow*", IEEE Transactions on Power Systems (**TPWRS**), vol. 35, no. 4, pp. 3290-3293, Jul. 2020.

[J11] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Power and Energy Flexibility of District Heating System and Its Application in Integrated Power and Heat Dispatch*", Energy (**EGY**), vol. 190, Jan. 2020.

[J12] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Integrated Power and Heat Dispatch Considering Available Reserve of Combined Heat and Power Units*", IEEE Transactions on Sustainable Energy (**TSTE**), vol. 10, no. 3, pp. 1300-1310, Jul. 2019.

[J13] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Active Splitting Strategy Searching Approach Based on MISOCP with Consideration of Island Stability*", Journal of Modern Power Systems and Clean Energy, vol. 7, no. 3, pp. 475-490, 2019.

[J14] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Modeling and Optimization of Multitype Power Sources Stochastic Unit Commitment Using Interval Number Programming*", Journal of Energy Engineering, vol. 143, no. 5, 2017.

[J15] Wei Hu, Yong Min, **Yifan Zhou**, *et al* " *Wind Power Forecasting Errors Modelling Approach Considering Temporal And Spatial Dependence*", Journal of Modern Power Systems and Clean Energy, vol. 5, no. 3, 2017.

[J16] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, "*Peak Regulation Compensation Price Decision for Combined Heat and Power Unit and Profit Allocation Method*", Proceedings of the Chinese Society for Electrical Engineering, vol.39, no.18, pp. 5325-5335+5579, 2019.

[J17] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, "*Coordinated Power and Heat Dispatch Considering Peak Regulation Initiative of Combined Heat and Power Unit*", Automation of Electric Power Systems, vol.43, no.19, pp. 42-51, 2019.

[J18] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Dynamic Comprehensive Evaluation of Chinese Power System Development Level Based on Provincial Data*", Automation of Electric Power Systems, vol.40, no.18, pp. 76-83, 2016.

Journal Papers Under Review

[J19] Dmitrii A. Etingov, Peng Zhang, Zefan Tang, **Yifan Zhou**, "*AI-Enabled Traveling Wave Protection for Microgrids*", IElectric Power Systems Research , under revision, in Nov. 2021.

[J20] **Yifan Zhou**, Peng Zhang, "*Noisy Intermediate-Scale Quantum Electromagnetic Transients Program*", IEEE Transactions on Power Systems (**TPWRS**) , under revision, Oct. 2021.

[J21] **Yifan Zhou**, Peng Zhang, "*Noise-Resilient Quantum Machine Learning for Power System Stability Assessment*", IEEE Transactions on Power Systems (**TPWRS**) , under revision, Sep. 2021.

[J22] **Yifan Zhou**, Peng Zhang, "*Stochastic Reachable Dynamics of Microgrids*", Electric Power Systems Research, submitted in Sep. 2021.

[J23] Fei Feng, **Yifan Zhou**, Peng Zhang, "*Networked microgrids power flow*", IEEE Transactions on Power Systems (**TPWRS**), submitted in Sep. 2021.

[J24] Fei Feng, Peng Zhang, Mikhail Bragin, **Yifan Zhou**, "*Novel Resolution of Unit Commitment Problems through Quantum Surrogate Lagrangian Relaxation*", IEEE Transactions on Power Systems (**TPWRS**), submitted in Sep. 2021.

Conference Publications

[C1] **Yifan Zhou**, Peng Zhang, "*Neural Electromagnetic Transients Program*", submitted to IEEE Power and Energy Society General Meeting (**PESGM**), accepted, 2022.

[C2] Zefan Tang, Peng Zhang, **Yifan Zhou**, "*Quantum Renewable Scenario Generation*", submitted to IEEE Power and Energy Society General Meeting (**PESGM**), accepted, 2022.

[C3] **Yifan Zhou**, Peng Zhang, Yue Meng " *An ODE-Enabled Distributed Transient Stability Analysis for Networked Microgrids*", IEEE Power and Energy Society General Meeting (**PESGM**), 2020.

[C4] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *A Semi-Supervised Anomaly Detection Method for Wind Farm Power Data Preprocessing*", IEEE Power and Energy Society General Meeting (**PESGM**), 2017.

[C5] Le Zheng, Wei Hu, **Yifan Zhou**, *et al*, " *Deep belief network based nonlinear representation learning for transient stability assessment*", IEEE Power and Energy Society General Meeting (**PESGM**), 2017.

[C6] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " MILP-based Splitting Strategy Searching Considering Island Connectivity and Voltage Stability Margin", IEEE Power and Energy Society General Meeting (**PESGM**), 2016.

[C7] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *A Novel Active Splitting Strategy Search Method with Modularity-based Network Partition*", IEEE Innovative Smart Grid Technologies - Asia (ISGT ASIA), 2015.

[C8] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Coherency Feature Extraction based on DFT-based Continuous Wavelet Transform*", IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), 2015.

[C9] **Yifan Zhou**, Wei Hu, Yong Min, *et al*, " *Modelization and Optimization of Multi-Type Power Generators Joint Scheduling based on Improved PSO*", IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), 2014.

Research Experiences

Highlights: Senior personnel of **3 federal projects**; core participant of 10 power system projects focusing on renewable energy, energy decarbonization, AI techniques, formal verification, quantum computing, etc.

AI-Grid: AI-Enabled, Provably Resilient, Programmable Networked Microgrids Oct. 2021 – Present

Senior Personnel, NSF, **$ 5 M**

- Jointly designed the AI-Grid prototype, an AI-enabled platform for modelling, verification and runtime control of networked microgrids towards scalable, self-protecting, autonomic and ultra-resilient smart communities.

- Served as the key personnel for the functionalities of a “resilient” AI-Grid (one of the three modules of AI-Grid), which integrates neural-physics models and learning-based formal verification for resilient microgrid operations.
- **Highlight**: Partnered with 30+ internationally renowned industry and R&D partners.

Solar PLUS: Solar Integration through Physics-Aware Learning Based Ultra-Scalable Modeling and Analytics Oct. 2021 – Present
Senior Personnel, DOE SETO, **$ 1.5 M**

- Contributed to learning-based dynamic models of solar PVs at all levels (i.e., transmission, distribution, and behind-the-meter).
- Contributed to data-driven dynamic verification of solar PVs under infinitely many solar generation scenarios.

AI-Enabled, Provably Resilient Networked Microgrids (Phase I) Aug. 2020 – May. 2021
Senior Personnel, NSF, **$ 1 M**

- Developed the **Neuro-Reachability** prototype, a data-driven platform for dynamic verification of networked microgrids with unidentified subsystems and heterogeneous uncertainties.
- Designed an **Neural-Physics Modeling** method to construct nonlinear state-space models of data rich, information poor (DRIP) microgrids.
- Research results led to two following proposals (1 NSF and 1 DOE), one first-author publication and two pending submission.
- **Highlight**: The **Neuro-Reachability** will be deployed in t**hree highly representative microgrids** in the US by Aug. 2023. The **Neural-Physics Modeling** will be demonstrated by **ISO New England** with real power system operational data.

SBU-UML Collaboration on Energy Resiliency for Navy (Phase II) Oct. 2021 – Present
ONR, **$ 6 M**

- Jointly proposed a three-level cybersecurity architecture for **cyber-physical networked microgrids**.
- A programmable attack-defense platform is under development.

Practical Quantum Analytics for Ultra-Efficient and Resilient Bulk Power Systems Operations Oct. 2020 – Present
DOE Office of Electricity, **$ 1.2 M**

- Pioneered quantum linear solver-based electromagnetic transients program (**QEMTP**) methods for both far-term fault-tolerant quantum era and the near-term noisy-intermediate-scale quantum era.
- Devised a quantum machine learning-based transient stability assessment (**QTSA**) method to unlock quantum potentials in power system stability analysis.
- Led the verification of aforementioned methods on IBM real quantum computers.
- Jointly designed quantum power flow (**QPF**) and quantum state estimation (**QSE**) for static power analysis.
- An **open-source QGrid Analytics Toolbox** is under development to support future computing needs for fast and resilient bulk power grid operations.
- Research results led to 1 following NSF proposal to be submitted, two first-author publications and two under review.

SCC: Empowering Smart and Connected Communities through Programmable Community Micrtogrids Sep. 2019 – Present
NSF, **$ 0.8 M**

- Established scalable and efficient distributed transient stability analytics of networked microgrids.
- Jointly developed a delayed-eigenanalysis method for cyber-physical networked microgrids.
- A **programmable operation platform of networked microgrid** is under development, which incorporates our distributed computation, reachability verification, and delayed-eigenanalysis tools.
- Research results led to three first-author publications.

Formal Analysis for Dynamic Stability Assessment of Large Interconnected Grids under Uncertainties Aug. 2019 – Nov. 2020
DOE Office of Electricity, **$ 1.05 M**

- Designed a series of reachability methods of power systems (i.e., **ReachFlow**, **ReachEigen**, **ReachDyn**, **SReachDyn**) to formally verify the steady-state performance, small-signal stability and large-signal stability of power systems under an infinite number of uncertain/stochastic scenarios in a single run.
- Research results led to 2 following NSF proposal, 5 first-author publications and 1 book under preparation.

Integrated Heat and Power Operation Utilizing Flexibility from District Heating System Jan. 2017 – Jul. 2019
State Grid Corporation of China (SGCC)

- Derived the **operational flexibility** of combined heat and power (CHP) units as well as that of distinct heating systems based on the polytope projection theory.
- Established a flexibility-driven, hierarchical **optimal energy dispatch** towards energy decarbonization of integrated heat and power systems (IPHS).
- Research results led to my PHD thesis and 5 first-author publications in Chinese and international journals.

Data-driven Renewable Energy Uncertainty Formulation Jan. 2016 – Dec. 2016
State Grid Corporation of China (SGCC)

- Designed a semi-supervised anomaly detection method for raw data preprocess of renewable energies.
- Established an uncertainty modelling method of renewable generations by pair-copula theory considering the temporal and spatial dependence.
- Research results led to 2 publications.

Active Splitting Control Decision of Interconnected Power Systems Jun. 2015 – May. 2017
State Grid Corporation of China (SGCC)

- Designed active splitting control of bulk power systems incorporating voltage and frequency stability.
- Conducted real-world splitting control analysis of the power system of Hubei province in China.
- Research results led to 4 first-author publications.

Coordinated Control of Multi-FACTS Jul. 2014 – Aug. 2015
China Electric Power Research Institute (CEPRI)

- Designed control strategies for for multi-FACTS based on various control theories (*i.e.*, optimal control, robust control and game-theoretic control) to enhance the small-signal stability of bulk power systems.

Teaching Experience

Instructor: ESE586 - Microgrids Spring 2021

- Graduate Course, Department of Electrical and Computer Engineering, Stony Brook University
- Course Evaluation: **4.7/5.0**

Teaching Assistant: 70220172 - Power System Theory and Analysis Spring 2017

- Graduate Course, Department of Electrical Engineering, Tsinghua University

Teaching Assistant: 30220343 - Automatic Control Theory Fall 2015, 2016, 2017

- Undergraduate Course, Department of Electrical Engineering, Tsinghua University

Teaching Assistant: 20220443 - Electric and Electronic Technique (2) Spring 2015

- Undergraduate Course, Department of Electrical Engineering, Tsinghua University

Mentoring

Qing Shen, now Ph.D. student at Stony Brook University.

Dmitrii A. Etingov, now Ph.D. student at Stony Brook University.

Fei Feng, now Ph.D. student at Stony Brook University.

Lizhi Wang, now Ph.D. student at Stony Brook University.

Peng Zhang, Master. graduated from Tsinghua University, now at Northern Hebei Electric Power Research Institute.

Services

Invited Research Talk

- Stony Brook University CPS & Verification Seminar: Reachability Analysis of Networked Microdots Oct. 2021
- New York's Offshore Wind Training Program: Grid Integration of Offshore Wind Energy Systems Jul. 2021

Journal Review

- **Editor of Energy Reports**
- Reviewer of IEEE Transactions on Power Systems, IEEE Transactions on Sustainable Energy, IEEE PES Letters, Energy

Awards

Reviewer Awards

- Outstanding Reviewer for IEEE Transactions on Power Systems 2020

Student Awards — Tsinghua University

- **Outstanding Graduate of Tsinghua University (1.5%)** 2014
- Outstanding Graduate of Beijing 2014
- Outstanding Thesis Award, Tsinghua University 2014
- Tsinghua First-Class Scholarship for Integrated Excellence 2015,2013,2012