

# Curriculum vitae for **Zhenhua Liu**

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## CONTACT DETAILS

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## RESEARCH OVERVIEW

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My research lies in the intersection of energy and big data systems and forms three main research themes: sustainable IT, IT for sustainability, and cloud computing. My broader research goal is to enable the next generation of AI systems that are environmentally friendly for continual learning and robust decision making in energy management and other mission-critical applications. It not only draws on tools from algorithms, networking, operations research, economics, and control, but also starts from theory and continues through academic implementation to industrial transfer, exemplified by HP Net-zero Energy Datacenter, a 2013 Computerworld Honors Laureate.

## RESEARCH KEYWORDS

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Sustainable computing, Demand response, Cloud computing, Scheduling and resource allocation, Online optimization, Market Design, Distributed Control

## EMPLOYMENT

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2015.8-pres      Assistant Professor (tenure track) of Operations Research  
Computer Science and Smart Energy Cluster (affiliated)  
Stony Brook University (SUNY at Stony Brook), NY

2014.6-2015.8    ITRI-Rosenfeld Fellow  
Lawrence Berkeley National Lab, Berkeley, CA

## EDUCATION

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2014              Ph.D. in Computer Science  
California Institute of Technology, Pasadena, CA  
*Advisors: Adam Wierman, Steven Low*

2011              M.S. in Computer Science  
California Institute of Technology, Pasadena, CA  
*Advisors: Adam Wierman, Steven Low*

2009              M.S. in Computer Science and Technology, Tsinghua University, Beijing, China  
B.S. in Economics, Peking University, Beijing, China

2006              B.E. in Measurement and Control, Tsinghua University, Beijing, China

## EXTERNAL FUNDING

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2018-2020      Industrial project on renewable energy prediction and power flow modeling with a private trading firm  
\$600,000, with Wei Zhu and Jiaqiao Hu, my portion 33%

2017-2020      NSF CNS-1717588  
NeTS: Small: Demystifying the role of prediction models: bridging prediction algorithms and resource provisioning  
\$450,000, with Anshul Gandhi, my portion 50%

2017-2020      NSF CNS-1730128  
II-EN: Collaborative Research: Enhancing the Parasol Experimental Testbed for Sustainable Computing  
Research infrastructure fund. Stony Brook University: \$24,215, with Anshul Gandhi, my portion 50%.

- 2016-2019 NSF CNS-1617698  
 NeTS: Small: Collaborative Research: Enabling Application-Level Performance Predictability in Public Clouds  
 Stony Brook University: \$211,500, my portion 100%
- 2015-2018 NSF CNS-1464388  
 CRII: NeTS: Enabling Demand Response from Cloud Data Centers - from Sustainable IT to IT for Sustainability  
 \$174,957, my portion 100%

## SELECTED HONORS AND AWARDS

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- 2017 **Outstanding Teacher** award, Stony Brook University
- 2016 **Excellence in Teaching** award, Stony Brook University
- 2016 Best Student Paper Award (finalist), ACM GreenMetrics
- 2015 **Research Initiation Initiative Grant** Award, NSF
- 2014 **SPEC Distinguished Dissertation Award** (honorable mention)
- 2014 ITRI-Rosenfeld Fellowship, Lawrence Berkeley National Laboratory
- 2014 Chinese Government Award for Outstanding Students Abroad
- 2013 **Computerworld Honors Laureate for Net-zero Energy Data Center**
- 2013 IEEE Sustainable Computing Register “Pick of the Month”
- 2012 ACM SIGMETRICS Travel Awards
- 2012 Best Paper Award, IEEE International Green Computing Conference (IGCC)
- 2011 Best Student Paper Award, ACM GreenMetrics
- 2011 Resnick Fellowship (finalist)
- 2009 Graduate Fellowship, California Institute of Technology
- 2009 Excellent Master Thesis Award, Tsinghua University

## INDUSTRIAL INTERACTIONS

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**Sustainable IT:** I helped HP design the industry’s first Net-zero Energy Datacenter, which was named a 2013 Computerworld Honors Laureate, and has been widely reported in media and news. The results were further integrated into the design and management of HP EcoPOD datacenter, which has been used by many major IT companies, e.g., Facebook, eBay, Apple, and research institute, e.g., National Renewable Energy Laboratory, and won the 2013 InfoWorld Green IT Award. In addition, *one patent* has been granted.

**IT for sustainability:** Two patents have been filed with HP and one of them was granted. Currently, I am working with industrial partners on deployment and technology transfer, including Modius on datacenter infrastructure management for demand response, Brooklyn Microgrid on market design, a Colorado utilities company on data center demand response, as well as a private company for energy trading.

**Big data systems:** I am actively initiating industrial collaborations and have made concrete progress with Mesosphere and MS Azure on cloud resource management and the deployment of my algorithms, as well as HP on the new rack-scale, memory centric supercomputing prototype – the machine. In addition, I have collaborated with Akamai on CDN workload management and Cloudera on big data analytics.

## TEACHING EXPERIENCE

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### Courses taught at Stony Brook University:

AMS 546 Network flows. **Course evaluation: 4.89/5 (Spring 2017)**

AMS 560/CS 591 Big data systems, algorithms, and networks. **Course evaluation: 4.82/5 (Spring 2017), 4.83/5 (Spring 2016)**  
AMS 301 Finite Mathematical Structures. **Course evaluation: 4.53/5 (Fall 2016)**  
AMS/CS 691 Smart Energy in the Information Age. **Course evaluation: 4.89/5 (Spring 2016).**

**Teaching assistantship at California Institute of Technology:**

CS/EE147 Network Performance Analysis, Spring 2013.  
CS/EE146 Advanced Networking: Green IT, Spring 2011.  
CS/EE145 Projects in Networking, Spring 2011.  
CS/EE143 Communication Networks, Fall 2010.

**Teaching awards:**

2017 **Outstanding Teacher** award, AMS Department, Stony Brook University  
2016 **Excellence in Teaching** award, AMS Department, Stony Brook University

**REFEREED JOURNAL AND CONFERENCE PUBLICATIONS**

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Scholar page: [https://scholar.google.com/citations?user=SnU\\_IhOAAAAJ&hl=en](https://scholar.google.com/citations?user=SnU_IhOAAAAJ&hl=en) (1,508 citations by Nov 2017)

*\*Names in italic are those of my own students.*

1. *Tan N. Le, Jie Liang, Zhenhua Liu, Ramesh K. Sitaraman, Jayakrishnan Nair and Bong Jun Choi*, “Optimal Energy Procurement for Geo-distributed Data Centers in Multi-timescale Electricity Markets”, **IFIP Performance**, 2017. Long paper. A shorter version appears in ACM Greenmetrics 2017.
2. *Joshua Comden, Tan N. Le, Yue Zhao, Bong Jun Choi and Zhenhua Liu*, “Geographically Coordinated Frequency Control”, **IEEE CDC**, 2017.
3. *Joshua Comden, Zhenhua Liu, Yue Zhao*. “Harnessing Flexible and Reliable Demand Response Under Customer Uncertainties”, **ACM E-energy**, 2017. A shorter version appears in ACM Greenmetrics 2017.
4. *Joshua Comden, Zhenhua Liu, Yue Zhao*. “Incentivizing reliable demand response with customers’ uncertainties and capacity planning”, **ACM Sigmetrics**, 2017. Extended abstract.
5. Girish Ghatikar, Salman Mashayekh, Michael Stadler, Rongxin Yin and Zhenhua Liu. “Distributed Energy Systems Integration and Demand Optimization for Autonomous Operations and Electric Grid Transactions”. **Applied Energy**. Volume 167, April 2016, pp 432-448.
6. *Tan N. Le, Zhenhua Liu, Yuan Chen, Cullen Bash*. “Joint Capacity Planning and Operational Management for Sustainable Data Centers and Demand Response”. **ACM E-energy**, 2016.
7. *Joshua Comden, Zhenhua Liu, Yue Zhao*. “Optimizing the Level of Commitment in Demand Response”. **ACM Greenmetrics**, 2016, Finalist for **Best Student Paper Award**.
8. Niangjun Chen, *Joshua Comden, Zhenhua Liu, Anshul Gandhi, Adam Wierman*. “Using Predictions in Online Optimization: Looking forward with an eye on the past”. **ACM Sigmetrics**, 2016.
9. Mosharaf Chowdhury, Zhenhua Liu, Ali Ghodsi, Ion Stoica. “Multi-Resource Fairness for Correlated and Elastic Demands”. **USENIX NSDI**, 2016.
10. Zhenhua Liu, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. “Greening Geographical Load Balancing”. **IEEE/ACM Transactions on Networking (ToN)**, Volume 23(2), March 2015, pp 657-671. Extension of a paper that appeared in ACM Sigmetrics, 2011.
11. Hao Chen, Zhenhua Liu, Ayse Coskun and Adam Wierman. “Optimizing Energy Storage Participation in Emerging Power Markets”. **IEEE IGSC**, 2015.

12. Zhenhua Liu, Iris Liu, Steven Low and Adam Wierman. "Pricing Data Center Demand Response". **ACM Sigmetrics**, 2014.
13. Adam Wierman, Zhenhua Liu, Iris Liu, and Hamed Mohsenian-Rad. "Opportunities and Challenges for Data Center Demand Response". **IEEE IGCC**, 2014.
14. Zhenhua Liu, Adam Wierman, Yuan Chen, Benjamin Razon and Niangjun Chen. "Data Center Demand Response: Avoiding the Coincident Peak via Workload Shifting and Local Generation". **Performance Evaluation**, vol. 70(10), October 2013. Conference version appeared in **IFIP Performance**. Made the **most downloaded list of all Performance Evaluation articles**.
15. Zhenhua Liu, Adam Wierman, Yuan Chen, Benjamin Razon and Niangjun Chen. "Data Center Demand Response". **ACM Sigmetrics**, 2013. Extended Abstract.
16. Zhenhua Liu, Yuan Chen, Cullen Bash, Adam Wierman, Daniel Gmach, Zhikui Wang, Manish Marwah and Chris Hyser. "Renewable and Cooling Aware Workload Management for Sustainable Data Centers". **ACM Sigmetrics**, 2012. An extension of this work is used in the **industry's first Net-zero Energy Data Center** by HP, which was named a **2013 Computerworld Honors Laureate**. Made the **most downloaded list** of all Sigmetrics papers in ACM Digital Library.
17. Minghong Lin, Zhenhua Liu, Adam Wierman and Lachlan L. H. Andrew. "Online Algorithms for Geographical Load Balancing". **IEEE IGCC**, 2012 (**Best Paper Award**).
18. Lachlan L. H. Andrew, Minghong Lin, Zhenhua Liu and Adam Wierman (*alphabetical order*). "Algorithms for Dynamic Capacity Provisioning". **Conference on Optical Internet**, 2012.
19. Martin Arlitt, Cullen Bash, Sergey Blagodurov, Yuan Chen, Tom Christian, Daniel Gmach, Chris Hyser, Niru Kumari, Zhenhua Liu, Manish Marwah, Alan McReynolds, Chandrakant Patel, Amip Shah, Zhikui Wang and Rongliang Zhou (*alphabetical order*). "Towards the Design and Operation of Net-zero Energy Data Centers". **IEEE ITherm**, 2012.
20. Zhenhua Liu, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. "Geographical Load Balancing with Renewables". *Performance Evaluation Review*, vol. 39(3), December 2011. Conference version appeared in **ACM GreenMetrics 2011**. (**Best Student Paper Award**).
21. Zhenhua Liu, Minghong Lin, Adam Wierman, Steven Low and Lachlan L. H. Andrew. "Greening Geographical Load Balancing". **ACM Sigmetrics**, 2011. *IEEE Sustainable Computing Register* "**Pick of the Month**", April 2013.
22. Xiaoping Zhang, Zhenhua Liu, Youjian Zhao and Hongtao Guan. "Scalable Router". **Journal of Software (China)**, vol. 19(6), 2008.
23. Zhenhua Liu, Xiaoping Zhang, Lars Westberg, Youjian Zhao and Ling Chen. "Protective Internet Protocol (PIP)". **IEEE ICNP**, 2008. Extended Abstract.
24. Zhenhua Liu, Xiaoping Zhang, Youjian Zhao and Hongtao Guan. "An Asymptotically Minimal Node-degree Topology for Load-Balanced Architectures". **IEEE GLOBECOM**, 2008.
25. Zhenhua Liu, Xiaoping Zhang, Dong Wang, Youjian Zhao, and Hongtao Guan. "A Game-Theoretic Analysis of TCP Vegas and FAST TCP". **CICT**, 2008.

## PATENTS

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1. "Generating a capacity schedule for a facility", US 9792568, granted on October 17, 2017
2. "Generating a demand response for an energy-consuming facility", US 9607343, granted on March 28, 2017
3. "Managing a facility", Publication date: September 18, 2014
4. "Power infrastructure sizing and workload management", Publication date: October 30, 2014
5. "Scalable Router Based on P2i". China CN100440847C

## SELECTED CONFERENCE AND INVITED TALKS

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- Microsoft Research/HP Labs/UC Berkeley. “Interchangeable Resource Allocation”. January 2018.
- IEEE CDC. “Geographically Coordinated Frequency Control”. December 2017.
- INFORMS Annual meeting. “Harnessing Flexible and Reliable Demand Response Under Customer Uncertainties”. October 2017.
- ACM E-energy. “Joint Capacity Planning and Operational Management for Sustainable Data Centers and Demand Response”. June 2016.
- IEEE IGSC. “Optimizing Energy Storage Participation in Emerging Power Markets”. December 2015.
- INFORMS Annual meeting. “Towards Multi-resource Fairness in Big Data Systems”. November, 2015.
- INFORMS Annual meeting. “Optimizing demand response”. November, 2014.
- ACM Sigmetrics. “Pricing data center demand response”. June 2014.
- Microsoft Research Cambridge/Huawei US/UC Berkeley/UCSD/Imperial College of London. “Sustainable IT and IT for Sustainability”. 2014.
- Green data storage workshop at DIMACS, Rutgers University. “Data Center Demand Response: Coordinating IT and the Smart Grid”. December 2013.
- IFIP Performance. “Data Center Demand Response: Avoiding the Coincident Peak via Workload Shifting and Local Generation”. September 2013.
- IBM Research/Bell Labs/Cornell University/Qualcomm Research. “Sustainable Data Centers and Demand Response”. June 2013.
- Tsinghua University. “Geographical Load Balancing for Renewable Energy Integration”. December 2012.
- ACM Sigmetrics. “Renewable and Cooling Aware Workload Management for Sustainable Data Centers”. June 2012.
- ACM Sigmetrics. “Greening Geographical Load Balancing”. June 2011.

## ADVISING EXPERIENCE

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### Student advising

- Anjul Tyagi, 2017.11-present, PhD student in Computer Science.
- Jessica Maghakian, 2017.8-present, PhD student in Operations Research.
- Siqiao Zhao, 2017.8-present, PhD student in Quantitative Finance.
- Xiao Sun, 2017.5-present, PhD student in Operations Research.
- Joshua Comden, 2015.5-present, PhD student in Operations Research.
- Tan Le, 2015.5-present, PhD student in Computer Science.
- Adhita Selvaraj, 2017.5-present, master student, independent study on cloud resource allocation.
- Aditi Jain, 2017.5-present, master student, independent study on geo-distributed analytics, e.g., GeoSpark.
- Jie Liang, 2015.8-2016.6, undergraduate student, independent study on data center energy provisioning in multi-timescale electricity markets. Jie published a full paper in IFIP Performance 2017, one of the best conference in performance evaluation, as the second author. Her work was done as a junior at Stony Brook University.

- Katie Knister, 2014, undergraduate student, independent study on dynamic pricing for demand response.
- Iris Liu, 2013-2014, undergraduate student, independent study on pricing data center demand response. Iris published a full paper in ACM Sigmetrics 2014, one of the best conference in performance evaluation, as the second author. Her work was done as a senior at CalTech.
- Benjamin Razon, 2012-2013, undergraduate student, independent study on data center demand response. Ben coauthored a full paper in Elsevier Performance Evaluation 2013. His work was done as a senior at CalTech.
- Yizhen Wang and Michael Hirshleifer, 2012 Summer Undergraduate Research Fellowship (SURF) students on renewable and cooling aware geographical load balancing.

#### **Graduate student qualification/thesis/candidacy committees:**

- Thesis committee: Gui Citovsky, PhD in AMS, Stony Brook University
- Preliminary exam committee: Zhi Li, PhD student in AMS, Stony Brook University
- Preliminary exam committee: Sichen Zhong, PhD student in AMS, Stony Brook University
- Preliminary exam committee: Su Jia, PhD student in AMS, Stony Brook University
- Preliminary exam committee: Yan Liang, PhD student in AMS, Stony Brook University
- RPE committee: Muhammad Wajahat, PhD student in CS, Stony Brook University
- RPE committee: Duin Back, PhD student in CS, SUNY Korea

#### **INVITED REFEREE FOR JOURNALS AND CONFERENCES**

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- **Organizing Committee**, ACM Greenmetrics 2016, 2017
- Technical Program Committee, ACM Sigmetrics 2016, 2018
- Technical Program Committee, ACM E-energy 2016, 2017, 2018
- Technical Program Committee, IEEE ICDCS 2016, 2017, 2018
- Technical Program Committee, IEEE SmartGridComm 2015, 2016
- Technical Program Committee, GREEN 2016
- Technical Program Committee, 27th International Teletraffic Congress (ITC), 2015, 2018
- IEEE/ACM Transactions on Networking
- IEEE Transactions on Computers
- IEEE Transactions on Communications
- ACM Transactions on Modeling and Performance Evaluation of Computing Systems
- ACM Computer Communication Review
- IEEE Transactions on Parallel and Distributed System
- IEEE Transactions on Services Computing
- IEEE Transactions on Cloud Computing
- IEEE Transactions on Vehicular Technology
- Elsevier Journal of Computer Networks
- Elsevier Journal of Sustainable Computing
- Springer Cluster Computing