

# Kevin J. Kircher

Assistant Professor of Mechanical Engineering  
Ray W. Herrick Laboratories, Room 1022  
Purdue University  
<https://kevinj kircher.com>  
kircher@purdue.edu

## Research interests

---

I work on control, optimization, and machine learning methods for energy systems in buildings, focusing on their interactions with the power grid. I'm particularly interested in new technologies for efficient electric heating.

## Education

---

2019–2022	Postdoctoral associate in Electrical Engineering and Computer Science, <b>Massachusetts Institute of Technology</b> <i>Advisors: Steven Leeb &amp; Leslie Norford</i>
2019	PhD in Mechanical Engineering, <b>Cornell University</b> <i>Advisor: K. Max Zhang</i>
2016	MS in Mechanical Engineering, <b>Cornell University</b>
2009	MEng in Engineering Physics, <b>Cornell University</b>
2008	BS in Applied Mathematics and Physics, <b>University of Wisconsin–Milwaukee</b>

## Publications

---

### PhD thesis

**K.J. Kircher**. “Heat pump aggregation, optimization and control.” Cornell University (2019).

*This thesis develops an economic model that could accelerate adoption of efficient electric heat pumps for low-carbon heating and cooling. It also develops optimization and control methods that let heat pumps provide reliability services to the power grid, unlocking new revenues and facilitating renewable integration.*

### Journal articles

13. A.O. Aderibole, E.K. Saathoff, **K.J. Kircher**, A.W. Langham, L.K. Norford and S.B. Leeb. “Characterizing Low-Data-Rate Power Line Communication Channels.” Submitted.
12. Z. Zhang, **K.J. Kircher**, Y. Cai, J.G. Breatly, D. Birge and L.K. Norford. “Mitigating peak load and heat stress under heat waves by optimizing thermostat setpoint and fan speed schedules.” Submitted.
11. **K.J. Kircher** and K.M. Zhang. “Ancillary service capacity and revenue estimation for aggregated variable-speed heat pumps.” Submitted.
10. A.O. Aderibole, **K.J. Kircher**, E.K. Saathoff, S.B. Leeb and L.K. Norford. “Adaptive Power Line Communication for Low-Data-Rate Control and Sensing.” Submitted.  
.....
9. A.O. Aderibole, **K.J. Kircher**, S.B. Leeb and L.K. Norford. “Distributed load control using reliable low-bandwidth power line communication.” *IEEE Access* (2022).

8. **K.J. Kircher**, A.O. Aderibole, L.K. Norford and S.B. Leeb. “Distributed peak shaving for small aggregations of cyclic loads.” *IEEE Transactions on Power Delivery* 37 (2022): 4315–4325.
7. A.O. Aderibole, E.K. Saathoff, **K.J. Kircher**, S.B. Leeb and L.K. Norford. “Power line communication for low-bandwidth control and sensing.” *IEEE Transactions on Power Delivery* (2021).
6. **K.J. Kircher** and K.M. Zhang. “Heat purchase agreements could lower barriers to heat pump adoption.” *Applied Energy* 286 (2021).
5. **K.J. Kircher**, W. Schaefer and K.M. Zhang. “A computationally efficient, high-fidelity testbed for building climate control.” *ASME Journal of Engineering for Sustainable Buildings and Cities* 2 (2020): 1–22.
4. Z. Lee, K. Gupta, **K.J. Kircher** and K.M. Zhang. “Mixed-integer model predictive control of variable-speed heat pumps.” *Energy and Buildings* 198 (2019): 75–83.
3. **K.J. Kircher** and K.M. Zhang. “On the lumped capacitance approximation accuracy in RC network building models.” *Energy and Buildings* 104 (2015): 454–462.
2. S.N. Palacio, **K.J. Kircher** and K.M. Zhang. “On the feasibility of providing power system spinning reserves from thermal storage.” *Energy and Buildings* 104 (2015): 131–138.
1. **K.J. Kircher**, X. Shi, S. Patil and K.M. Zhang. “Cleanroom energy efficiency strategies: Modeling and simulation.” *Energy and Buildings* 42 (2010): 282–289.

## Conference proceedings

7. **K.J. Kircher**, Y. Cai, L.K. Norford and S.B. Leeb. “Controlling big, diverse, nonlinear load aggregations for grid services by adjusting device setpoints.” *IEEE Conference on Decision and Control (CDC)*, 2021.
6. Y. Cai, J. Burek, S. Das, J.R. Gregory, L.K. Norford, J. Wang and **K.J. Kircher**. “Reducing greenhouse gas emissions by optimizing room temperature set-points.” *International Conference on Machine Learning (ICML): Workshop on Tackling Climate Change with Machine Learning*, 2021.
5. **K.J. Kircher** and K.M. Zhang. “Sample-average model predictive control of uncertain linear systems.” *IEEE Conference on Decision and Control (CDC)*, 2016.
4. **K.J. Kircher** and K.M. Zhang. “Testing building controls with the BLDG toolbox.” *American Control Conference (ACC)*, 2016. Invited paper.
3. **K.J. Kircher** and K.M. Zhang. “Model predictive control of thermal storage for demand response.” *American Control Conference (ACC)*, 2015. Invited paper.
2. **K.J. Kircher**, G. Ghatikar, S. Greenberg, D. Watson, R. Diamond, D. Sartor, C. Federspeil, A. McEachern and T. Owen. “Toward the holy grail of perfect information: Lessons learned from implementing an energy information system in a commercial building.” *ACEEE Summer Study on Energy Efficiency in Buildings*, 2010.
1. P.A. Mathew, R. Clear, **K.J. Kircher**, T. Webster, K.H. Lee and T. Hoyt. “Advanced benchmarking for complex building types: Laboratories as an exemplar.” *ACEEE Summer Study on Energy Efficiency in Buildings*, 2010.

## Course notes

5. **K.J. Kircher** and E.Y. Bitar. “Robust and stochastic optimization,” based on Cornell ECE 6990.
4. **K.J. Kircher** and A.S. Lewis. “Convex analysis,” based on Cornell ORIE 6328.
3. **K.J. Kircher** and D.P. Williamson. “Linear programming,” based on Cornell ORIE 6300.
2. **K.J. Kircher** and S.G. Henderson. “Monte Carlo simulation,” based on Cornell ORIE 6580.
1. **K.J. Kircher** and M.L. Psiaki. “Model-based estimation,” based on Cornell MAE 6760.

## Funding

---

2. “Smart heat: Aggregating renewable-electric-heating-thermal-storage systems for grid services.” Co-authored with K. Max Zhang (PI) and Justin Dobbs. NSF Energy, Power, Controls and Networks grant 1711546 (8/2017–8/2020), \$330,000.
1. Hydro Research Foundation fellowship. Full graduate tuition and stipend (6/2014–6/2016).

## Teaching

---

Fall 2022	Thermodynamics I, Purdue University
2014–2015	Teaching assistant trainer, Cornell University College of Engineering <i>Trained hundreds of graduate student teaching assistants from 14 departments.</i>
Fall 2013	Multivariable Calculus teaching assistant, Cornell University
Spring 2013	Dynamics teaching assistant, Cornell University
2007–2008	Physics in Everyday Life teaching assistant, University of Wisconsin–Milwaukee
2005–2007	Mathematics tutor, University of Wisconsin–Milwaukee

## Mentoring

---

*Co-advised the research of 15 undergraduate, master’s and PhD students from 7 fields of study.*

2022–	Elias Pergantis, PhD, Purdue University Mechanical Engineering
2022–	Priyadarshan, PhD, Purdue University Mechanical Engineering
2021–2022	Morgan Santoni-Colvin, SM, MIT Technology and Policy Program
2021–2022	Stella Zhuqing Zhang, MArch, MIT Architecture
2021–2022	Julia Wang, SB/SM, MIT Computer Science
2019–2022	Yuan Cai, SM, MIT Computer Science and Building Technology
2019–2022	Adedayo Aderibole, PhD, MIT Electrical Engineering and Computer Science
2017–2018	Kartikay Gupta, MS, Cornell University Mechanical Engineering
2016	Kevin Leong, MEng, Cornell University Systems Engineering
2015–2016	Sean Hidaka, MEng, Cornell University Mechanical Engineering
2015	Walter Schaefer, MEng, Cornell University Mechanical Engineering
2015	Eric Hui Fat Tse, BS, Cornell University Mechanical Engineering
2015	Stefan Rauscher, BS, RWTH Aachen Mechanical Engineering
2014–2015	Julius Scheuber, BS, RWTH Aachen Mechanical Engineering
2014–2015	Siddharth Deshpande, MEng, Cornell University Mechanical Engineering

## Talks

---

21. Herrick Laboratories Industrial Advisory Committee, West Lafayette, IN. *Toward smart electrification*. October, 2022.
20. U.S. Department of Energy Loan Programs Office, Washington, D.C. *Third-party ownership models for financing and aggregating electric heat pumps*. March, 2022.
19. Carnegie Mellon University Department of Electrical and Computer Engineering, Burlington, VT. *Smart electrification: How control systems in buildings can accelerate decarbonization*. March, 2022.

18. University of Vermont Department of Electrical and Biomedical Engineering, Burlington, VT. *Smart electrification: How control systems in buildings can accelerate decarbonization*. March, 2022.
17. Purdue University Department of Mechanical Engineering, West Lafayette, IN. *Smart electrification: How control systems in buildings can accelerate decarbonization*. February, 2022.
16. MIT Department of Mechanical Engineering and Schwarzman College of Computing, Cambridge, MA. *Planet Earth has a fever. . . but better building control software can help*. January, 2022.
15. IEEE Conference on Decision and Control, Austin, TX. *A general, scalable grid-service control framework for aggregated electrical devices*. December, 2021.
14. Tune-In on MIT's Climate Action Plan for the Decade, MIT, Cambridge, MA. *How artificial intelligence can reduce campus carbon emissions*. November, 2021.
13. MIT Department of Facilities, Cambridge, MA. *Shifting electrical load by perturbing zone air temperature setpoints*. February, 2020.
12. Schneider Electric, Cambridge, MA. *Shifting load by perturbing temperature setpoints*. January, 2020.
11. Cornell University Energy and Environment Research Lab, Ithaca, NY. *Heat purchase agreements could lower barriers to heat pump adoption*. PhD defense, July, 2019.
10. Cornell University Energy and Environment Research Lab, Ithaca, NY. *A crash course in stochastic control*. November, 2017.
9. IEEE Conference on Decision and Control, Las Vegas, NV. *Sample-average approximation in stochastic model predictive control*. December, 2016.
8. HydroVision International, Minneapolis, MN. *Operating a Hawai'ian microgrid without fuel*. July, 2016.
7. American Control Conference, Boston, MA. *Testing building controls in MATLAB with the BLDG toolbox*. July, 2016.
6. Cornell University, Ithaca, NY. *Controlling buildings for comfort, energy efficiency, and power system services*. Admission to candidacy exam, November, 2015.
5. Cornell University Economics and Engineering of Electricity Research Group, Ithaca, NY. *Flexible demand from the building operator's perspective*. October, 2015.
4. Cornell University Energy Seminar, Ithaca, NY. *How can buildings help the grid?* September, 2015.
3. HydroVision International, Portland, OR. *Pumped hydro controls for a Hawai'ian microgrid*. July, 2015.
2. American Control Conference, Chicago, IL. *Economic MPC of thermal storage for demand response*. July, 2015.
1. University of Hawaii at Hilo. *A little island on the Big Island: UH-Hilo microgrid design*. May, 2013.

## Media coverage

---

August 2022	Experts: Cash incentives in climate bill could revolutionize U.S. homes, 1 HVAC at a time. <b>USA Today</b> .
May 2022	The U.S. is addicted to gas heating. A new bill may make going electric the easy choice. <b>HuffPost</b> .
April 2022	How does a heat pump work? <b>Carbon Switch</b> .
April 2021	Unlocking home electrification with heat pumps. <b>The Energy Gang podcast</b> .

## Select employment and volunteering

---

- |           |  |
|-----------|--|
| 2009–2010 | Building Technologies research associate, Lawrence Berkeley National Laboratory<br><i>Deployed sensors throughout a 90,000 ft<sup>2</sup> office building to collect granular energy data.</i> |
| 2009      | Volunteer, Amanecer solar oven project, Totogalpa, Nicaragua<br><i>Designed and built solar ovens for smoke-free cooking with a rural women's cooperative.</i>                                 |
| 2008      | Volunteer, AguaClara water supply project, Cuatro Comunidades, Honduras<br><i>Designed and built locally-sourced, off-grid water filtration plants in remote villages.</i>                     |

## Reviewing

---

IEEE Transactions on Power Systems, IEEE Transactions on Smart Grid, IEEE Transactions on Power Delivery, Applied Energy, Energy and Buildings, Journal of Cleaner Production, Control Engineering Practice, IEEE Conference on Decision and Control, American Control Conference.