

Stephen J. Lee

PhD Candidate, MIT
Fellow, The Energy for Growth Hub

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Research Statement

Stephen's research advances methods from energy systems analysis, machine learning, and applied economics to inform infrastructure planning and policy design in support of global development and climate goals. Stephen's inference and optimization models propose cost-optimal electrification plans at continent-scales and individual building-resolutions. These plans represent roadmaps for global energy investment and elucidate pathways for jointly achieving universal electricity access and decarbonizing the power sector in developing countries.

Education

- 2018 – Present – **Ph.D. Electrical Engineering and Computer Science**, *Massachusetts Institute of Technology, Cambridge, MA, USA.*
Expected
- Concentrations in Machine Learning and Energy Systems
 - Committee: Prof. Ignacio J. Pérez-Arriaga, Dr. John Fisher III, Dr. Robert Stoner, Prof. Jay Taneja
 - Relevant Coursework: 6.867 Machine Learning, 6.869 Advances in Computer Vision, 6.438 Algorithms for Inference, 6.255 Optimization Methods, 6.431 Probabilistic Systems Analysis, 6.336 Introduction to Numerical Simulation
- 2017-2018 **S.M. Electrical Engineering and Computer Science**, *Massachusetts Institute of Technology, Cambridge, MA.*
- 2015-2018 **S.M. Technology and Policy**, *Massachusetts Institute of Technology, Cambridge, MA.*
- Concentration in Energy and Environmental Economics
 - Advisors: Prof. Ignacio J. Pérez-Arriaga, Dr. John Fisher III
- 2009-2013 **B.S. Materials Science & Engineering; Second Major in Economics**, *Johns Hopkins University, Baltimore, MD.*

Papers

- 2021 M. Luke, P. Somani, T. Cotterman, D. Suri, **S.J. Lee**, No COVID-19 Climate "Silver Lining" in the U.S. Power Sector: CO₂ Emissions Reductions Not Statistically Significant, Additional Risk to Coal Generators is Minimal, *Nature Communications, Accepted*
- 2021 J. Shekhar, D. Suri, P. Somani, **S.J. Lee**, M. Arora, Reduced renewable energy stability in India following COVID-19: Insights and key policy recommendations, *Renewable & Sustainable Energy Reviews*
- 2020 C. Dean, **S.J. Lee**, J. Pacheco, J. Fisher, Learning to Count: Lightweight Data Fusion with Deep Conjugate Mappings, *arXiv preprint arXiv:2011.10607*

- 2019 **S.J. Lee**, E. Sánchez, A. González-García, P. Ciller, P. Duenas, J. Taneja, F. de Cuadra, J. Lumbreras, H. Daly, R. Stoner, I.J. Pérez-Arriaga, Investigating the Necessity of Demand Characterization and Stimulation for Geospatial Electrification Planning in Developing Countries, *MIT Center for Energy and Environmental Policy Research Working Papers*
- 2019 A. González-García, P. Ciller, **S.J. Lee**, T. Cotterman, R. Amatya, R. Stoner, I.J. Pérez-Arriaga, Promotion of mini-grids for rural electrification in Uganda, *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH*
- 2019 P. Ciller, D. Ellman, C. Vergara, A. González-García, **S.J. Lee**, C. Drouin, M. Brusnahan, Y. Borofsky, C. Mateo, R. Amatya, R. Stoner, F. de Cuadra, I.J. Pérez-Arriaga, Optimal Electrification Planning Incorporating On- and Off-Grid Technologies: The Reference Electrification Model (REM), *Proceedings of the IEEE*
- 2018 **S.J. Lee**, Adaptive Electricity Access Planning, *Massachusetts Institute of Technology*
- 2018 R. Amatya, M. Barbar, M. Brusnahan, P. Ciller, T. Cotterman, F. de Cuadra, P. Dueñas, D. Ellman, A. González-García, **S.J. Lee**, C. Mateo, R. Palacios, I.J. Pérez-Arriaga, R.J. Stoner, C.R. Vergara, Computer-aided electrification planning in developing countries: The Reference Electrification Model (REM), *Working Papers IIT No. WP-IIT-18-112A*
- 2018 I.J. Pérez-Arriaga, R. Stoner, R. Rahnema, **S.J. Lee**, G. Jacquot, A. González-García, and P. Dueñas. A utility approach to accelerate universal electricity access in less developed countries: A regulatory proposal, *Economics of Energy & Environmental Policy*
- 2018 M. Luke, **S.J. Lee**, Z. Pekarek, and A. Dimitrova, Blockchain in Electricity: a Critical Review of Progress to Date, *eurelectric*
- 2013 J. Sinha, **S.J. Lee**, H. Kong, T. Swift, and H.E. Katz, Tetrathiafulvalene-functionalized Thiophene Copolymerized with 3, 3''-Didodecylquaterthiophene: Synthesis, Response to Trinitrotoluene, and Thermoelectric Behavior, *Macromolecules*
- 2013 J. Sinha, R. Ireland, **S.J. Lee**, and H.E. Katz, Synergistic Thermoelectric Power Factor Increase in Films Incorporating Tellurium and Thiophene-based Semiconductors, *Materials Research Society Communications*

Book Contributions

- 2018 Sunny-side up: electricity for clean cooking, *World Energy Outlook 2018*, IEA, Paris, <https://doi.org/10.1787/weo-2018-en>.
- 2018 Enlightened thinking: the value of high-resolution electrification planning for achieving universal electricity access, *World Energy Outlook 2018*, IEA, Paris, <https://doi.org/10.1787/weo-2018-en>.

Short Articles

- 2021 **S.J. Lee**, Z. Shah, B. Min, J. Taneja, Nighttime Lights Satellite Imagery: Challenges and Opportunities, *Energy for Growth Hub*
- 2021 **S.J. Lee**, A planner's guide to acquiring building locations data, *Energy for Growth Hub*
- 2020 **S.J. Lee**, R. Stoner, I.J. Pérez-Arriaga, The Integrated Distribution Framework and the Global Commission to End Energy Poverty: Exploring Pathways for Accelerating Universal Access to Modern Energy Services, *Working Paper*, DOI: 10.13140/RG.2.2.23442.20162
- 2020 **S.J. Lee**, L. Aoudi, Opportunities for Mutually Beneficial Public Policy and Machine Learning Climate Solutions, Working Paper, DOI: 10.13140/RG.2.2.12575.10401
- 2020 **S.J. Lee**, J. Taneja, Why Demand Demands More Attention, *Energy for Growth Hub*
- 2019 **S.J. Lee**, The Virtuous Cycle of Clean Cooking and Electricity Costs, *Energy for Growth Hub*
- 2018 **S.J. Lee**, Empowered Planning with Models, Satellites, & Machine Learning, *Energy for Growth Hub*
- 2018 M. Luke, **S.J. Lee**, Z. Pekarek, and A. Dimitrova, Blockchain in Electricity: A Call for Policy and Regulatory Foresight, *eurelectric*

Selected Talks and Presentations

- 2021 Webinar Presenter, *MITEI-Madhya Pradesh Energy Department Energy Seminar*, Bhopal, Madhya Pradesh, India
- 2020 Webinar Presenter, *Load Research Chapter of the South African Institute of Electrical Engineers (SAIEE)*, Johannesburg, South Africa
- 2019 Presenter, *Asian Development Bank Innovation Speakers' Series*, Manila, Philippines
- 2018 Panelist, *2018 MIT Africa Innovate Conference, Power & Energy*, Cambridge, MA, USA
- 2018 Presenter, *University Program Review, NNSA's Office of Defense Nuclear Nonproliferation Research and Development*, Ann Arbor, MI, USA
- 2017 Presenter, *Hack4Climate, associated with the 2017 United Nations Climate Change Conference (COP23)*, Bonn, Germany
- 2016 Presenter, *Tata India Symposium*, Cambridge, MA, USA
- 2013 Presenter, *Provost's Undergraduate Research Award Recognition Ceremony*, Baltimore, MD, USA

Selected Awards and Honors

- 2021 Research Funding Recipient, *International Energy Agency*
- 2020 Research Funding Recipient, *Enel Foundation*
- 2019 Research Funding Recipient, *Energy for Growth Hub*
- 2018 Nominee, Best Master's Thesis Award, *MIT Institute for Data, Systems, and Society*
- 2015-2017 Tata Graduate Research Fellowship, *MIT Tata Center for Technology and Design*
 - Full stipend and tuition support for research pertinent to design and entrepreneurship in developing countries
- 2016 Semifinalist, *MIT Clean Energy Prize*
- 2013 Departmental and University Honors, *Johns Hopkins University*

Professional Certifications

- 2014 Oracle Certified Associate, Java SE 7 Programmer (OCAJP 7)
- 2013 SEMOSS Analytics Certification

Teaching Experience

- 2019 **Teaching Assistant**, 6.041/6.431 Probabilistic Systems Analysis, *Department of Electrical Engineering and Computer Science*.
- 2018 **Teaching Assistant and Guest Lecturer**, 15.017/6.934 Engineering, Economics, and Regulation for Energy Access in Developing Countries, *MIT Sloan School of Management and Department of Electrical Engineering and Computer Science*.
Received 7.0/7.0 average scores across all student evaluation categories.
- 2017 **Guest Lecturer**, 15.S02 Planning, Policy, and Technology for Energy Access in Developing Countries, *MIT Sloan School of Management*.

Selected Professional Experience

- 2018 – Present **Fellow**, *The Energy for Growth Hub*, Washington, D.C..

- Produced written memos for the Hub on select opportunities in data science and policy for the realization of a high-energy future to power industrial and commercial development, job creation, and economic growth globally.
- Acted as an ambassador on behalf of the Hub's "Big Data" team to present on research activities and evaluate partnership opportunities internationally.

2015 – **Researcher**, *MIT Energy Initiative*, Cambridge, MA.

Present

- Led projects to better understand how productive uses of energy yield economic growth. This work is elucidating new avenues for coordinated infrastructure planning, integrating electricity access, clean cooking, agriculture, and climate goals.
- Developed electric load characterization algorithms, employed computational energy systems models, and conducted analyses to inform large-scale electrification infrastructure planning efforts as part of the Universal Energy Access Group (universalaccess.mit.edu). Analyses presented to senior government officials affecting national energy policy in India, Uganda, and Rwanda.
- Developing adaptive management and policymaking frameworks for rationalized infrastructure planning, incorporating data-driven methodologies, multi-stakeholder collaboration, and the characterization of uncertainty.

2015 – **Researcher**, *MIT Computer Science and Artificial Intelligence Laboratory*, Cambridge, MA.

Present

- Developed machine learning and Bayesian modeling approaches to infer geospatial characteristics from multimodal and multiscale inputs. Produced comparison studies of logistic regression and Gaussian process approaches for electrification status estimation in developing countries. Designed hierarchical graphical models for probabilistic data fusion to incorporate expert knowledge for the analysis of sparse datasets.
- Designed convolutional neural network architectures for the semantic segmentation of satellite imagery using TensorFlow and Keras. Built a computer vision system to consume imagery via the Google/ESRI maps and georeference features for large-scale feature extraction on GPU-enabled Amazon EC2 servers. Modified web-based manual image annotation tools to crowdsource point and area-based training data sets using Amazon S3, Amazon Mechanical Turk, Boto, and the Google Realtime API.

2018 **Affiliated Industry Expert**, *NERA Economic Consulting*, Boston, MA.

- Co-authored industry reports on distributed ledger technologies and their potential impact in the power and utilities sector. Coordinated with over 50 stakeholders from eurelectric's platform members and reviewed U.S. and European regulations to outline potential benefits of and barriers for technology deployment.

2016-present **Independent Consultant**, Cambridge, MA.

- Economic, machine learning, and analytics consulting as an independent contractor, via Biospheric AI, LLC, or via Highland Energy Analytics, LLC for the Energy Innovation Reform Project (EIRP), Government of West Bengal, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and Tata Power DDL

2013 – 2015 **Software Engineering, Full Stack**, *SEMOSS*, Arlington, VA.

- Developed data processing and visualization components of the open source analytics environment, SEMOSS (semoss.org). Led new feature development efforts across the full application stack and refactored client-specific analyses into analytic routines for general-purpose data exploration

2013 – 2015 **Consultant**, *Deloitte Consulting LLP*, Arlington, VA.

- Performed systems and optimization analyses for the National Oceanic and Atmospheric Administration (NOAA) and the Military Health System (MHS) using SEMOSS, Python, and Excel/VBA. Performed network analyses to inform information systems migration efforts towards service-oriented architectures, inform technology investment decisions, and eliminate system redundancies.
- Led a business case analysis for the Defense Logistics Agency (DLA) Energy Sustainment, Restoration and Modernization (SRM) Office with projected cost savings of over \$90 million in five years and prepared figures that were presented to Congress.
- Codeveloped web-based dashboards for comparative financial analytics in the Power and Utilities, Retail, and Technology sectors with Deloitte's Global Benchmarking Center. Dashboards allow executives to assess performance relative to competitors by business segment and identify high-priority areas for improvement.

2009 – 2013 **Researcher**, *Johns Hopkins University Whiting School of Engineering and Henry A. Rowland Department of Physics and Astronomy*, Baltimore, MD.

- Developed novel solution-processable thermoelectric materials for solid-state power generation from temperature gradients under the supervision of Prof. Howard E. Katz.
- Investigated the correlation between structure, processing, and performance of P3HT:PCBM bulk heterojunction organic solar cells.

References

Available upon request.