

RESEARCH SUMMARY

My research focuses on CO₂ recovery pathways for carbon sequestration, environmental technologies based on recovered CO₂, and energy and transportation planning for achieving climate targets. I approach solutions to these contemporary issues in carbon management using knowledge and methods from environmental, chemical, and mechanical engineering, operations research, decision science, and economics.

EDUCATION

May '15 **Ph.D., Mechanical Engineering** ■ **University of Michigan, Ann Arbor, MI, USA**

Committee Steven J. Skerlos (chair), Mark S. Daskin, Neil P. Dasgupta, Ming Xu, David A. Stephenson

Dissertation Environmental and Economic Assessment of Carbon Dioxide Recovery and Mitigation in the Industrial and Energy Sectors

May '09 **M.S., Mechanical Engineering** ■ **University of Florida, Gainesville, FL, USA**

May '06 **B.E., Mechanical Engineering** ■ **University of Pune, Pune, MH, India**

AWARDS & HONORS

2014 College of Engineering Distinguished Leadership Award ■ University of Michigan

2012 E. Wayne Kay Graduate Scholarship ■ Society of Manufacturing Engineers

2012 Martin Luther King Jr. Spirit Award ■ University of Michigan

2009 Department of Mechanical Engineering Fellowship ■ University of Michigan

2007 College of Engineering Graduate Scholarship ■ University of Florida

GRANTS AWARDED

National Science Foundation. Market driven emissions from recovered CO₂ industrial gas (\$277,253). Jul 2012 to Jul 2015, PI: Steven J. Skerlos (Contributed equally to the proposal).

Dow Distinguished Award for Interdisciplinary Sustainability. Retrofitting Ann Arbor: The Living Building Challenge (\$15,000). Jan to Dec 2014, PIs: Desai, D., Chow, A., Supekar, S., Ayril, D., Herbert, E., Skerlos, S.

JOURNAL ARTICLES

Supekar, S. D., & Skerlos, S. J. (2015). Reassessing the efficiency penalty from carbon capture in coal-fired power plants. *Environmental Science & Technology*, 49(20), 12576–12584. DOI: [10.1021/acs.est.5b03052](https://doi.org/10.1021/acs.est.5b03052)

Supekar, S. D., & Skerlos, S. J. (2014). Market-driven emissions from recovery of carbon dioxide gas. *Environmental Science and Technology*, 48(24), 1–21. DOI: [10.1021/es503485z](https://doi.org/10.1021/es503485z)

Stephenson, D. A., Skerlos, S. J., King, A. S., & **Supekar, S. D.** (2014). Rough turning Inconel 750 with supercritical CO₂-based minimum quantity lubrication. *Journal of Materials Processing Technology*, 214(3), 673–680. DOI: [10.1016/j.jmatprotec.2013.10.003](https://doi.org/10.1016/j.jmatprotec.2013.10.003)

Supekar, S. D., & Skerlos, S. J. (2014). Supercritical carbon dioxide in microelectronics manufacturing: marginal cradle-to-grave emissions. *Procedia CIRP*, 15, 461–466. DOI: [10.1016/j.procir.2014.06.061](https://doi.org/10.1016/j.procir.2014.06.061)

Supekar, S. D., Gozen, B. A., Bediz, B., Ozdoganlar, O. B., & Skerlos, S. J. (2013). Feasibility of supercritical carbon dioxide based metalworking fluids in micromilling. *Journal of Manufacturing Science and Engineering*, 135(2), 024501. DOI: [10.1115/1.4023375](https://doi.org/10.1115/1.4023375)

Supekar, S. D., Clarens, A. F., Stephenson, D. A., & Skerlos, S. J. (2012). Performance of supercritical carbon dioxide sprays as coolants and lubricants in representative metalworking operations. *Journal of Materials Processing Technology*, 212(12), 2652–2658. DOI: [10.1016/j.jmatprotec.2012.07.020](https://doi.org/10.1016/j.jmatprotec.2012.07.020)

Supekar, S. D., & Skerlos, S. J. To bleed or not to bleed: Steam extraction from power plant turbines and boilers for carbon capture. *Energy & Environmental Science*, In Review.

PEER-REVIEWED CONFERENCE PROCEEDINGS

- Supekar, S. D.**, & Skerlos, S. J. (2013). Market driven emissions associated with supplying recovered carbon dioxide to sustainable manufacturing applications. In G. Seliger (Ed.), *Proceedings of the 11th Global Conference on Sustainable Manufacturing - Innovative Solutions* (pp. 330–336). Berlin: Universitätsverlag der TU Berlin. [Available online](#)
- Supekar, S. D.**, Caruso, K. A., Daskin, M. S., & Skerlos, S. J. (2013). Least-cost technology investments in the passenger vehicle and electric sectors to meet greenhouse gas emissions targets to 2050. In A. Y. C. Nee, B. Song, & S.-K. Ong (Eds.), *Re-engineering Manufacturing for Sustainability*. Singapore: Springer Singapore. DOI: [10.1007/978-981-4451-48-2](#)

MANUSCRIPTS IN PREPARATION

- Supekar, S. D.**, Kieckhäfer, K., & Skerlos, S. J. Technological costs of delayed climate action in the automotive sectors. In preparation for submission to *Environmental Science & Technology*.
- Raichur, V., **Supekar, S. D.**, & Skerlos, S. J. Reexamining the role of energy storage in utility-scale renewable power expansion. In preparation for submission to *Energy Policy*.
- Liang, S., Stylianou, K., Jolliet, O., **Supekar, S. D.**, Skerlos, S. J., & Xu, M. Death footprints of nations associated with fine particulate matter (PM_{2.5}), In preparation for submission to *Environmental Science & Technology*.

PRESENTATIONS & POSTERS

Invited Seminars

- ASME International Mechanical Engineering Congress & Exposition*. Technology trajectories to achieve emission reduction targets in the U.S. Energy Sector, November 18, 2015, Houston, TX.
- University of California, Davis*. Achieving greenhouse gas emission targets at least cost: The fossil fueled inertia of legacy power plants, October 8, 2015, Davis, CA.
- NASA Ames Research Center*. Marginal environmental impacts from recovery of carbon dioxide gas, June 28, 2014, Mountain View, CA.
- Michigan DEQ Retired Engineer Technical Assistance Program*. Supercritical carbon dioxide based metalworking fluids, November 21, 2011, Lansing, MI.
- Michigan Green Chemistry and Engineering Conference*. Supercritical carbon dioxide based metalworking fluids, October 27, 2011, Ann Arbor, MI.

Presentations (Presenter Underlined)

- Supekar, S. D.**, Daskin, M. S., & Skerlos, S. J. *AEESP Research and Education Conference*. Technology trajectories to achieve emission reduction targets in the U.S. Energy Sector, June 15, 2015, New Haven, CT.

Posters (Presenter Underlined)

- Supekar, S. D.**, & **Skerlos, S. J.** Least-cost carbon mitigation and technology applications. *National Academy of Engineering China-America Frontiers of Engineering*, Jun 2015, Irvine, CA, USA.
- Supekar, S. D.**, & Skerlos, S. J. Pollution prevention and resource recovery using industrial carbon dioxide gas. *University of Rhode Island Global Product Sustainability Workshop*, Oct 2014, Kingston, RI, USA.
- Supekar, S. D.**, Clarens, A. F., Krauss, G. G., & Skerlos, S. J. Environmentally benign high-performance metalworking fluids based on supercritical carbon dioxide. *University of Michigan Engineering Graduate Symposium*, Oct 2011, Ann Arbor, MI, USA (awarded best poster in Design and Manufacturing).

EMPLOYMENT

- Oct '15 - Present Lecturer, Division of Integrative Systems & Design ■ University of Michigan, Ann Arbor, MI
- Jan '15 - Present Research Fellow, Dept. of Mechanical Engineering ■ University of Michigan, Ann Arbor, MI
- Jul '06 - Apr '07 Design Engineer, R&D Division ■ Forbes Marshall Ltd., Pune, India

RESEARCH EXPERIENCE

- Sep '12 - Present* **Least-cost greenhouse gas mitigation strategies for the U.S. energy sector**
Faculty PIs Steven J. Skerlos & Mark S. Daskin ■ University of Michigan
Research Lead Sarang D. Supekar ■ University of Michigan
 This project models the U.S. automotive and electricity generation fleets, their existing and projected technology, operation, and maintenance costs, and their existing and projected emission characteristics in a societal cost-minimization framework to inform climate change policy questions. This work has (1) identified cost-optimal technology trajectories to collectively cut about 55 billion tons of CO₂ over forty years, (2) estimated emissions that may occur in the absence of policy incentives due to market factors, (3) ascertained the window of time within which reduction of emissions by 30 - 60% by 2050 is technologically feasible, and (4) identified the incremental costs of delayed action on meeting these climate targets.
- Jan '12 - Present* **Market-driven emissions from recovery of CO₂ industrial gas**
Faculty PIs Steven J. Skerlos ■ University of Michigan
Research Lead Sarang D. Supekar ■ University of Michigan
 The project examines the recovered CO₂ supply chain, and estimates the cradle-to-grave environmental impacts associated with recovering CO₂ from high purity sources and flue gases for use in industrial applications and for sequestration. The key outcomes of this work are (1) the development of a market-based allocation methodology in a consequential life cycle assessment framework, which can be applied to recovered CO₂ as well as other industrial co-products, (2) development of a revised set of greenhouse gas accounting operational boundaries to incorporate reuse and sequestration as fates for CO₂, (3) creation of a process-based life cycle emissions, energy use, and water use inventory for CO₂ recovered from various point sources, and (4) quantification of the effects of mass feedbacks, CO₂ quality, and steam sourcing on energy penalties and cost effectiveness of power plants with carbon capture.
- May '10 - Dec '11* **Supercritical CO₂ metalworking fluids in mechanical micro-machining processes**
Faculty PIs Steven J. Skerlos ■ University of Michigan; Burak Ozdoganlar ■ Carnegie Mellon University
Research Lead Sarang D. Supekar ■ University of Michigan
 This project ascertained the effectiveness of supercritical CO₂ metalworking fluids (MWFs) as an enabler for environmentally benign mechanical micro-machining processes to replace chemical fabrication processes without performance trade-offs. Cutting forces and surface characteristics of Cu101 and AISI304 were measured and analyzed in a partial factorial experiment set. Results indicated improved micro-machinability, warranting further exploration of underlying mechanisms.
- Sep '09 - Dec '11* **Supercritical CO₂ metalworking fluids in industrial macro-machining processes**
Faculty PIs Steven J. Skerlos & Kim F. Hayes ■ University of Michigan
Research Lead Sarang D. Supekar ■ University of Michigan
 This project created a comprehensive assessment of the applicability of supercritical CO₂ MWFs relative to other MWFs used in a wide variety of manufacturing processes and engineering materials in industry practice. Specific contributions include analysis of tool wear, machining forces, and thermal data collected from a large set of machining experiments at industrial conditions, and data synthesis to determine operating conditions and underlying mechanisms where supercritical CO₂ MWFs provided improved machining productivity compared to other MWFs.

TEACHING EXPERIENCE

Lecturer

AY 2015 **Sustainable Design and Engineering (ISD 588/589) ■ University of Michigan**

Online-by-design content development for undergraduate and graduate courses in sustainable design and engineering for on-campus as well as distance learning students. Course material includes economic, environmental and social aspects of sustainability as they pertain to engineering design, life cycle assessment, carbon/water/energy footprints, and mass and energy balances for air, water, and energy resources.

Graduate Student Instructor

F '12 **Sustainability Engineering Principles (CEE 265, 100+ students) ■ University of Michigan**

Hosted recitations and discussions, taught course content during office hours, developed homework assignments, and graded exams. Additionally, I developed and gave a lecture titled 'Resource Consumption and Recycling.'

W & F '11 **Sustainable Design of Technology Systems (ME 589, 100+ students) ■ University of Michigan**

Developing homework assignments and exams, provided guidance on term projects, taught course content during office hours, and graded exams. Additionally, I developed and gave a lecture titled 'Transportation Emissions and Policy.'

Course Content Development

W & F '13 **Sustainable Engineering and Design (ME 499/CEE 265) ■ University of Michigan**

Developed case studies on (1) consequential life cycle assessment using recovered CO₂-based metalworking fluids as an example, (2) assessment of environmental impacts of a corkscrew assembly as a function of its design attributes by combining machine design principles with life cycle assessment, and (3) comparison of the environmental, economic, and social impacts from the fuel cycles of corn ethanol and soybean biodiesel.

Section Instructor

AY 2008 **Hindi (HIN 1130/1131/2200/2201) ■ University of Florida**

Performed the duties of both an adjunct faculty and a teaching assistant in the Dept. of Languages, Literatures, and Cultures, which included developing curricula, delivering lectures, and grading assignments and exams.

Graduate & Undergraduate Mentoring

Sp & F '15 Mentored a Design Science graduate student in on the experimental design, data analysis, and synthesis on a project that examines the role of energy storage systems for renewable power.

F '15 Supervised a Mechanical Engineering undergraduate student on a research project that determines least-cost energy strategies for Michigan to achieve EPA's CO₂ reduction target of 32% by 2030.

PROFESSIONAL ACTIVITIES

Peer-Review for Journals

Resources, Conservation, and Recycling; Journal of Cleaner Production; Journal of Manufacturing Processes; Journal of Manufacturing Systems; Environments

Membership

Association of Environmental Engineering and Science Professors (AEESP), American Society of Mechanical Engineers (ASME), Tau Beta Pi Engineering Honor Society (TBP)

SERVICE & LEADERSHIP

University Service

- AY 2013* BLUElab Living Building Challenge Team ■ Technical lead for rainwater catchment, storage, and distribution system design and simulation
- 2013* Intimate Partner Violence Prevention and Help ■ Workshop organizer for ME staff and students
- AY 2011* Provost's Student Budget Advisory Committee ■ College of Engineering representative
- 2011* 'Recruit at Home' Graduate Recruitment at University of Florida ■ Workshop organizer
- F '11 - '14* Tau Beta Pi - Michigan Gamma ■ Chapter advisor
- 2005* Energy Audit Quality Circle ■ Part of 5-member team that performed energy audit of the college campus (awarded first place at the International Conference on Students' Quality Control Circles)

Community Outreach

- 2013* S.O.S. Community Services Empty Bowls Sale ■ Potter and event coordinator
- 2012 - 2013* Pioneer High School Science Fair ■ Judge
- 2012* Michigan Mentorship Program ■ Mentor for high school students interested in engineering
- AY 2010* MindSET (STEM program for local school students from low-income families) ■ Program founder
- 2009* SAE 'A World in Motion' (Design program for elementary school students) ■ Team mentor