MCSC | MIT Climate & Sustainability Consortium

Impact Report 2023

welcome

Message from MCSC Leadership

During her inaugural address in May 2023, President Sally Kornbluth urged the entire MIT community to join together and address the global crises of the current era — with climate change being at the forefront.

President Kornbluth emphasized how tackling challenges of this scale will require groundbreaking research, new forms of collaborations, and renewed efforts to take timely action. The MIT Climate & Sustainability Consortium (MCSC) is an example of this kind of innovative approach.

The MCSC represents MIT's commitment to solving the climate crisis; over the last three years, the Consortium has fostered collaborations across industries and MIT schools, demonstrating the importance of an interdisciplinary approach in having a real-world impact. The deep engagement by MCSC member companies allows MIT to develop solutions with the input and guidance from organizations that have global reach across their value chains.

A lot of this work is happening through research that the MCSC is supporting across campus. The recipients of its Seed Award funding in Spring 2022 have made impressive breakthroughs in their projects — from reducing the carbon footprint of chemicals using bacteria to harnessing hydrogen's potential to address long-haul trucking emissions. MCSC member companies have been closely engaged in the work that is unfolding with the Seed Awards projects, as well as other directed projects, and have provided valuable feedback that has helped the researchers focus on solutions that are relevant, implementable, and scalable.

Throughout the last year, we have also made great strides in the work happening in our impact pathways, the themes that shape our work. The MCSC Impact Fellows leading this work have published several white papers that summarize key findings in areas such as voluntary carbon markets, decarbonizing heavy duty trucking, and e-waste management. They have also hosted numerous study groups and outcome workshops to summarize progress and continue to propel work forward. We are pleased to feature this increased emphasis on implementation and outcomes throughout this Impact Report.

The MCSC's focus on research extends to students, as we welcomed 19 undergraduates, from across all schools at MIT, into our Climate & Sustainability Scholars Program for the 2023-2024 academic year. These students will have the opportunity to explore and strengthen their interests and skills in the climate and sustainability realms, while implementing research projects directly supported by faculty and principal investigators across MIT. In addition to the diverse majors of the students, we are excited about seeing an increase in students exploring place-based and community-focused projects as well as computing-related projects, aligning with the MCSC's interest in these areas. We also continue to support student research through our established and growing Undergraduate Research Opportunities Program (UROP).

In November 2023, the MCSC held its annual symposium, which brought together member companies and the MIT community to facilitate collective action. The two-day event, held at MIT, exemplified the energy that can be sparked when companies, across sectors, and academia join forces. The MCSC is now building off the ideas and next steps that emerged in the topics explored at the event, such as data and computing, the future of social sustainability, decarbonizing transportation, sustainable finance, and biodiversity.

As we look ahead, we are eager to embrace the newly announced "Climate Project at MIT," which represents an ambitious new model of accelerated, university-led innovation. It is designed to marshal the Institute's talent and resources to research, develop, deploy, and scale up serious solutions to help change the planet's climate trajectory. Through this initiative, MIT will expand resources to support climate-related research, education, and technology transfer — and the MCSC is well-positioned to engage with this new vision for climate at MIT and connect MCSC members to new activities across the Institute. We are inspired by the future, as we continue to reflect on and grow from the present. Thank you for your support.

Anantha P. Chandrakasan | Chair
Elsa Olivetti | Co-Director
Desiree Plata | Co-Director
Jeremy Gregory | Executive Director

Contents

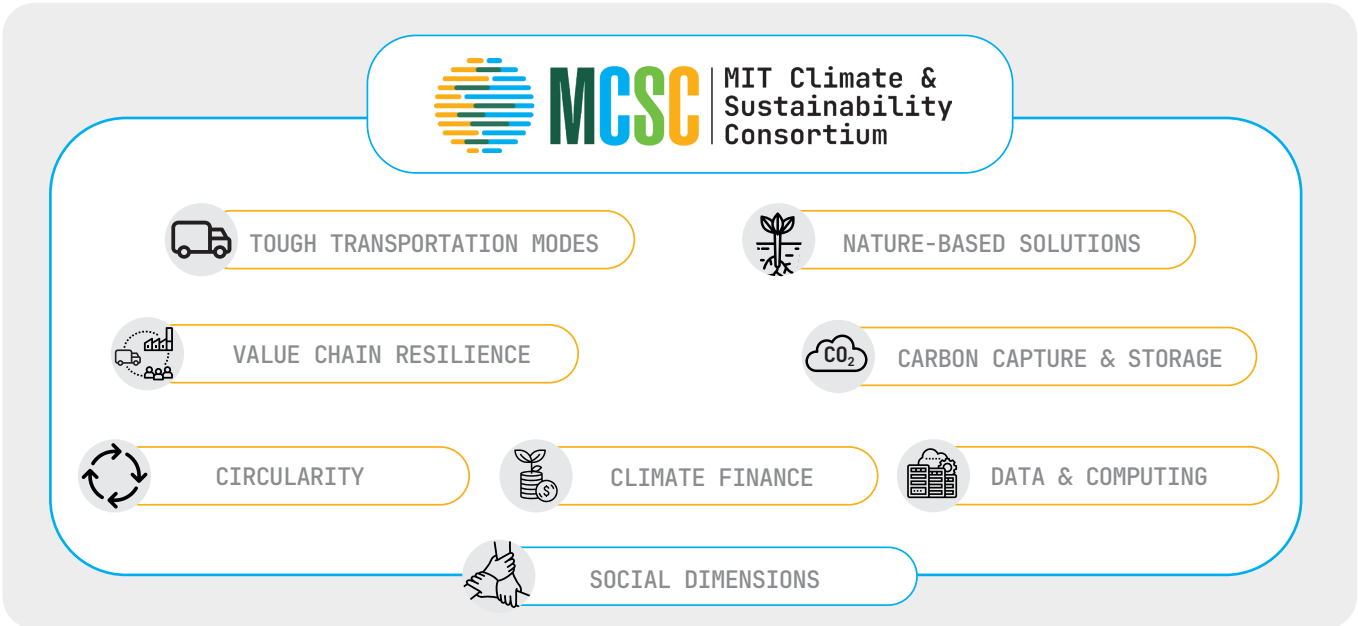
The limited printed version of this annual report is on recycled paper.

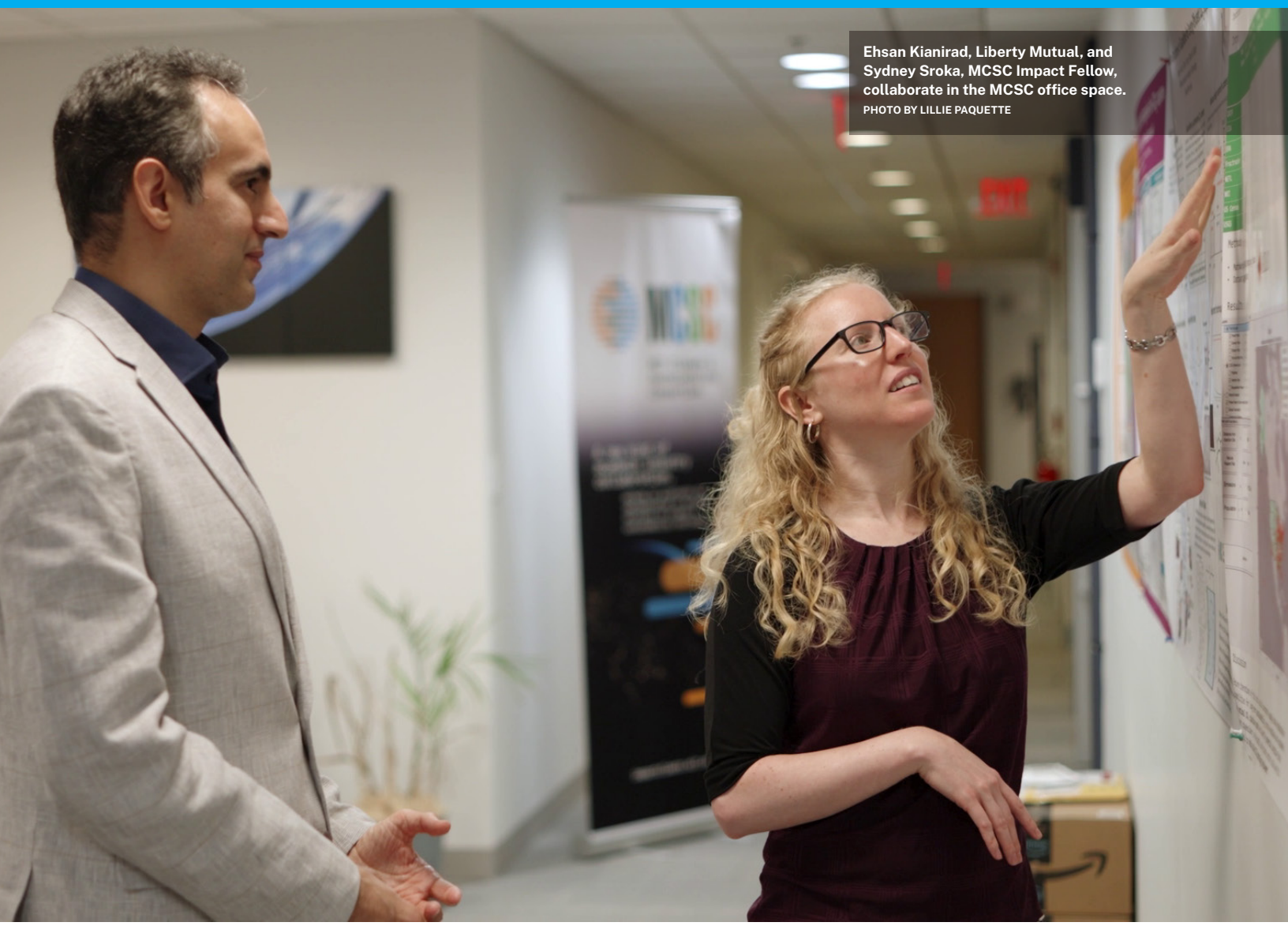
Our Work

The MCSC is a unique academia-industry collaboration, working together to vastly accelerate the implementation of large-scale, real-world solutions, across sectors, to help meet global climate and sustainability challenges. We aim to lay the groundwork for one critical aspect of MIT's continued and intensified commitment to climate: helping large companies usher in, adapt to, and prosper in a decarbonized world.

The three pillars that guide our work are **strategize**: link stated company goals to value chains, enhance synergy, and find blind spots; **implement**: define, design, and pilot cross-industry technology, process, and organizational change; and **educate**: embed sustainability practice throughout workforce and university education. Our impact pathways are themes that help shape the work we do. They are based on member company input surrounding their organizational strategies and goals as well as the climate-focused expertise and work that is unfolding at MIT.

Current Focus Areas





Ehsan Kianirad, Liberty Mutual, and Sydney Sroka, MCSC Impact Fellow, collaborate in the MCSC office space. PHOTO BY LILLIE PAQUETTE

The MCSC engages with MIT Professor Connor Coley and his team to move work in the Carbon Capture & Storage pathway forward. PHOTO BY LILLIE PAQUETTE

Member Companies

MCSC member companies recognize industry's profound responsibility for action on climate change and its unique ability to rapidly deploy and optimize solutions. Representing the heart of global capital, they have committed not only to working with MIT but with each other, to confront climate challenge with the urgency required to realize their goals — and to be part of solving this existential threat for society.

These industry leaders can both help inspire transformative change within their own sectors and demonstrate the value of working together, across sectors, at scale.

2023 Industry Advisory Board Members

Read more about the Industry Advisory Board here.

JIM ANDREW
Chief Sustainability Officer
PepsiCo, Inc.

SOLOMON ASSEFA
Vice President
IBM Research

GREG DOWNING
Director of Sustainability
Cargill

NOLLAIG FORREST
Chief Sustainability Officer
Holcim

JAMES GOWEN
Senior Vice President, Global Supply Chain & Chief Sustainability Officer
Verizon

FRANCIS HYATT
Executive Vice President and Chief Sustainability Officer
Liberty Mutual Insurance

ALISHA JOHNSON WILDER
Director, Environment, Policy & Social Initiatives/Racial Equity & Justice Initiative
Apple

ABEL LEITES
Vice President,
Verizon Global Supply Chain
Verizon

A.N. SREERAM
Senior Vice President and Chief Technology Officer
Dow

CHRIS RAYMOND
Chief Sustainability Officer
Boeing

JAVIER RODRÍGUEZ SOLER
Global Head of Sustainability
BBVA

SUSAN UTHAYAKUMAR
Chief Sustainability and Energy Officer
Prologis, Inc.

MAGALI ANDERSON
Chief Sustainability and Innovation Officer
Holcim, until August 2023

SARAH CHANDLER
Vice President of Environment and Supply Chain Innovation
Apple

ELLEN EBNER
Director, Research & Technology's Sustainability & Future Mobility
Boeing

ROBYN GLASER
Senior Vice President of Business Affairs
RWCB, a Kraft Group Company

TONY HOBSON
Senior Vice President of Strategic Planning and Kraft Operations
RWCB, a Kraft Group Company

JAN-WILLEM JANNINK
Global Sustainable Value Chain Lead
Accenture

ROB STUART
CEO, Nexplore
Executive General Manager, Information Systems and Digital, CIMIC Group

JAVIER LOSADA
Chief Sustainability Officer
Inditex

AKSHAY RAJHANS
Lead Research Scientist and Head of the Advanced Research & Technology Office
MathWorks

KATIE ROWEN
Senior Vice President,
Chief Legal and Administrative Officer
Vontier

NATE STREED
Senior Global Director of Sustainability & ESG
Vontier

LUIS COLOMA
Head of Care for Life and Nature
Inditex

We would also like to welcome new IAB members: Lina Azuero, RWCB, a Kraft Group Company; Juan Bernabe-Moreno, IBM Research; and Vikrant (Vik) Viniak, Accenture.

MCSC Community

Leadership

ANANTHA P. CHANDRAKASAN
Chair
Chief Innovation and Strategy Officer, MIT; Dean, MIT School of Engineering; Vannevar Bush Professor of Electrical Engineering and Computer Science

Anantha was named MIT's first chief innovation and strategy officer, effective February 2024. He will continue to serve as dean of engineering and MCSC Chair. As chief innovation and strategy officer, Chandrakasan will work closely with MIT President Sally Kornbluth to advance the ambitious agenda that she has laid out in the first year of her presidency.

ELSA OLIVETTI
Co-Director
Associate Dean, MIT School of Engineering; Jerry McAfee Professor in Engineering; Professor, Department of Materials Science and Engineering

Elsa was appointed associate dean of engineering at MIT, helping lead and shape the school-wide climate and sustainability efforts – as well as oversee diversity, equity, and inclusion activities across the School of Engineering. This is an opportunity to amplify the work Olivetti is doing with the MCSC.

DESIREE PLATA
Co-Director
Gilbert W. Winslow Career Development Professor in Civil Engineering Associate Professor, Civil and Environmental Engineering; MIT School of Engineering

Desirée was named co-director of the MCSC, effective September 1, 2023. Her expertise illustrates her commitment to translating academic innovations for real-world implementation — and will help advance our mission and propel climate and sustainability solutions forward.

JEREMY GREGORY
Executive Director

JEFFREY GROSSMAN
Strategic Advisor
Morton and Claire Goulder and Family Professor in Environmental Systems, Professor of Materials Science and Engineering, MacVicar Faculty Fellow

Adminstrative Staff

ELISE CHAMBERS
Program Manager for Student, Postdoctoral, and MIT Engagement

MOLLY CHASE
Communications Manager

KATIE DAEHN
Research Scientist

JAY LAMOUR
Program Coordinator

MELISSA ZGOLA
Program Manager for Member Engagement

Faculty Steering Committee

An interdisciplinary group of MIT faculty, working collaboratively with the MCSC to share their perspectives and help shape a common vision. Read more about the Faculty Steering Committee here.

STEVEN BARRETT
Professor, Aeronautics and Astronautics
MIT School of Engineering

MEGAN A. BLACK
Associate Professor of History
MIT School of Humanities, Arts, and Social Sciences

STEFANIE JEGELKA
Associate Professor, Electrical Engineering & Computer Science
MIT School of Engineering

JEREMIAH JOHNSON
Professor, Chemistry
MIT School of Science

DAVID HSU
Associate Professor, Urban and Environmental Planning
MIT School of Architecture and Planning

HEATHER J. KULIK
Associate Professor, Chemical Engineering
MIT School of Engineering

CHAKANETSA MAVHUNGA
Associate Professor, Science, Technology, and Society
MIT School of Humanities, Arts, and Social Sciences

DAVID MCGEE
Associate Professor, Earth, Atmospheric and Planetary Sciences
MIT School of Science

DAVID PERREAULT
Joseph F. and Nancy P. Keithley Professor in Electrical Engineering
MIT School of Engineering

ROBERTO RIGOBON
Society of Sloan Fellows Professor
Professor, Applied Economics
Sloan School of Management

MARIA YANG
Associate Dean
Gail E. Kendall (1978) Professor,
Mechanical Engineering
School of Engineering

SIQI ZHENG
Samuel Tak Lee Champion Professor
Professor, Urban and Real Estate Sustainability
MIT School of Architecture and Planning

YANCHONG (KAREN) ZHENG
George Maverick Bunker Professor of Management
Associate Professor, Operations Management;
Sloan School of Management

READ MORE ABOUT THE MCSC COMMUNITY.

2023 Impact Fellows

This program is a postdoctoral opportunity for individuals who want to transcend academia and industry to apply their expertise to near-term change for a more sustainable future. Impact Fellows work with MIT researchers and consortium industry members — in collaboration with external organizations and communities — to implement solutions needed for global economic transformation to address the global climate change and sustainability crisis. Read more about the MCSC Impact Fellows here.


NOMAN BASHIR


AMANDA BISCHOFF


JUNGWOO CHUN


EVAN COLEMAN


LAURA FRYE-LEVINE


DANIKA MACDONELL


POUSHALI MAJI


AKACHUKWU (AC) OBI


SYDNEY SROKA


ANEIL TRIPATHY

Climate & Sustainability Scholars

These undergraduate students are passionate about climate and sustainability and eager to explore and strengthen their interests and skills, while implementing research projects directly supported by faculty and principal investigators across MIT. Read more about these students on the MCSC website and on pages 32-33 of this report.


MARIA ALDER


ISELLE BARRIOS


MITALI CHOWDHURY


NORA DONNELLY


YICHEN GAO


RUNAKO GENTLES


SIERRA GREEN


AALIYA HUSSAIN


LUCY KIM


ARI PERÓ


SHREYA RESHAMWALA

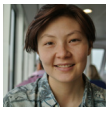

GILLIAN ROEDER

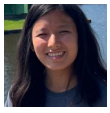

SAM SALWAN


ANANDA SANTOS FIGUEIREDO


ERIN THOMPSON


DANIEL TONG


KAI VAN BRUNT


PAIGE YEUNG


PAUL IRVINE
Teaching Assistant


MELISSA STOK
Teaching Assistant

Impact Report design by Chandra Tallman Design

Member Company Voices

Nexplore | Torsten Galle

Research Advisor and Knowledge Manager

"In this era of profound and multifaceted change, collective action is paramount. The MCSC provides a crucial forum for organizations to unite, exchange insights, and craft shared solutions. Yet, our endeavors must always prioritize the well-being of the most marginalized among us, ensuring that progress is inclusive and equitable. Only then can we truly claim to be charting a course that benefits all of humanity."

Nexplore is distinguished as a leading provider of software and technology in the global construction sector, relentlessly pushing boundaries with innovative solutions tailored for achieving sustainability in the industry. Their commitment to advancing data-driven and lifecycle-focused practices has marked them as a significant player in the field. In collaboration with the Sustainability Consortium (MCSC), Nexplore pioneers important sustainability research, particularly around reusable concrete and the decarbonization of computing.

MathWorks | Akshay Rajhans

Lead Research Scientist and Head of the Advanced Research & Technology Office

"Computation underpins many of the climate and sustainability challenges facing us, including MCSC's impact areas of value chain resilience, climate finance, and transportation. MCSC enriched our understanding of the state of the art by giving us a platform to engage with researchers and practitioners from MIT and the member companies. Partnering with the MIT colleagues on the geospatial mapping tool and an analytical study in climate finance allowed us to contribute towards the cause in a concrete and meaningful way."

MathWorks develops mathematical computing software used to accelerate the pace of engineering and science. They have been actively partnering with universities, startups, commercial entities, and non-profits to enable innovative solutions, especially in electrification, climate science, and climate finance. Through their involvement with the MCSC, they have collaborated with member companies and MIT researchers across campus, contributed to the development of an interactive mapping tool that supports resilience planning, and engaged with MIT undergraduates by supporting their research projects. MathWorks employees with a range of technical expertise have provided their advice and knowledge in the MCSC focus areas of resilience, finance, and social dimensions.

Dow | A.N. Sreeram

Chief Technology Officer and Senior Vice President of Research & Development

"The MCSC excels at focusing on solutions that are grounded in rigorous science and engineering, and possible at scale. We appreciate these principles and how they support feasible implementation."

Dow is a world leader in materials science and an inaugural member of MCSC. Their involvement with MCSC has ranged from mentoring Undergraduate Research Opportunity Program (UROP) projects to participating in Impact Fellow working groups, seed projects with professors, and brainstorming sessions with MIT and fellow member companies. Dow's expertise in materials science and R&D is valued on a wide-range of topics from business models to technology development. Dow has also welcomed MCSC leaders to their world headquarters and R&D facilities in Midland, MI, USA.

Cargill | Dana Boyer

Sustainability Manager, Climate

"Cargill has had the opportunity to engage in several unique projects and collaborations through the MCSC, working closely with other member companies whose viewpoints and strategies have encouraged new ways of thinking. We value the deep focus on research the MCSC brings to our work through fostering connections between our team and the MIT's vibrant research community."

Cargill is a global food manufacturer that connects farmers with markets, customers with ingredients, and people and animals with the food they need to thrive. Cargill has been a strategic collaborator with several other MCSC member companies. Their perspectives on diverse topics such as soil carbon measurement, electrification in long-haul trucking, and limits to biomass availability for biofuels have helped moved the MCSC's work forward.

Social Sustainability: Central to MCSC's Strategy

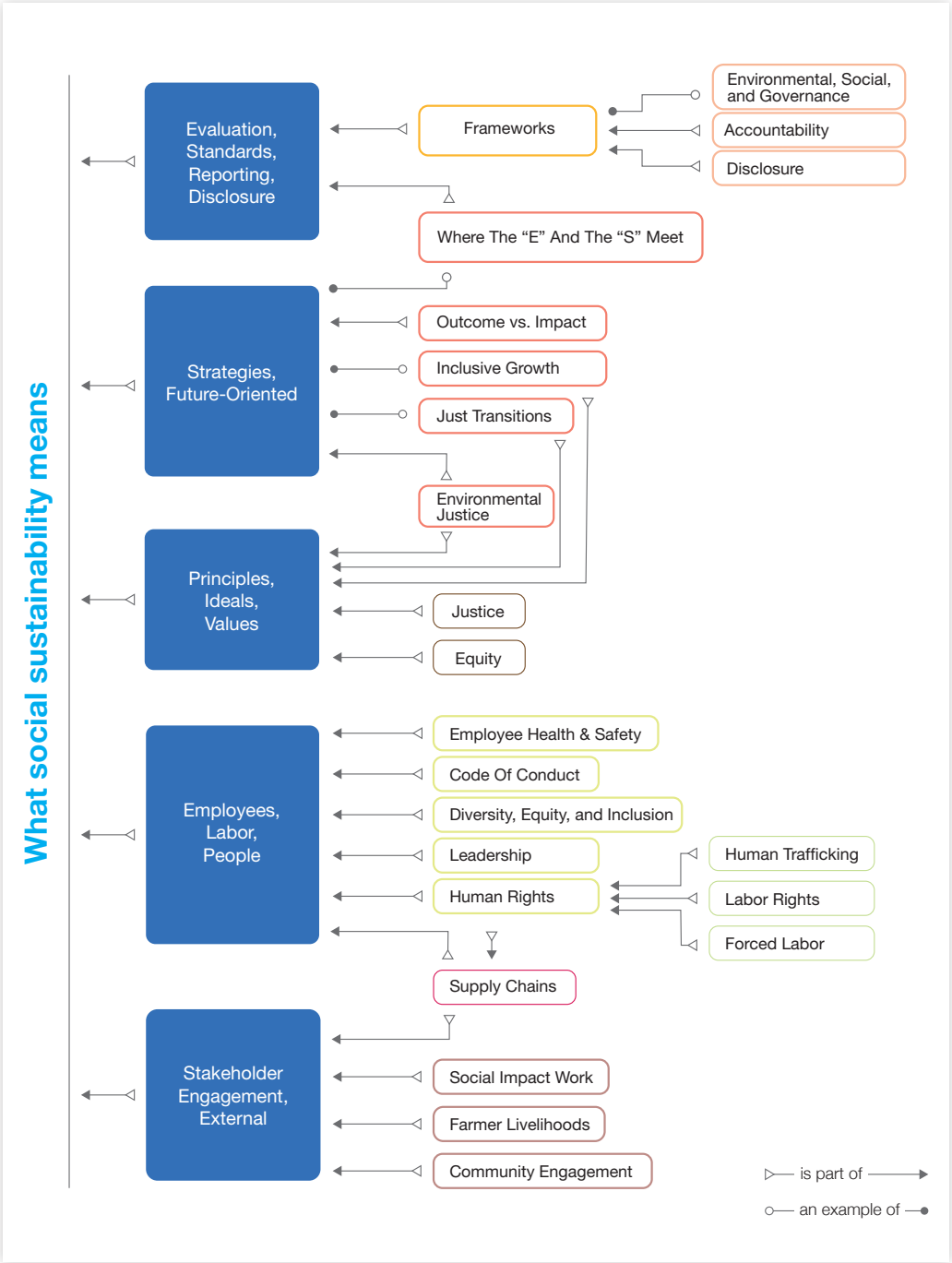
LAURA FRYE-LEVINE

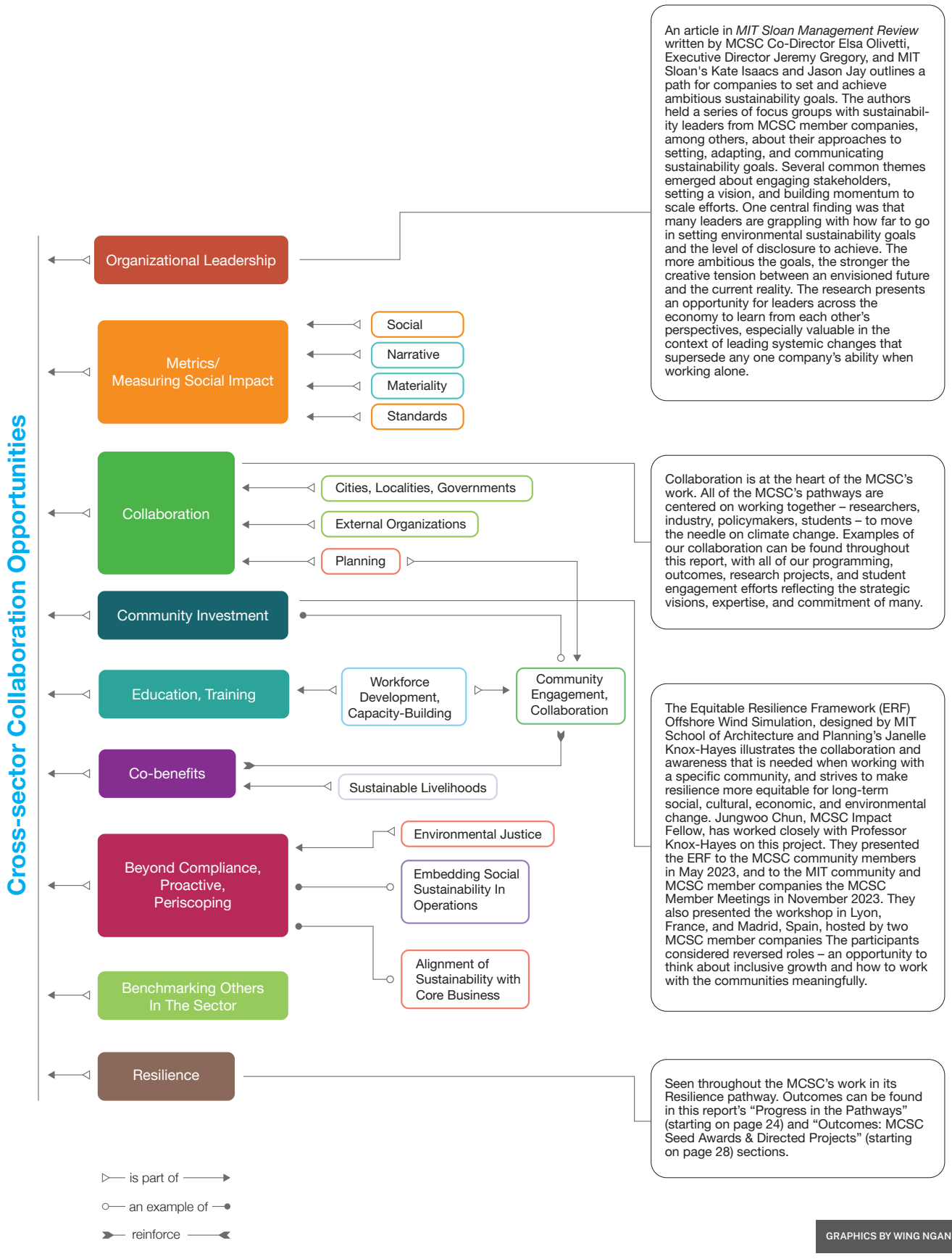
JUNGWOO CHUN

Throughout 2023, Impact Fellows **Laura Frye-Levine** and **Jungwoo Chun** conducted a robust interview project to listen to and understand MCSC member company perspectives on the nature, extent, and future of social sustainability. Frye-Levine and Chun led in-depth semi-structured interviews with more than 50 individuals (some across multiple conversations) about the challenges and opportunities facing professionals in a wide array of job functions in social sustainability across the diverse sectors represented in the MCSC's membership. Through this meaningful dialogue, they have begun to assess the depth, complexity, and structure of thinking about social sustainability, as well as concerns, needs, opportunities and trends. The interviews were structured around four central questions:

1. What is your definition of social sustainability?
2. What opportunities do you see in cross-sector collaboration and stakeholder partnership at the MCSC?
3. What processes and programs do you have in place and what are you driving forward?
4. What challenges do you face in your work?

Based on the discussions they had, and the trust the process has built across individual member companies, the MCSC can more deeply shape its strategy with social sustainability at the foundation. Through that framing, we can determine innovative solutions while also learning how these solutions might be best implemented given the social systems in which they operate. A subset of the interview findings are captured in these two representations in answer to questions 1 and 4.





An article in *MIT Sloan Management Review* written by MCSC Co-Director Elsa Olivetti, Executive Director Jeremy Gregory, and MIT Sloan's Kate Isaacs and Jason Jay outlines a path for companies to set and achieve ambitious sustainability goals. The authors held a series of focus groups with sustainability leaders from MCSC member companies, among others, about their approaches to setting, adapting, and communicating sustainability goals. Several common themes emerged about engaging stakeholders, setting a vision, and building momentum to scale efforts. One central finding was that many leaders are grappling with how far to go in setting environmental sustainability goals and the level of disclosure to achieve. The more ambitious the goals, the stronger the creative tension between an envisioned future and the current reality. The research presents an opportunity for leaders across the economy to learn from each other's perspectives, especially valuable in the context of leading systemic changes that supersede any one company's ability when working alone.

Collaboration is at the heart of the MCSC's work. All of the MCSC's pathways are centered on working together – researchers, industry, policymakers, students – to move the needle on climate change. Examples of our collaboration can be found throughout this report, with all of our programming, outcomes, research projects, and student engagement efforts reflecting the strategic visions, expertise, and commitment of many.

The Equitable Resilience Framework (ERF) Offshore Wind Simulation, designed by MIT School of Architecture and Planning's Janelle Knox-Hayes illustrates the collaboration and awareness that is needed when working with a specific community, and strives to make resilience more equitable for long-term social, cultural, economic, and environmental change. Jungwoo Chun, MCSC Impact Fellow, has worked closely with Professor Knox-Hayes on this project. They presented the ERF to the MCSC community members in May 2023, and to the MIT community and MCSC member companies the MCSC Member Meetings in November 2023. They also presented the workshop in Lyon, France, and Madrid, Spain, hosted by two MCSC member companies The participants considered reversed roles – an opportunity to think about inclusive growth and how to work with the communities meaningfully.

Seen throughout the MCSC's work in its Resilience pathway. Outcomes can be found in this report's "Progress in the Pathways" (starting on page 24) and "Outcomes: MCSC Seed Awards & Directed Projects" (starting on page 28) sections.

GRAPHICS BY WING NGAN

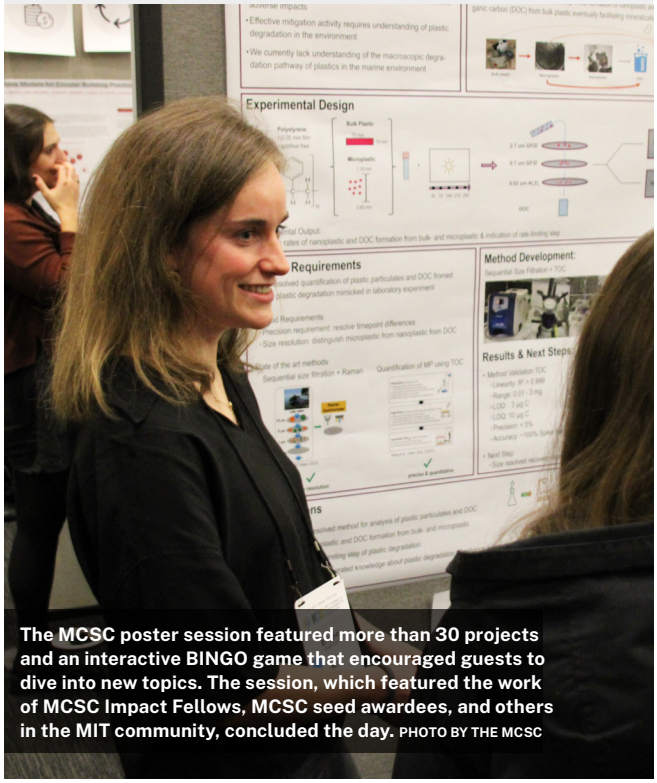
Member Meetings Connect Work Across Focus Areas

At its 2023 Member Meetings, MCSC member companies came together with the MIT community to share and amplify their brainpower and drive toward specificity when it comes to developing scalable solutions to climate change. This two-day event exemplified the energy, ideas, and innovations that can be sparked when companies, across sectors, and academia join forces.

READ MORE

Joining forces with MITEI to explore opportunities in maritime shipping and computing

The event started with two sessions held in conjunction with the MIT Energy Initiative Future Energy Systems Center featuring speakers from MIT, industry, and government. The **first session on decarbonizing maritime shipping**, an industry that relies on high-density fuels to go long distances and has the potential to increase its portion of global emissions to 10%, featured different perspectives along the value chain. The **second session dove into opportunities to decarbonize computing**, particularly large data centers, with **Noman Bashir**, MCSC Impact Fellow, starting the discussion by outlining the evidence for significant growth in computing, as well as the factors that contribute to the operational and embodied carbon footprint of computing.



The MCSC poster session featured more than 30 projects and an interactive BINGO game that encouraged guests to dive into new topics. The session, which featured the work of MCSC Impact Fellows, MCSC seed awardees, and others in the MIT community, concluded the day. PHOTO BY THE MCSC

Making social sustainability central to strategy

As organizations continue to strategize and plan for a decarbonized future, the relevant social dimensions must be embedded into supply chains and decision-making. But while setting corporate social sustainability goals is productive, the implementation aspect is not always clear. These sentiments were central to the **session about the future of social sustainability** led by **Laura Frye-Levine** and **Jungwoo Chun**, MCSC Impact Fellows.

"When it comes to achieving a more sustainable cocoa sector, there are multiple and interconnected issues and factors at play, which means that action in any one area is likely to influence another," **Rupert Day**, Farmer Livelihood Advisor at Cargill, explained. "This makes it essential to take a comprehensive, holistic approach to decision-making that considers all relevant information and possible outcomes before launching into any new or adjusted initiatives. In this way, we ensure that each of our actions will have a concrete, positive impact."

The panel also featured **Dylan Mayer**, Sustainability Strategy Manager at Verizon; **Marina Rakhlin**, Program Director, Partnerships and ESG Strategy at IBM; and **Indalecio Perez**, Head of Sustainability Engagement at Inditex. Adding another perspective on the more human and behavioral side of sustainability was the **session focused on changing behavior across sustainable finance**, organized by **Aneil Tripathy** and **Poushali Maji**, MCSC Impact Fellows.

Marina Rakhlin, IBM, speaks during session on social sustainability. PHOTO BY GRETCHEN ERTL

Sally Kornbluth, President; Richard Lester, Japan Steel Industry Professor and Vice Provost; and Anantha Chandrakasan, MCSC Chair and Dean of the School of Engineering spoke during the opening session.
PHOTOS BY GRETCHEN ERTL

Navigating the transition to a decarbonized future

A panel with representation from Liberty Mutual Insurance and MIT, moderated by **Sydney Sroka**, MCSC Impact Fellow, sparked **discussion around the physical and transition risks of climate change**.

"The transition to a decarbonized future requires a strategy that accounts for the larger systems that a company operates within, as opposed to focusing primarily on factors within a company's control and fulfilling individual reporting obligations," said **Rakhi Kumar**, Senior Vice President at Liberty Mutual Insurance, who also provided an overview of transition risk, made connections to historical examples of disruptive transition, and discussed how climate impacts bring systems-level challenges to the forefront.

Highlighting an opportunity to improve the risk assessment tools available to decision-makers, **Victoria Yanco**, Sustainability Consultant at Liberty Mutual Insurance, spoke about how current risk models and scenario analyses are used to take a systems-level approach to transition risk planning.

Incorporating biodiversity into corporate goal setting

Amanda Bischoff, MCSC Impact Fellow, moderated a **session about opportunities to drive measurably positive outcomes in biodiversity protection and recovery**. Since biodiversity encompasses many research areas and is defined differently across scientific disciplines, collecting data is difficult to scale and requires careful design and data interpretation.

Sami Ghazi, PepsiCo, talks to Desiree Plata, MCSC.

Lina Azuero, UN1F1ED2 Global Packaging Group/ Rand Whitney Containerboard, collaborates with other representatives from MCSC member companies.

PHOTOS BY GRETCHEN ERTL

Member Meetings continued

Harnessing the opportunities of data to improve materials circularity

Data continued to be a central theme to the conversation as attendees **explored the importance of having high-quality data on materials flows in creating a circular economy**. This session, moderated by **Evan Coleman** and **Poushali Maji**, MCSC Impact Fellows, explored using materials passports as a data traceability mechanism in circular supply chains for enhanced resource recovery and optimal materials development. Presenters included **Inge Donovan**, **Jenna Schnitzler**, and **Hazel Mann** of MIT Architecture, who talked about Pixelframe, a structural system designed for disassembly and reuse in a circular building economy. From the industry side, **Sophie Wu**, Regional Head, Geocycle North America, Holcim, spoke about using waste as resources in the construction materials supply chain. **Antoine Allanore**, Professor of Metallurgy and the Heather N. Lechtman Professor of Materials Science and Engineering at MIT, added an academic and research lens, sharing his knowledge about valorizing mixed waste streams.

During this session, attendees had the opportunity to play 6cycle, created by Coleman and Maji, which highlighted the opportunities in data conservation and collection along supply chains.

Lowering barriers to decarbonized transportation

Industry experts in logistics services and infrastructure provision convened to discuss **key barriers to transitioning trucking fleets to electrification and low-carbon fuels**, and opportunities for stakeholders to pool resources to lower the barriers to decarbonized transportation.

"We are interested in bringing a broad array of technologies together for customers to optimize their operations – from fleet and driver management solutions to end-to-end decarbonization support across EV, CNG/RNG, and H2," said **Nate Valaik**, Director, Strategy & Business Development, Alternative Energy & Sustainable Fleets at Vontier. "From an infrastructure pooling perspective, we are thinking about how we can get people in the same room to talk about the benefits of collective utilization. We need a diverse set of stakeholders to collaborate on complex issues; as we build relationships and have conversations, this will happen organically."

Moderated by **Danika MacDonell**, MCSC Impact Fellow, the panel generated many ideas for how academic research can support fleet transition and pooling efforts.

L to R: Rakhi Kumar, Liberty Mutual Insurance; Chelsea Blau, Cargill; and Victoria Yanco, Liberty Mutual Insurance; play 6cycle.

Janelle Knox-Hayes, Professor of Economic Geography and Planning (both standing) at MIT, along with Jungwoo Chun, Department of Urban Studies and Planning, led an interactive simulation exercise applying the Equitable Resilience Framework. Representatives from Liberty Mutual Insurance and Inditex work together as they explore the issues and trade-offs involved in the development of offshore wind energy projects. PHOTO BY THE MCSC

Nate Valaik of Vontier (left) spoke on a panel discussion on lowering barriers to decarbonized transportation.

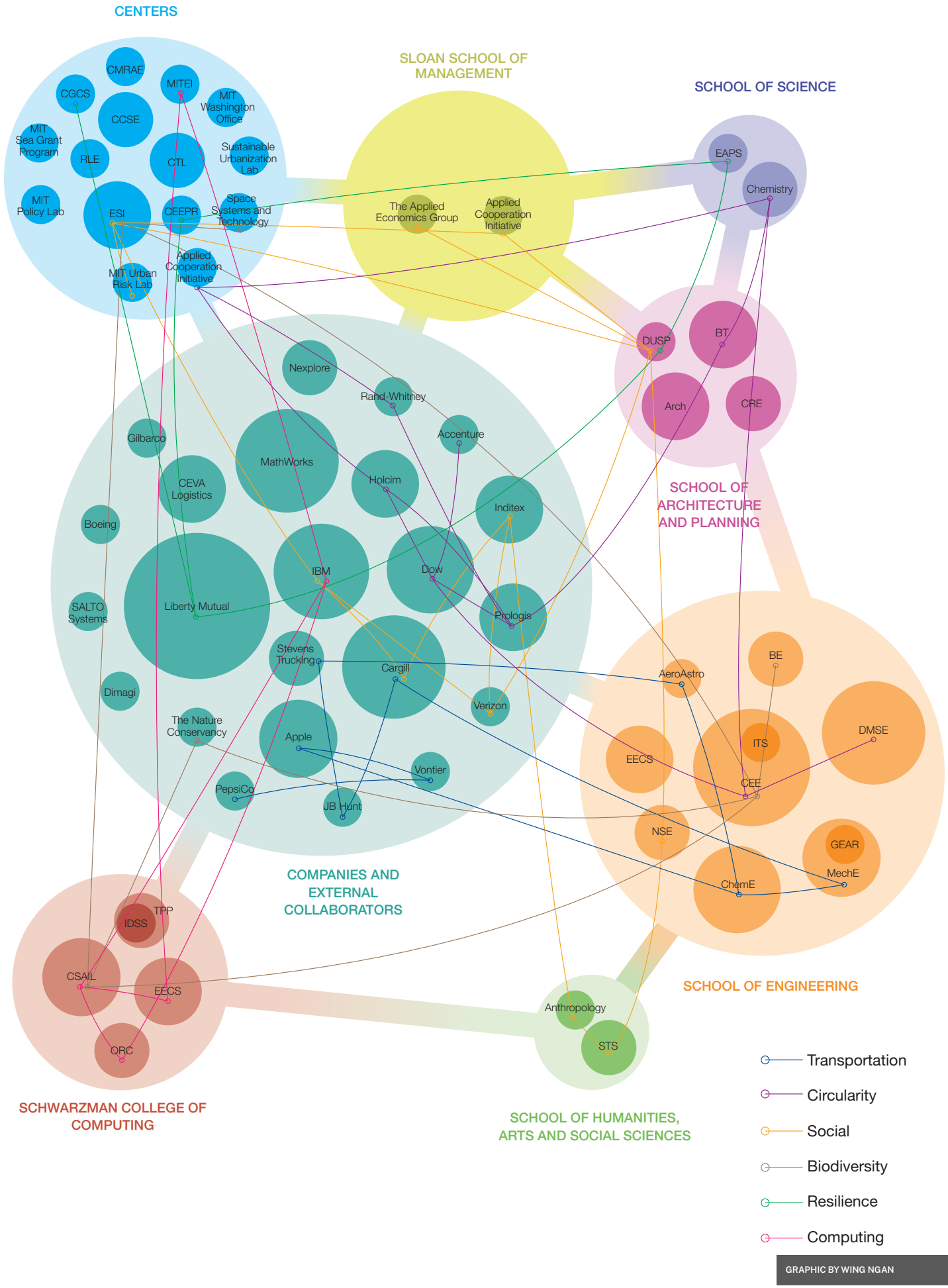
The MCSC's Innovation Ecosystem Comes Together at the 2023 Member Meetings

The MCSC's vibrant community includes experts across MIT's schools, departments, labs, and centers, as well as across MCSC member companies and other relevant industries. This network is fundamental to the MCSC's ability to progress and innovate – and recently came together at the MCSC Member Meetings in November 2023 (read more on pages 14-17).

These Member Meetings are one manifestation of the MCSC's fully linked, connected nature, which occurs across all of our pathways and topics of investigation, explored throughout this report.

The graphic to the right is a snapshot of the diverse participation at this two-day event and visualizes just one snapshot of the links the Member Meetings facilitated – representing the MCSC's much larger focus on connectivity and collaboration. In the graphic, the size of the circles, which represent a wide range of MIT entities and MCSC member companies, correlates with the number of attendees. The overlay of thin lines highlights the speakers within each topical session.

PHOTO BY GRETCHEN ERTL



GRAPHIC BY WING NGAN

Study Groups

Throughout the year, the MCSC hosts study groups for member companies and the MIT community to come together to learn more about certain topics and to spark new ideas and collaborations. Highlights include:

Interventions to Enhance Soil Carbon — Outlook and Challenges

February 2023


DANA BOYER


RUOFEI JIA


CESAR TERRER

This session featured a panel discussion with Cesar Terrer, MIT Assistant Professor of Civil and Environmental Engineering; Ruofei Jia, MIT Graduate Student in Civil and Environmental Engineering; and Dana Boyer, Sustainability Manager for Climate at Cargill. Ruofei Jia shared an introduction to the science of soil carbon, while Dana Boyer spoke about the agricultural industry perspective on corporate challenges. Their remarks were followed by an audience Q&A with the panelists.

Accounting for Greenhouse Gas Emissions in Renewable Energy

May 2023


PAUL JOSKOW


JULIE NEWMAN


ANDY WU

This session featured Paul Joskow, MIT Professor of Economics, Emeritus; Julie Newman, Director of Sustainability at MIT Julie Newman; and Andy Wu, Senior Consultant at Liberty Mutual. They discussed renewable energy procurement and the associated greenhouse gas (GHG) accounting, in particular for purchase power agreements. The discussion began with an overview of current scope 2 GHG accounting and reporting practices, followed by presentations by each of the panelists, and last, an audience Q&A.

140+

ATTENDEES AT MCSC STUDY GROUPS IN 2023

Behavioral Interventions for Circularity

September 2023

EREZ YOELI

Erez Yoeli, Research Scientist at MIT's Sloan School of Management, led this session on designing behavioral interventions. He discussed implementing three elements of a behavioral intervention: observability, eliminating plausible deniability, and communicating expectations. Attendees then collectively worked through applying this "checklist" to case studies: recycling contamination and "wish cycling," consumer engagement in promoting circularity in textiles and electronics, and encouraging adoption of recycled construction materials.

Alternative Fuels and Powertrains Study Group

June 2023

This session featured William H. Green, MIT Professor in Chemical Engineering; Sayandeep Biswas, MIT Ph.D. Candidate in Chemical Engineering; Joel van Rensburg, President of Alternative Fuels ANGI/Gasboy at Vontier; and Lewis M. Fulton, Director of STEPS (Sustainable Transportation Energy Pathways) at UC Davis. This study group explored the interests and pain points the MCSC has been hearing from member companies on navigating the transition to alternative fuels and powertrains in heavy duty trucking. The panelists, from academia and industry, shared their perspectives on key topics: feasibility and niches for different alternative fuel and powertrain options, barriers to adoption in the industry, the role of policy in supporting the transition, and initial opportunities for adoption.

Voices from Across Campus: MCSC Sustainability Speaker Series

Each Friday, the MCSC hosts a speaker to share what they are working on with the MCSC community. In 2023, we hosted researchers, experts in a diverse range of fields, MCSC Seed Award recipients, faculty members, and students to amplify and extend their latest efforts.

APRIL 2023 | **DAVID BABSON**
Executive Director, MIT Climate Grand Challenges

Launched in 2020, MIT's Climate Grand Challenges is designed to mobilize the Institute's entire research community around tackling the most difficult unsolved climate problems in emissions reduction, climate adaptation and resilience, risk forecasting, carbon removal, and understanding the human impacts of climate change. **David Babson** gave an update on the current status of the initiative, and shared the vision for its future.

JULY 2023 | **DEBORAH DOUGLAS**
Director of Collections and Curator of Science & Technolgoy, MIT Museum

Deborah Douglas, an expert on MIT history, stopped by the MCSC to share a crash course on the MIT Radiation Laboratory, the United States' second-largest R&D effort during World War II. During the presentation, Dr. Douglas explored the lessons this famous enterprise might have for climate and sustainability efforts today.

AUGUST 2023 | **DREW STORY**
Managing Director, MIT Policy Lab

Drew Story spoke to the MCSC community about the MIT Policy Lab's role in providing scholars with specialized guidance and training on public policy and mobilizing research to transfer knowledge into practice. The MIT Policy Lab helps increase the impact of academic research and supports MIT researchers from all disciplines engage effectively with public policy.

DECEMBER 2023 | **CHRIS RABE**
Postdoctoral Associate in Environmental and Sustainable Education at the MIT Environmental Solutions Initiative

Chris Rabe shared an overview of climate justice education including historical foundations, definitions, challenges, and strategies in development for its increased inclusion across the curriculum at MIT and beyond. He explored how and why climate justice knowledge and practice, as well as climate justice educational components, could be relevant for the work of the MCSC and its member companies.

Thank you to all our speakers, as well as our community members who join us each week to listen! If you are interested in attending a Friday lunch at the MCSC, please e-mail **mcsc@mit.edu**.

THE MCSC HOSTED
50+
EXPERTS ACROSS THE MIT COMMUNITY AND BEYOND FOR ITS SUSTAINABILITY SPEAKER SERIES IN 2023.

Deborah Douglas

Drew Story

Implement

Progress in MCSC Pathways

These selected outcomes and highlights showcase the work happening within the MCSC pathways, led by the MCSC Impact Fellows and staff.

White Papers

Exploring Voluntary Carbon Markets Through Cross-Industry Perspectives and Collaborations



A new white paper co-authored by researchers at the MCSC, BBVA, and IBM explores both the challenges and potential of voluntary carbon markets through a collaborative and cross-industry approach. The authors — MCSC Impact Fellows Evan Coleman, Aneil Tripathy, and Sydney Sroka; IBM Research's Levente Klein, Ademir Ferreira da Silva, and Marina Rakhlin; and BBVA's Beatriz Roa Tejero and Jon Díez Aldonza — emphasize how the uncertainty related to measurements and assessment must be addressed urgently with new rigorous scientific and economic approaches.

RELATED OUTCOME WORKSHOP The MCSC hosted an outcome workshop to discuss efforts at the MCSC to improve transparency and credibility in carbon markets, in June 2023.

BBVA IBM

READ MORE

Alternative Fuels and Powertrains to Decarbonize Heavy Duty Trucking

During a panel discussion hosted by the MCSC, experts from across academia and MCSC member companies discussed opportunities and barriers that trucking fleets face as they navigate the shift to low-carbon alternative fuels and powertrains. A new white paper — written by MCSC Impact Fellow Danika MacDonell and MIT graduate students Sayandeep Biswas and Kariana Moreno Sader — explores some of the key points and outcomes from this conversation, as well as from other research being done in the MCSC's Tough Transportation Modes focus area.

RELATED OUTCOME WORKSHOP The MCSC hosted an outcome workshop to discuss the data needs and data gaps of the tool in February 2023.

READ MORE

Exploring E-waste Challenges Through a Regulatory Complexity Lens & Potential Steps to Move Forward

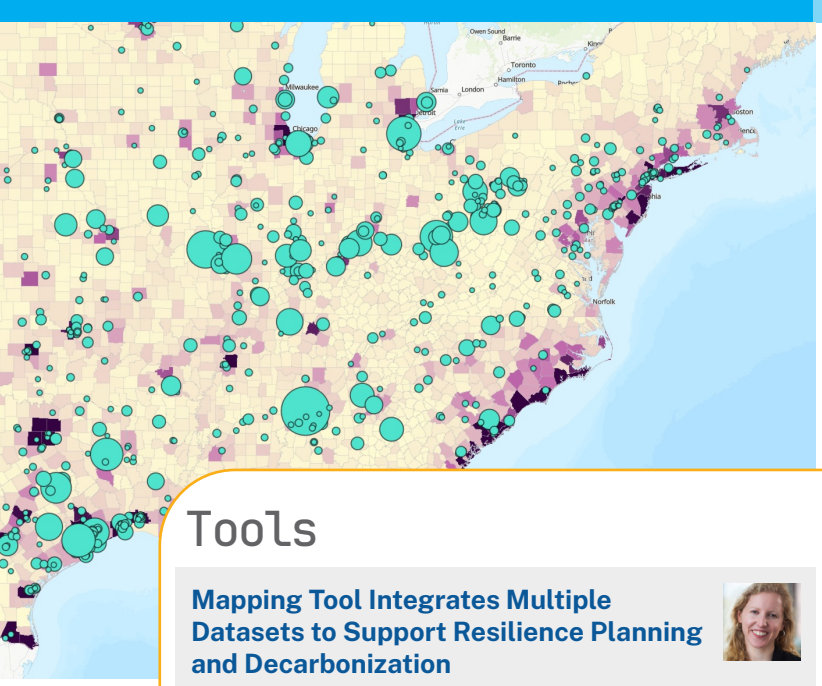
A new MCSC white paper explores the opportunities and barriers of responsible e-waste recovery. The authors, Poushali Maji, MCSC Impact Fellow, and Susannah Pratt Calvin, Environment and Supply Chain Innovation at Apple, dive into the challenges surrounding e-waste, through a regulatory complexity lens, and propose potential steps and solutions to move forward.

READ MORE

Frameworks for Responsible Growth in Generative AI

Several MIT scholars were awarded seed grants to probe the social implications of generative AI and explore the technology's impact on democracy, education, sustainability, communications, and more. Noman Bashir, MCSC Impact Fellow, and Elsa Olivetti, MCSC Co-Director, are part of a team that was selected to receive funding to write an impact paper on their discoveries surrounding the climate and sustainability implications of generative AI. The paper's other co-authors include James Cuff, Executive Director of the Office of Research Computing & Data; Priya Donti, Assistant Professor in Electrical Engineering and Computer Science; Sydney Sroka, Research Scientist; Marika Ilic, Senior Research Scientist at Laboratory for Information and Decision Systems; and Vivienne Sze, Associate Professor in Electrical Engineering and Computer Science.

READ MORE



180+

ATTENDEES AT MCSC OUTCOME WORKSHOPS IN 2023.

Tools

Mapping Tool Integrates Multiple Datasets to Support Resilience Planning and Decarbonization

The MCSC created an Interactive Geospatial Mapping Tool to help member companies visualize and understand the barriers to resilience planning and decarbonization. Developed by Sydney Sroka, MCSC Impact Fellow, in collaboration with MCSC members and colleagues, the mapping tool hosts a unique combination of data necessary for addressing decarbonization and resilience planning. The two flagship analyses this tool supports are site selection for deep decarbonization efforts and vulnerability assessments for vegetation. Many more social data layers were added, including information on disadvantaged communities and on Thriving Communities Technical Assistance Centers; these are essential to help users plan decarbonization and resilience activities collaboratively with local communities.

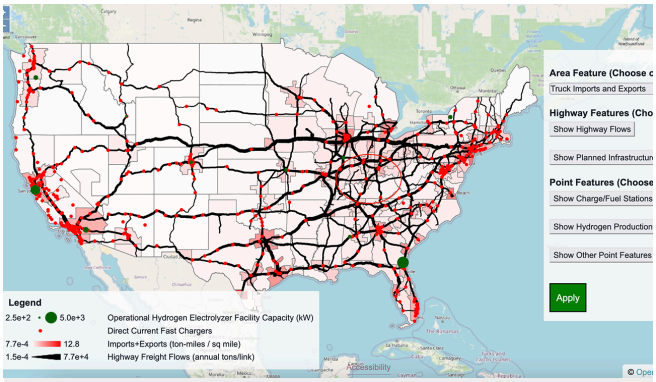
RELATED OUTCOME WORKSHOP hosted an outcome workshop to discuss the data needs and data gaps of the tool in February 2023.

READ MORE

Game Explores Material Passports and Sustainable Supply Chains

Harnessing the power of data throughout material loops can support the transition to a circular economy by facilitating strategic supply chain management decisions. Material passports, which list all the materials in a product or construction during its life cycle, are one valuable tool for decision-makers — documenting and conserving important data that can create value at both the recycler/downstream end and the manufacturer/upstream end of a supply chain. A new game, 6cycle, developed by Evan Coleman and Poushali Maji, MCSC Impact Fellows, demonstrates the use of such material passports, simulating the challenges and opportunities in building and maintaining circular supply chains.

READ MORE



Geospatial Decision Support Tool for Fleets

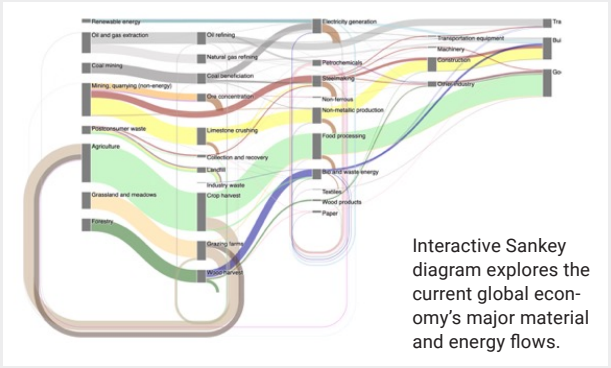
The MCSC's Geospatial Decision Support Tool helps trucking industry stakeholders and fleet owners assess where and how best to decarbonize their fleets by transitioning to low-carbon energy carriers. Developed by Danika MacDonell, MCSC Impact Fellow, alongside Florian Allroggen, Research Scientist, and Micah Borrero, undergraduate researcher, the tool hosts public freight-flow and emissions-related data for trucking, focusing on in-depth analysis and visualization of freight analysis framework (FAF5) data, complemented by supporting information from many other sources. Together, the information represents a robust geospatial picture of regional freight flow densities, planned and available infrastructure, emission intensities, and relevant regulations and incentives — leading to strategic decision-making support for fleet transitions.

READ MORE

Other Selected Highlights

Climate Tipping Points

Katie Daehn, Research Scientist, and Professor **Elsa Olivetti** have been working on an interactive Sankey diagram tool to explore the major material and energy flows in the current global economy, which we can use to explore scale and visualize connections between sectors. This framework also provides a physical basis for evaluating how low-carbon resources (biomass, renewable electricity, end-of-life scrap, and carbon capture and storage) may be scaled up to 2050. Cross-sector competition or synergy may lead to unexpected dynamics in this transition, and the team presents a model of the feedback between the metals and energy industry in the transition to renewable electricity. They envision a future where these sectors work together to build out abundant renewable energy while continually reducing environmental impacts. The interactive Sankey diagram will be available more broadly in 2024.

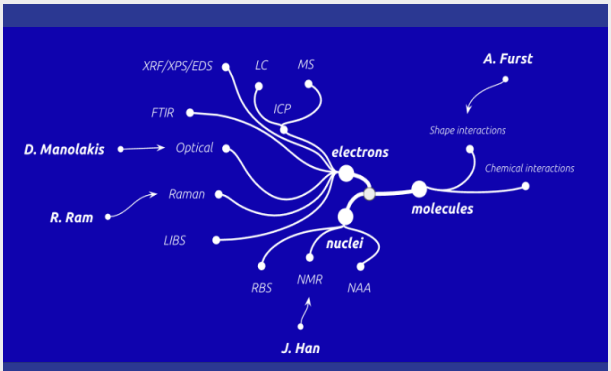


Interactive Sankey diagram explores the current global economy's major material and energy flows.

RELATED OUTCOME WORKSHOP The MCSC hosted an outcome workshop to investigate opportunities for positively reinforcing transitions across sectors via Sankey diagrams in April 2023.

Biodiversity & Soil Measurement

MCSC seed awardees and experts within MCSC member companies are continuing to guide efforts to quantify, and set goals around, how enhancing and strengthening biodiversity is complementary to mitigating and adapting to climate change. In addition, the Terrer Lab at MIT, in coordination with Impact Fellow **Evan Coleman**, has been collaborating with member companies on an upcoming white paper explaining the uncertainties and data gaps inhibiting investment in interventions to achieve soil carbon sequestration. **Amanda Bischoff**, Impact Fellow, is also supporting the MCSC's engagement on topics across measurement and biodiversity, working closely with the MIT Voigt Lab.



A map of the measurement methods currently available to count atoms like carbon in complex systems like soil.

RELATED OUTCOME WORKSHOP The MCSC hosted an outcome workshop to explore guidance on measurement practices for monitoring, reporting and verifying the multi-faceted climate benefits of soil interventions in June 2023.

IN ADDITION TO STRUCTURED EVENTS, THE MCSC FACILITATED

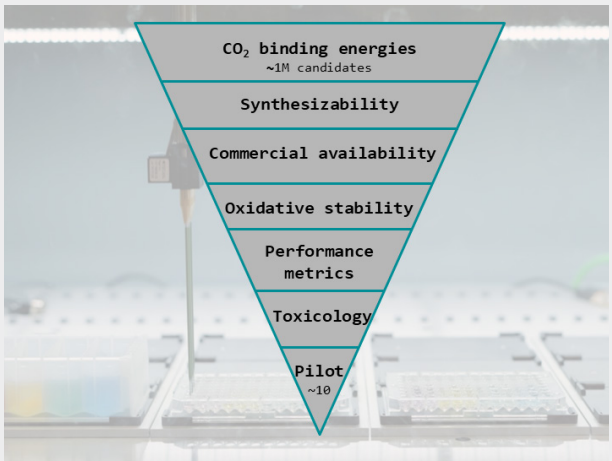
25

CROSS-DISCIPLINARY STRATEGY CONVERSATIONS BETWEEN TWO OR MORE COMPANIES IN 2023.

PHOTO BY THE MCSC

Chemical Development Advances

An MIT research team spanning Materials Science (DMSE), Chemical Engineering (ChemE), Mechanical Engineering (MechE), and Chemistry continue to collaborate to develop a class of energy-efficient, amine-based CO2 capture sorbents. DMSE graduate student Avni Singhal, working with the MCSC and Professor Rafael Gomez-Bombarelli (DMSE) analyzed thousands of potential CO2 capture materials computationally, and observed a clear trend that aligns with chemical theory. ChemE graduate student Fang-Yu Kuo working in Professor Betar Gallant's lab (MechE) has identified synthetic pathways to isolate critical targets for bench-scale testing. Using automated synthesis tools, Professor Connor Coley's lab (ChemE) is exploring high-throughput derivatization of materials with the desirable electronic characteristics. Lastly, Professor Robert Gilliard (Chemistry), an expert in organic heterocycles, started working with the MCSC team, and his group will rapidly advance multi-gram synthesis of the most promising candidates with methodologies amenable to industry process chemistry.



RELATED OUTCOME WORKSHOP The MCSC hosted an outcome workshop to showcase its chemical development advances — addressing multiple barriers to implementation of carbon capture in non-powerplant industries through computational and experimental investigations for member feedback — in April 2023.

Outcomes: MCSC Funded Research

In 2022, the MCSC awarded 20 projects a total of $5 million over two years in its first-ever Seed Award Program. The winning projects are led by principal investigators across all five of MIT's schools. In addition to the Seed Awards, the MCSC funds directed projects that align with the interests of member companies. This list of projects highlights both Seed Award and directed projects – showcasing selected outcomes from both, organized by MCSC themes.

SOCIAL DIMENSIONS

- "Anthro-engineering decarbonization at the million-person scale," led by Professor Manduhai Buyandelger, Department of Anthropology, and Professor Michael Short, Department of Nuclear Science and Engineering
- "Sustainable solutions for climate change adaptation: weaving traditional ecological knowledge and STEAM," led by Professor Janelle Knox-Hayes, Department of Urban Studies and Planning, and Associate Professor Miho Mazereeuw, Department of Architecture

OUTCOME

MIT students and researchers are working to understand and address issues surrounding decarbonization and air pollution through a unique interdisciplinary initiative that brings together anthropology and engineering. The "Anthro-Engineering: Decarbonization at the Million-Person Scale" class and project explores the design of a culturally appropriate, affordable, and sustainable intervention to create a pathway to decarbonization in Ulaanbaatar, Mongolia, the coldest and most polluted city in the world. The students and researchers have traveled to Mongolia twice during MIT's Independent Activities Period and have collaborated with community and university partners to conduct research, exchange insights, and develop a solution to reduce household coal consumption. The team presented at the GerHub Speaker Series at the National University of Mongolia, Ulaanbaatar, Mongolia in January 2023 and at the Cross-STS HASTS Roundtable event in Cambridge, Mass. in March 2023. PHOTO COURTESY OF JIYOO JYE

TOUGH TRANSPORTATION MODES

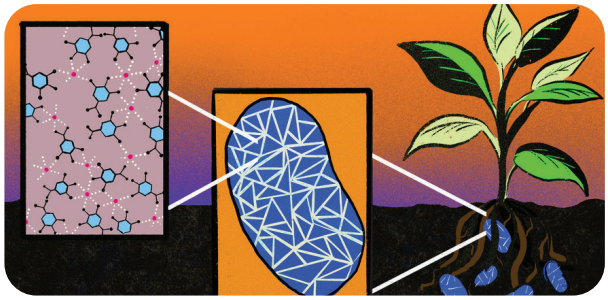
- "Logistics electrification through scalable and inter-operable charging infrastructure: operations, planning, and policy," led by Professor Alex Jacquillat, MIT Sloan School of Management
- "Powertrain and system design for LOHC-powered long-haul trucking," led by Professor William Green, Department of Chemical Engineering, and Professor Wai K. Cheng, Department of Mechanical Engineering
- "Large Scale Use of Ammonia as a Fuel," led by Professor Noelle Eckley Selin, Department of Earth, Atmospheric and Planetary Sciences, and Professor Steven Barrett, Department of Aeronautics and Astronautics
- "Novel onboard hydrogen storage architecture for fuel-cell-electric heavy-duty commercial vehicles," led by Associate Professor Amos Winter, Department of Mechanical Engineering, Visting Scholar Bryony DuPont, and Graduate Researcher ZhiYi Liang, Department of Mechanical Engineering

OUTCOME

MIT researchers led by Professor Green are harnessing hydrogen's potential to address long-haul trucking emissions. In a recent paper published in *Energy & Fuels*, Professor Green and his team, including graduate students Sayandeep Biswas and Kariana Moreno Sader, explore a cost-effective way to transport and store hydrogen using liquid organic hydrogen carriers (LOHCs). PHOTO COURTESY OF THE GREEN GROUP

NATURE-BASED SOLUTIONS

- "Carbon sequestration through sustainable practices by smallholder farmers," led by Professor Joann de Zegher, MIT Sloan School of Management, and Professor Karen Zheng, MIT Sloan School of Management
- "Coatings to protect and enhance diverse microbes for improved soil health and crop yields," led by Professor Ariel Furst, Department of Chemical Engineering, and Associate Professor Mary Gehring, Department of Biology
- "ECO-LENS: Mainstreaming biodiversity data through AI," led by Professor John Fernández, Department of Architecture
- "Growing season length, productivity, and carbon balance of global ecosystems under climate change," led by Professor Charles Harvey, Department of Civil and Environmental Engineering, and Assistant Professor César Terrer, Department of Civil and Environmental Engineering
- "Soil Organic Carbon (SOC) Concentration Quantification," led by Senior Staff Member Laura Kennedy, Civil Space Systems and Technology, Lincoln Lab



OUTCOME

Researchers at MIT are reducing the carbon footprint of chemical fertilizer production by replacing some of that fertilizer with a more sustainable source — bacteria. They have devised a metal-organic coating that protects bacterial cells from damage without impeding their growth or function. In a new study, they found that these coated bacteria improved the germination rate of a variety of seeds, including vegetables such as corn and bok choy. The team, led Professor Furst, and including Benjamin Burke '23, Gang Fan, Pris Wasuwanich, and Evan Moore '23, recently had their work published in the *Journal of the American Chemical Society Au*. PHOTO COURTESY OF JOSE-LUIS OLIVARES, MIT, BASED ON FIGURES COURTESY OF THE RESEARCHERS

VALUE CHAIN RESILIENCE

- "Collaborative community mapping toolkit for resilience planning," led by Associate Professor Miho Mazereeuw, Department of Architecture, and Professor Nicholas de Monchaux, Department of Architecture
- "CP4All: Fast and local climate projections with scientific machine learning — towards accessibility for all of humanity," led by Principal Research Scientist Chris Hill, Department of Earth, Atmospheric and Planetary Sciences, and Professor Dava Newman, Department of Aeronautics and Astronautics
- "Emissions reductions and productivity in U.S. manufacturing," led by Assistant Professor Mert Demirer, MIT Sloan School of Management, and Assistant Professor Jing Li, MIT Sloan School of Management
- "Sustainable Separation and Purification of Biochemicals and Biofuels using Membranes," led by Professor John Lienhard, Department of Mechanical Engineering, and Professor Nicolas Hadjiconstantinou, Department of Mechanical Engineering

OUTCOME

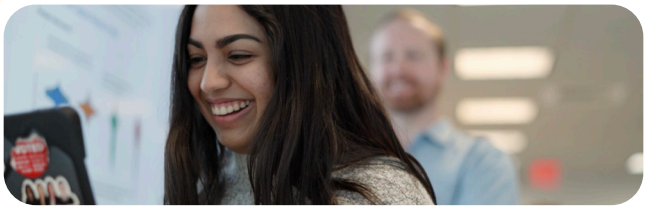
Postdoctoral associate Liying Qiu, along with Professor Howland, Professor Saurabh Amin, Department of Civil and Environmental Engineering, and postdoctoral associate Rahman Khorramfar, presented at the *American Geophysical Union (AGU) Fall Meeting 2023*. Their presentation was on the impacts of spatiotemporal variability of meteorological conditions on designing wind-and-solar based electricity systems.

- "Toolkit for assessing the vulnerability of industry infrastructure siting to climate change," led by Assistant Professor Michael Howland, Department of Civil and Environmental Engineering

Outcomes: continued

CARBON CAPTURE & STORAGE

- "High Throughput Virtual Screening of Heterocycles for CO2 Capture," led by Associate Professor Rafael Gomez-Bombarelli, Department of Materials Science and Engineering
- "Guanidines for CO2 Capture," led by Associate Professor Betar Gallant, Department of Mechanical Engineering
- "Automation-Assisted Synthesis of Carbon Capture Materials," led by Professor Connor Coley, Departments of Chemical Engineering and Electrical Engineering and Computer Science
- "High-throughput Virtual Screening of Oxidative Stability Powered by Quantum Chemistry and Machine Learning," led by Professor William Green, Department of Chemical Engineering



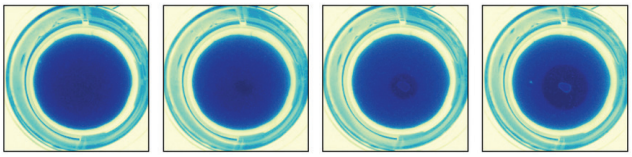
OUTCOME

Avni Singhal, PhD student, presented at the 2023 American Chemical Society (ACS) Spring 2023. Her presentation was entitled "High-throughput study of pi-conjugated nucleophiles for CO2 capture."

- "ML-guided Screening of Conductive Metal–Organic Frameworks for CO2 Electro-conversion," led by Professor Aristide Gumyusenge, Department of Materials Science and Engineering, and Professor Iwnetim Abate, Department of Materials Science and Engineering

CIRCULARITY

- "Clear Zone," led by Professor Bradley Olsen, Department of Chemical Engineering
- "Colorimetric Sulfidation for Aluminum Recycling," led by Associate Professor Antoine Allanore, Department of Materials Science and Engineering
- "Double Loop Circularity in Materials Design Demonstrated on Polyurethanes," led by Professor Brad Olsen, Department of Chemical Engineering, and Professor Kristala Prather, Department of Chemical Engineering
- "Engineering of a microbial consortium to degrade and valorize plastic waste," led by Associate Professor Otto Cordero, Department of Civil and Environmental Engineering, and Professor Desiree Plata, Department of Civil and Environmental Engineering
- "Fruit-peel-inspired, biodegradable packaging platform with multifunctional barrier properties," led by Professor Kripa Varanasi, Department of Mechanical Engineering
- "High Throughput Screening of Sustainable Polyesters for Fibers," led by Professor Gregory Rutledge, Department of Chemical Engineering, and Professor Bradley Olsen, Department of Chemical Engineering
- "Short-term and long-term efficiency gains in reverse supply chains," led by Professor Yossi Sheffi, Department of Civil and Environmental Engineering
- "The costs and benefits of circularity in building construction," led by Professor Siqi Zheng, Department of Urban Studies and Planning, and Principal Research Scientist Randolph Kirchain, MIT Concrete Sustainability Hub



OUTCOME

The development of biodegradable polymers remains limited by current biodegradation testing methods. To address this limitation, a team of MIT researchers, led by Professor Olsen, has developed an expansive biodegradation dataset to help determine whether or not a polymer is biodegradable. Their findings were published in *The Proceedings of the National Academy of Sciences (PNAS)*, a peer reviewed journal of the National Academy of Sciences, in a paper titled "High-Throughput Experimentation for Discovery of Biodegradable Polyesters." The MIT team includes PhD candidates Katharina A. Fransen and Sarah H. M. Av-Ron, as well as postdoc Dylan J. Walsh and undergraduate students Tess R. Buchanan, Dechen T. Rota, and Lana Van Note.

PHOTO COURTESY OF THE OLSEN RESEARCH GROUP

- "Circular design for reinforced concrete frames: Optimization and prototyping of a modular, reconfigurable structural system," led by Professor Caitlin Mueller, Departments of Civil and Environmental Engineering and Architecture
- "Cleavable comonomers for sustainable vinylic thermosets," led by Professor Jeremiah Johnson, Department of Chemistry

CIRCULARITY CONTINUED

- "Circular design for reinforced concrete frames: Optimization and prototyping of a modular, reconfigurable structural system," led by Caitlin Mueller, Associate Professor of Civil and Environmental Engineering and Associate Professor of Architecture

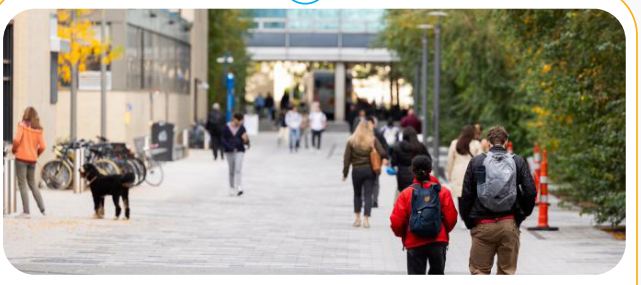
OUTCOME

A team of researchers at MIT, led by Professor Mueller, are exploring a promising strategy for concrete reuse, through the support of the MCSC — developing design and computation strategies that would allow the concrete building elements to be disassembled and rebuilt several times, reducing the environmental impact of the structural system. The team, which includes Inge Donovan and Jenna Schnitzler (MArch + SMBT), Lucila Carlos (B.Eng), Pitipat Wongsittikan (SMBT), and PhD student Keith Lee, is designing reusable concrete building components, a system called PixelFrame, and recently built and tested their first prototype at half-scale, an important milestone. They are collaborating with industry experts at Holcim, a leader in innovative and sustainable building solutions, and Prologis, a leader in logistics real estate with a focus on high-barrier, high-growth markets. In particular, Ryan Roberts, Group Head of Sustainable Construction at Holcim, and Forrest Etter, Director of Design and Construction Innovation at Prologis, have shared critical insights and expertise as the project continues to progress.

PHOTO COURTESY OF THE MUELLER GROUP

OTHER MCSC-RELATED THEMES

- "Pathways to Net Zero Greenhouse Gas Emissions for Higher Education Institutions and Companies," led by Executive Director Jeremy Gregory, MIT Climate and Sustainability Consortium; Postdoctoral Associate Leela Velautham; and MIT Director of Sustainability Julie Newman



OUTCOME

A team at MIT is exploring the similarities and differences between how U.S-based Higher Education Institutions (HEIs) and corporations plan to achieve their climate targets and whether it is appropriate for HEIs to adopt science-based targets (SBTs). Through their research, Leela Velautham, Postdoctoral Researcher; Jeremy Gregory, Executive Director of the MIT Climate & Sustainability Consortium; and Julie Newman, Director of Sustainability bring together diverse perspectives on SBTs, corporate sustainability target setting, and sustainability in higher education — offering an overview of potential benefits and disadvantages of HEIs adopting SBTs. Their findings were published in *The International Journal of Sustainability in Higher Education* in a paper entitled "Science-Based Targets for Higher Education? Evaluating Alignment between Ivy+ Climate Action Plans and the Science Based Targets Initiative's Net-Zero Standards."

Educate

Educating Future Climate Leaders

The MCSC's Climate & Sustainability Scholars Program enables MIT undergraduates to have a unique, yearlong, interdisciplinary experience developing and implementing climate and sustainability research projects. Inspired by MIT's successful SuperUROP program, the Climate & Sustainability Scholars Program has three elements: Climate.UAR course, experiential learning opportunities, and mentorship.

2022-2023 Scholars Highlights

JADE CHONGSATHAPORNPONG

Jade investigated photo-modulated catalytic reactions for clean energy applications, building off a study, published in *Nature*, conducted by a team of MIT researchers. At the end of the program, Jade chose to present his research in an academic paper and create videos that convey the less technical background that motivated the project.

READ FULL PROFILE

"The most important long-term thing I got from the program was a network of other people interested in sustainability, all with very different perspectives ranging from business to chemistry, and computer science to policy. A close second would be insights gleaned from the diverse array of speakers we had invited."

GOSHA GEOGDZHAYEV

Gosha worked on applying mathematical system thinking to predict extremes in a simple chaotic system as a proxy for the more complex Earth's climate system. One way Gosha interacted with his findings was through the creation of a short informational "Ted Talk" video, conveying his findings in a way that would be accessible to audiences of all academic backgrounds.

READ FULL PROFILE

"Innovation isn't so much the data that we are working with as it is the abstraction, where we are taking a method that had been developed with an eye toward a very abstract mathematical system and applying it to the very real question of climate change."

DAHLIA DRY

Dahlia conducted in-field water quality monitoring, motivated by the question: what's in our water? Dahlia's research addressed the critical need to develop and scale up on-site monitoring technologies by engineering more advanced instrumentation in order to fill the water data gap. She helped develop a field-deployable implementation of Raman spectroscopy, a non-destructive chemical analysis technique.

READ FULL PROFILE

"I thrive when I get to work at the interface between software and hardware, which I was able to do through my MCSC-related research. I love thinking about the best way to connect a bunch of disparate components so that the composite system functions elegantly, as more than just the sum of its parts."

COLLABORATED WITH:

HARRY TULLER
Professor of Materials Science and Engineering

RAFFAELE FERRARI
Cecil and Ida Green Professor of Oceanography in MIT's Department of Earth, Atmospheric, and Planetary Sciences (EAPS)

ANDRE SOUZA
Research Scientist

RAJEEV RAM
Professor of Electrical Engineering

NILI PERSITS
Graduate student in P rofessor Ram's group at the Research Lab of Electronics

2023-2024 Scholars Highlights

KAI VAN BRUNT
Physics and Mathematics with a Concentration in Chinese

"This semester I worked on using computer vision to count salmon in the rivers of Alaska and the PNW. As a physics and math major whose work previously focused on researching fusion energy as a source of clean, renewable energy, this project was a big change! I learned a lot about the more human side of sustainability work: communicating and working with stakeholders; working on a tool to make tasks easier for biologists and conservationists focused on this problem; avenues of sustainability outside of direct climate change abatement, like species/biodiversity monitoring. I'm excited to continue my work in the sustainability space with a better understanding of all the different types of work that exist."

RUNAKO GENTLES
Environmental Engineering

"I really appreciate that MCSC has created an intellectual space where I can hone my communication skills through written assignments, presentations, and small group discussions on a variety of sustainability topics. Practicing to share my research and opinions to the MCSC scholars community has been invaluable to my growth as a climate leader, and I look forward to improving how I articulate my ideas in this space."

SAM SALWAN
Political Science and Computer Science, Economics and Data Science

"Through the meaningful research guidance and cross-disciplinary environment that the MCSC Scholars Program provides, I have been able to cultivate my research skills while situating them in a social impact context, fostering a more dedicated approach to my academic pursuits. Interacting with students from diverse fields within the climate and sustainability landscape as an economics student has also offered insights into relevant developments and encouraging thoughtful consideration of their potential impacts on the economy."

MITALI CHOWDHURY
Biological Engineering

"Participating in the MCSC Climate Scholars program has exposed me to many different fields that are contributing to solving the climate crisis. Coming from a major that does not have a focus on sustainability or climate solutions, it has been exciting to hear about the ways that my own field as well as other disciplines can tie into the environment. The effort to combat climate change requires multidisciplinary, collaborative efforts; this program really highlights this fact and allows us to practice the skills needed to think across fields through a broad range of speakers, connections within our diverse cohort, and engaging in a year-long research project."

THE MCSC CLIMATE & SUSTAINABILITY SCHOLARS PROGRAM SUPPORTED

5,600+

HOURS OF STUDENT RESEARCH IN 2023.

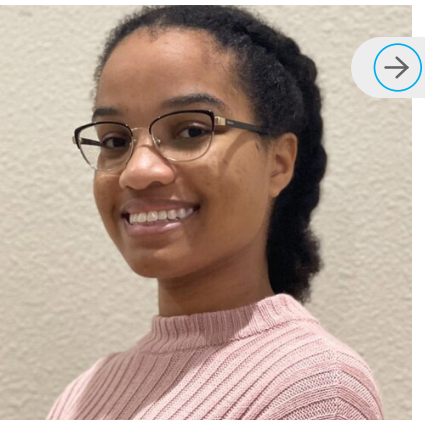
Educate

Panelists from MCSC Member Companies Share Career Insights

The MCSC and MIT Career Advising & Professional Development hosted a Careers in Sustainability event to help MIT students learn about diverse career paths in the climate and sustainability realms, ranging from insurance to aerospace to technology to materials science. Thank you to our experienced panelists from MCSC member companies for joining us and sharing your insights: Gretchen Baier, Dow; Ellen Ebner, Boeing; Marina Rakhlin, IBM Research; and Victoria Yanco, Liberty Mutual Insurance.

Undergraduate Research Opportunities Program (UROP)

In 2023, the MCSC continued to support student research through UROP. We funded 14 students during Independent Activities Period (IAP) in January (plus two additional affiliated UROPs), 21 students during the spring semester (plus three additional affiliated UROPs), 15 students during the summer term, and 20 students during the fall. The students, who came from a wide variety of departments, worked on topics related to the MCSC impact pathways and cross-cutting themes, collaborating closely with MCSC Impact Fellows and other researchers across campus.



Student Spotlight | Kezia Hector

Through UROP, MIT Student Focuses Research to Explore Data and Hurricane Intensity

MIT student Kezia Hector, who is majoring in Chemical Engineering, worked with the MCSC through the Undergraduate Research Opportunities Program for several semesters. Kezia collaborated with Sydney Sroka, Impact Fellow, to determine hurricane intensity using reanalysis data and machine learning. She had the opportunity to present at the American Meteorological Society (AMS) Conference to share this work.

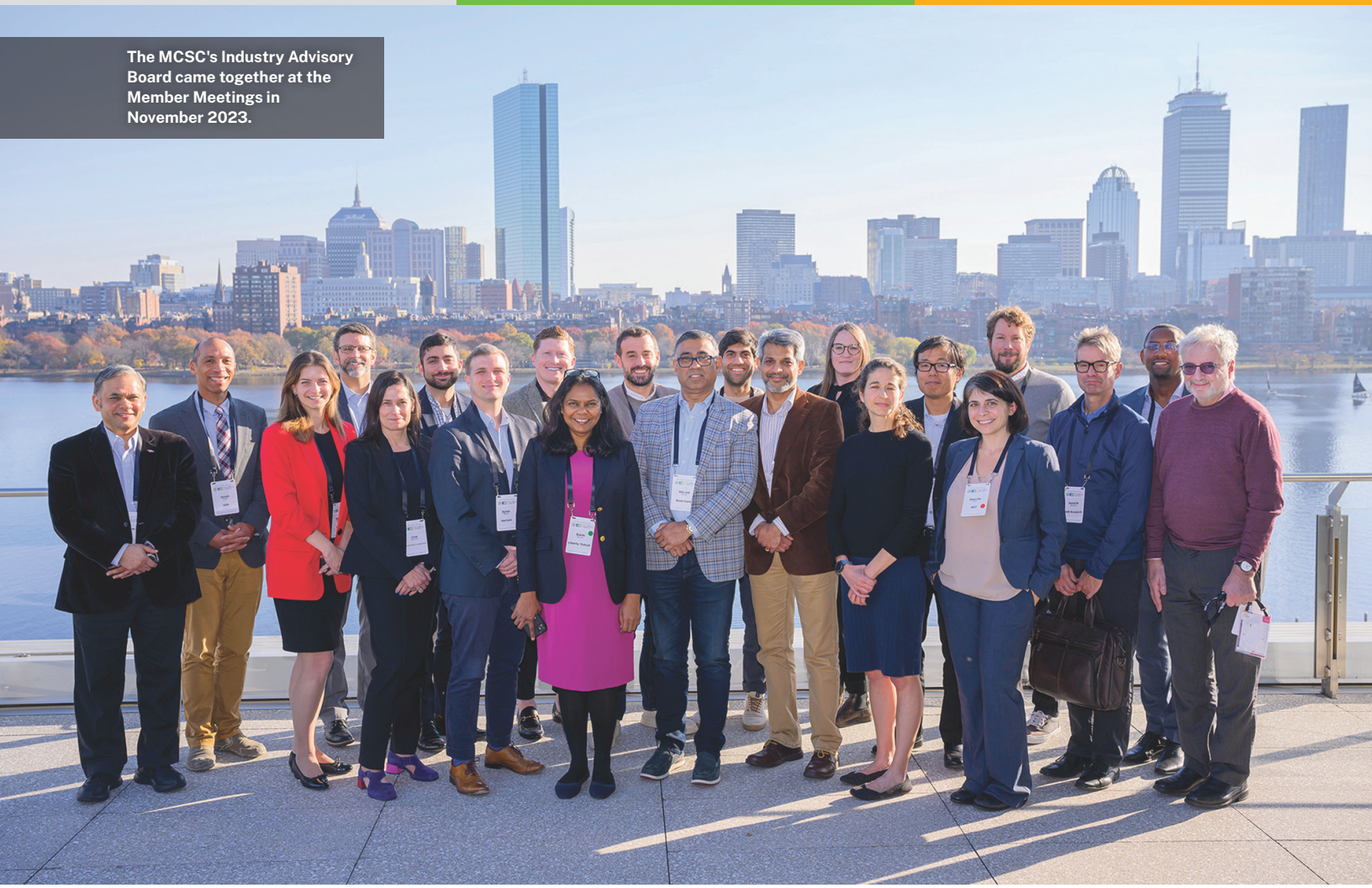
THE MCSC FUNDED

75

TOTAL UNDERGRADUATE RESEARCH OPPORTUNITIES IN 2023.

Panelists from MCSC member companies share career insights with MIT undergraduate students.
PHOTO COURTESY OF THE MCSC

The MCSC's Industry Advisory Board came together at the Member Meetings in November 2023.



MCSC Chair Anantha Chandrakasan addresses the MCSC's Industry Advisory Board at the Member Meetings.

Member Benefits

Benefits and expectations of MCSC member companies include:

- Participation in developing climate & sustainability impact pathways
- Appointment to MCSC Industry Advisory Board
- Exposure to MIT leaders in climate and sustainability research
- Participation in MCSC online/ in-person seminars and workshops
- Direct partnerships with MIT undergraduates conducting climate and sustainability-related research
- Opportunity to engage with and mentor climate-focused student clubs and groups, in addition to student entrepreneurship efforts on climate mitigation and adaptation
- Option to expand relationship into larger and focused efforts, including separate research agreements

COMPREHENSIVE OVERVIEW OF BENEFITS:

PHOTOS BY GRETCHEN ERTL


MCSC
MIT Climate &
Sustainability
Consortium