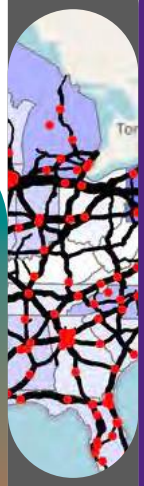
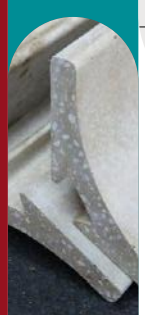




MIT Climate & Sustainability Consortium

Impact Report 2025

MCSC

Industry Collaborations to Accelerate Impact

Desirée Plata

Five Years of Progress & More Innovation to Come

The MCSC was established five years ago in 2021, and this milestone presents an opportunity to reflect on all we have accomplished while sparking renewed ambition and setting a clear charge for continued progress. What began as a set of ideas and intentions has grown and evolved into tangible efforts to drive impact via critical industry-academia collaborations.

While this impact report highlights updates from 2025, the work and outcomes have roots and connections to our key moments throughout the past five years. The timeline graphic on the following pages shows some of these moments in our sustained effort to move the needle on climate. We view our first five years as a foundation for our current and future work!

Industry Feedback Shapes Our Outcomes

Throughout the last year, the MCSC's team of researchers have shaped and propelled our work based on the priorities and feedback of member companies. We have many examples of this, which you'll learn about in this report, including the Geo-TIDE tool and Pixelframe. Our Seed Award projects have also presented many opportunities for member companies to work directly with MIT faculty and make progress together.

Caitlin Mueller

Jeremy Gregory

Driving Impact Through Research

Now, we are continuing to invest in some of our existing projects to support the deeper development of promising technologies, and exploring new topics of interest to our member companies. Emerging themes include the economics of decarbonization, resilient supply chains, data centers, textiles and agriculture.

We are committed to accelerating the implementation of real-world solutions to pressing climate and sustainability challenges. Thank you for being a part of our journey.

Desirée Plata
Director

Caitlin Mueller
Associate Director

Jeremy Gregory
Executive Director

Contents

Celebrating Five Years: MCSC Highlights Over Time

To commemorate the five-year anniversary of the MCSC's launch, this timeline shares some key highlights and accomplishments over the years. We are grateful to our community who made this progress possible, and we are eager to continue driving impact through critical industry-academia collaborations.

Where We

2021

June 2021: Five virtual MCSC workshops center on shared themes that resonate across industry members' climate and sustainability targets and goals. The themes, which shape the MCSC's current focus areas, were:

- Decarbonizing **tough transport** sectors
- **Nature-based solutions** to carbon removal and decarbonizing agriculture
- Materials Circularity in **Organics**
- Equity-centered Strategies for Circularity in **Inorganic Materials**
- Engineering-based Solutions to **Carbon Removal** and CCUS

November 2021: The MCSC hosts its **first Annual Symposium**, bringing together member companies and the MIT community; strategic discussions continue.

January 2021: Founding MCSC members announced; ready to start meaningful cross-sector collaborations to move the needle on climate.

September 2021: First cohort of postdoctoral Impact Fellows selected; prepared to make their marks on the climate industry and apply their expertise to near-term change for a more sustainable future.

December 2021: In its first year, the MCSC **funds 25+ UROPs** from across the Institute both on the MCSC themes and with individual Principal Investigators throughout MIT.

2022

January 2022: Growing from ongoing conversations among members and the MIT community, the MCSC establishes **key focus areas to guide work:**

- **Tough Transportation Modes**
- **Value Chain Resilience**
- **Circularity**
- **Nature-Based Solutions**
- **Carbon Capture and Storage**
- **Data & Computing**
- **Social Dimensions**
- **Climate Finance**

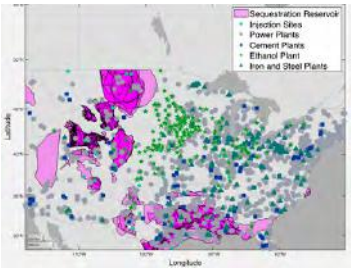
March 2022: The MCSC hosts the **Climate Implications of Computing and Communications workshop** with MIT-IBM Watson AI Lab and the Schwarzman College of Computing, highlighting how new approaches to computing can save energy and help the planet.

April 2022: The MCSC **announces its Climate & Sustainability Scholars Program,** offering undergraduate students a unique way to develop and implement research projects with the strong support of each other and MIT faculty, set to begin in the fall.

May 2022: Recipients of the MCSC's **inaugural Seed Awards Program** are announced, featuring research from across MIT.

October 2022: The MCSC hosts its **second Annual Symposium,** bringing together experts and industry leaders to present a range of sessions, from climate implications of computing and communications to climate finance and entrepreneurship.

Celebrating Five Years: MCSC Highlights Over Time



March 2023: Outcome (Tool): **Interactive geospatial mapping tool** launches, to help member companies visualize and understand the barriers to resilience planning and decarbonization.

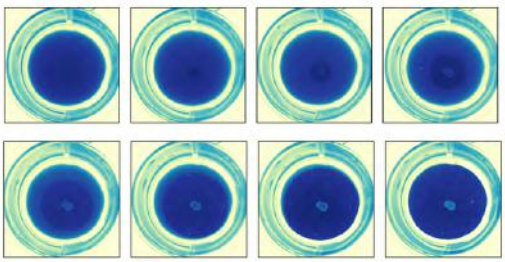
September 2023: Outcome (MCSC White Paper): **Carbon Credits and Credibility**: A Collaborative Endeavor, examining measurement challenges in voluntary carbon markets, and Alternative Fuels and Powertrains to Decarbonize Heavy Duty Trucking, exploring opportunities and barriers that trucking fleets face as they navigate the shift to low-carbon alternative fuels and powertrains.

September 2023: Outcome (Seed Award): ***Energy and Fuels* paper** features a cost-effective way to transport and store hydrogen using liquid organic hydrogen carriers (LOHCs), developed by Professor William Green and team.

Where We

2023

May 2023: Outcome (Seed Award): ***PNAS* paper** featuring an expansive biodegradation dataset, developed by Professor Bradley Olsen and team, to help determine whether or not a polymer is biodegradable.



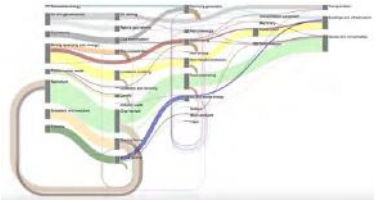
October 2023: Outcome (MCSC White Paper): **Unlocking the Supply of E-waste** for Materials Recovery: Regulatory Complexity in Transboundary Movement, co-authored with Apple, explores e-waste challenges through a regulatory complexity lens and proposes potential steps to move forward.

November 2023: The MCSC hosts its **third Annual Symposium,** exemplifying the energy, ideas, and innovations that can be sparked when companies across sectors and academia join forces.

March 2024: Outcome (Tool): The MCSC's **Geospatial Decision Support Tool (Geo-TIDE)** launches, helping trucking industry stakeholders and fleet owners assess where and how best to decarbonize their fleets by transitioning to low-carbon energy carriers.

March 2024: Outcome (Seed Award): ***Journal of the American Chemical Society* paper** addressing the challenges that come with managing end-of-life for synthetic polymers, featuring work by Professor Jeremiah Johnson and team.

April 2024: Outcome (MCSC White Paper): **Nature-Based Climate Solutions:** Current Uncertainties and Data Gaps in the Assessment of Soil Carbon Sequestration Potentials, explores modes of ecosystem intervention that present opportunities to mitigate climate change.



August 2024: Outcome (Tool): **Interactive Sankey diagram** comprehensively maps the global economy to study the uses of carbon and the effects of decarbonization.

2024

Have Been

January 2024: Outcome: **6Cycle**, an interactive game, demonstrates the use of material passports, simulating the challenges and opportunities in building and maintaining circular supply chains.

April 2024: Outcome (MCSC White Paper): The **Climate and Sustainability Implications of Generative AI** highlights how the excitement around Gen-AI is leading to an incomplete consideration of value that ignores the potential costs. The authors call for more responsible development of Gen-AI using a comparative benefit-cost evaluation framework.

July 2024: Outcome (Seed Award): ***Environmental Research Letters* paper** recognizes research funded by MCSC that finds health risks, and negative impacts on climate and air quality from using ammonia as an alternative shipping fuel.

Celebrating Five Years: MCSC Highlights Over Time

November 2024: The MCSC hosts its **fourth Annual Symposium,** bringing member companies and the MIT community together to discuss the efficacy of current methods to meet decarbonization objectives and brainstorm how to leverage solutions for greater climate impact.

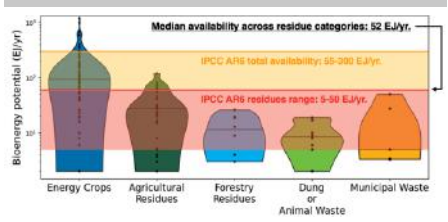
April 2025: Outcome (Technical Guide): **Geospatial Trucking Industry Decarbonization Explorer (Geo-TIDE): Technical Guide and Methodology** explores the functionality of the tool and the methodology behind its evolution and development.

May 2025: Outcome (Seed Award): **Pixelframe,** a modular constructive system encouraging reuse of building material, developed by MIT researchers, is exhibited at Venice Biennale's 19th International Architecture Exhibition. Later in the year (December 2025), Pixelframe announced the completed fabrication of a full-scale prototype, a Pixelframe beam designed to span 6 meters.

2024

2025

October 2024: Recipients of the **MCSC's 2024 Seed Awards Program** are announced, featuring research from across MIT.



February 2025: Outcome (MCSC White Paper): **Global Bioenergy Availability** evaluates decarbonization efforts in the maritime shipping and air transportation industries as a step in the right direction in the fight against climate change.

February 2025: Outcome (MCSC White Paper): A Taxonomy for **Social Sustainability in Corporate Communication** establishes a standard for how companies should address social sustainability.

Have Been

2026

July 2025: Outcome (Seed Award): ***PNAS* paper**, featuring work led by MIT Professors César Terrer and Charles Harvey, as well as Research Scientist Evan Fricke, explores the relationship between seed-dispersing animals and the reduction of carbon absorption in forests.

July 2025: **Geo-TIDE data files** become accessible on Amazon Web Services; later in the year (October 2025), Geo-TIDE is also recognized with the MIT Prize for Open Data.

October 2025: Outcome: ***Journal of Cleaner Production* article** explores the roles and responsibilities of, and challenges faced by CSOs across higher education and industry, as well as investigating why this traditionally corporate title has recently emerged in a higher education context.

April 2026: The MCSC hosts its **fifth Annual Symposium,** a series of interactive workshops with MCSC member companies, MIT researchers, and other key stakeholders. Outcomes from the workshops help shape the MCSC's research roadmap for the coming year.

June 2025: Outcome (MCSC White Paper): **Shared Electric Vehicle Charging Networks:** A Flexible Approach to Support Deployment of Electric Fleets, co-authored by Prologis and Accenture, illustrates the economic and functional benefits of pooling infrastructure investment within the trucking industry, and calls for the establishment of an industry consortium that is dedicated to facilitating the planning and deployment of pooled charging infrastructure.

August–November 2025: MIT faculty leading the MCSC's 2024 seed projects **shared their findings and explored next steps** through a series of workshops with MCSC member companies. Members provided the critical industry perspective needed to help make the work implementable and scalable.

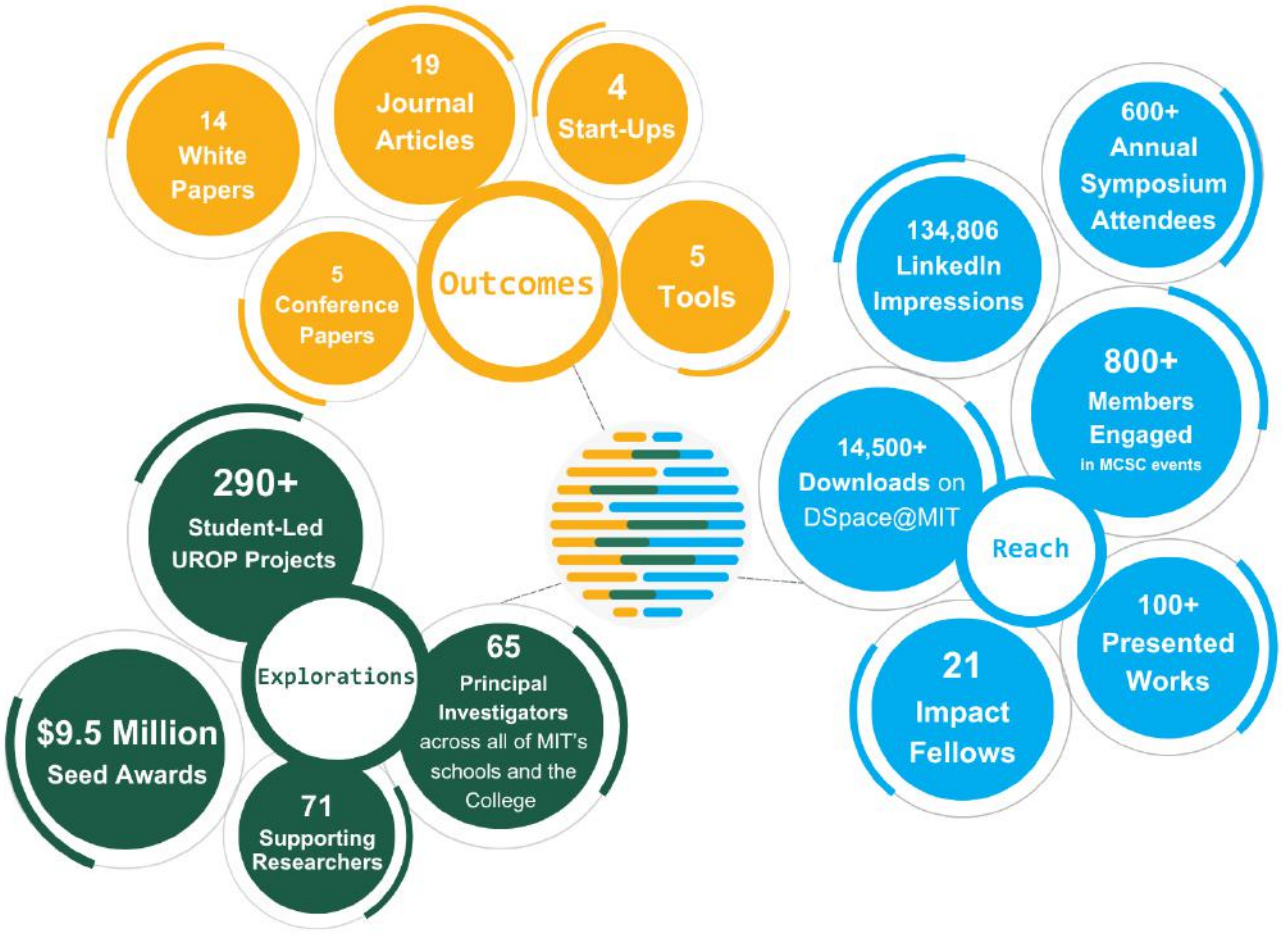
January 2026: Outcome (MCSC White Paper): **Vital Biodiversity Systems: A Companion Paper**, co-authored with IBM and Inditex, explores the complexities of biodiversity data systems and calls for innovation in creating data tools and platforms that are aligned with ecological realities, inform biodiversity pathways, and integrate ecosystem sciences.

About Us

The MIT Climate & Sustainability Consortium (MCSC) creates new collaboration opportunities that amplify and extend MIT's commitment to climate, while empowering industry to usher in, adapt to, and prosper in a decarbonized economy and world. We work together with industry and academia to accelerate the implementation of large-scale, real-world solutions, across sectors, to help meet global climate and sustainability challenges.

We strategize with researchers and member companies to determine common pain points, define the most impactful problems and articulate questions that researchers can tackle, and align on impact areas. We engage our stakeholders to co-develop cross-industry solutions that can be piloted and scaled. Through interactive and hands-on workshops, we help to educate and engage our member companies on the latest innovations and emerging trends, grow our shared knowledge, while also communicating our findings and breakthroughs with the MIT community and broader public.

These actions are how we move the needle on climate progress. The figure below summarizes the MCSC's impact in three main areas: outcomes, exploration, and reach.



Key Themes Shaped by Industry Priorities

The MCSC's work is guided by several key themes, which evolve and emerge based on member companies' priorities and needs. Themes that are currently shaping our work include:

Tough Transportation Modes

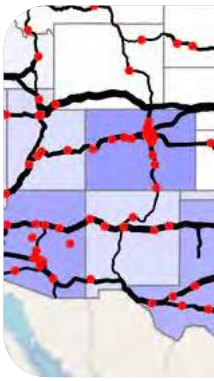
Resilient Value Chains and Supply Chains

Data & Computing (Generative AI, Data Centers)

Circularity

Nature-Based Solutions

Carbon Capture & Storage



Climate Finance

Social Dimensions

MCSC Member Companies: Cross-Sector Collaboration

Our members represent the heart of global capital. These industry leaders are inspiring transformative change within their own sectors while also demonstrating the value of working together, across sectors, at scale.

MCSC members have sponsored

40+

research projects

2025 Industry Advisory Board Members

Jim Andrew
Executive Vice President
Chief Sustainability Officer
PepsiCo, Inc.

Roald Brouwer
Chief Technology Officer
Amrize

Sarah Chandler
Vice President of Environment and Supply Chain Innovation
Apple

Luis Coloma
Head of Care for Life and Nature
Inditex

Greg Downing
Senior Director, Climate
Cargill

James Gowen
SVP, New Revenue Generation and Chief Sustainability Officer
Verizon

Kara Hurst
Chief Sustainability Officer
Amazon

Francis Hyatt
EVP, Chief Community Investments & Sustainability Officer
Liberty Mutual Insurance

Jan-Willem Jannink
Managing Director in Supply Chain & Engineering
Accenture

Alisha Johnson Wilder
Senior Director, Environment, Policy, and Social Initiatives
Apple

Roger Martella
Chief Corporate Officer, Chief Sustainability Officer
GE Vernova

Marissa McInnis
Senior Director, Sustainability and Small Business
Verizon

Christina Shim
Chief Sustainability Officer
IBM

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

Susan Uthayakumar
Chief Sustainability and Energy Officer
Prologis, Inc.

Andrew Veroneau
Vice President of Corporate Development
Rand-Whitney

Kommy Weldemariam
Chief Scientist
Amazon

MCSC Community

Leadership

Paula Hammond
Dean, MIT School of Engineering; Institute Professor
Chair

Paula Hammond was named dean of MIT's School of Engineering, effective January 16, 2026.

Anantha Chandrakasan
Provost, MIT; Vannevar Bush Professor of Electrical Engineering and Computer Science
Executive Senior Advisor

Anantha Chandrakasan was named MIT's Provost, effective July 1, 2025.

Desirée Plata
School of Engineering Distinguished Climate and Energy Professor
Director

Caitlin Mueller
Associate Professor of Civil and Environmental Engineering; Associate Professor of Architecture
Associate Director

In September 2025, Professor Mueller was recognized with Architectural Record's Innovator of the Year Award.

The MCSC engaged

450+

industry representatives and members of MIT's research community at events in 2025.

Elsa Olivetti
Jerry McAfee Professor in Engineering; Professor, Department of Materials Science and Engineering
Strategic Advisor

Jeremy Gregory
Executive Director

Administrative Staff

Melissa Zgola
Program Manager for Member Engagement

Molly Chase
Communications Manager

Jay Lamour
Program Coordinator

Postdoctoral Impact Fellows

Noman Bashir
MCSC Impact Fellow

Amanda Bischoff
MCSC Impact Fellow

Jonathan Broyles
MCSC Impact Fellow

Danika Eamer
MCSC Impact Fellow

← Check out Danika's thought leadership video discussing how we can decarbonize hard-to-abate transportation sectors like long-haul trucking and maritime shipping.

Past Impact Fellows have gone on to work in both academia and industry. Recent alumni of our Impact Fellows program landed positions at Amazon, Ceres, and PowerON Energy Solutions.

Mary Kate Mitchell Lane
MCSC Impact Fellow

Laurent Lioté
MCSC Impact Fellow

Bram van der Kroft
MCSC Impact Fellow

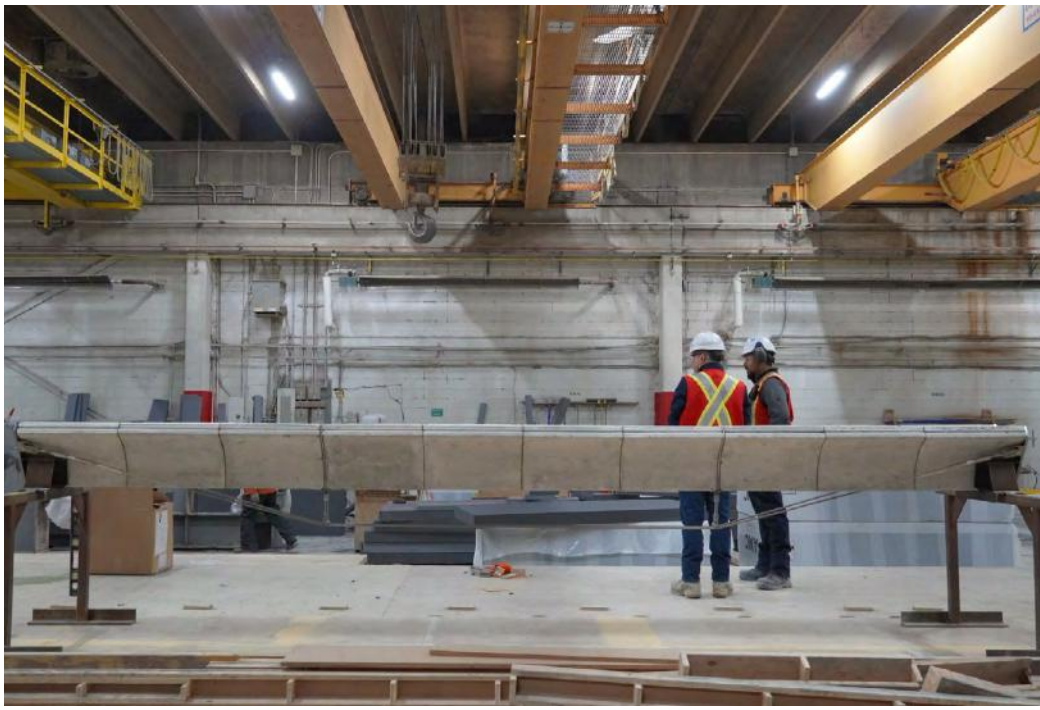
← Check out Bram's thought leadership video discussing how investors can push companies to improve their ESG performance.

Michelle Westerlaken
MCSC Impact Fellow

← Check out Michelle's thought leadership video discussing how we can design data technologies that treat ecosystems as living, dynamic, and unpredictable.

Entrepreneurship and Innovation: Central to the MCSC

MCSC researchers shape and propel our work based on the priorities and feedback of member companies. MCSC member companies provide the critical industry perspective needed to help make the technologies and tools we develop implementable and scalable. The innovations showcased here have deep connections with the MCSC; they were spun out from MCSC-funded research projects or developed and launched by MCSC Impact Fellows.



Copin

Copin's community-driven mapping incorporates local insights and enhances socio-cultural understanding of the environment, knowledge often missing from official maps.

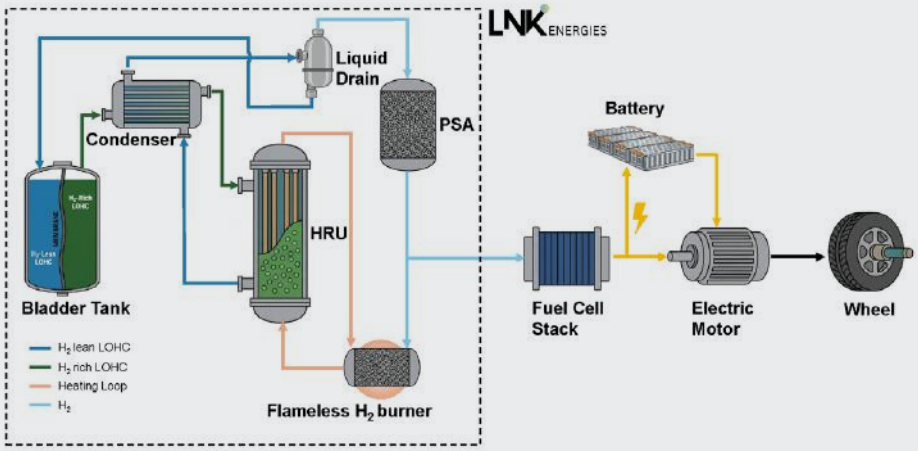
Pixelframe

Pixelframe is a modular precast concrete constructive system that is designed for reuse, alongside up-front material savings.

Recent updates include:

- Pixelframe was exhibited at the Venice Biennale's 19th International Architecture Exhibition, the largest architecture festival in the world.
- The team completed the fabrication of a full-scale prototype, a Pixelframe beam designed to span 6 meters.

pixel.frame



LNK Energies

LNK Energies unlocks a new way to move and use hydrogen – safely, affordably, and at scale.

6Cycle

6cycle is a game that offers a practical way of understanding the complexities of sustainable resource management in a circular economy.

Geo-TIDE

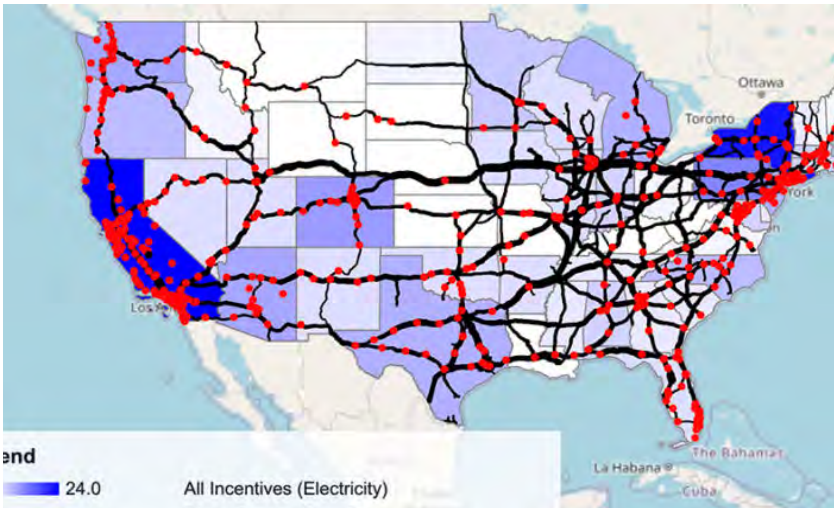
Geo-TIDE is a public, interactive decision-support tool to help trucking industry stakeholders identify and evaluate early opportunities for fleet and infrastructure decarbonization.

Recent updates include:

- The tool's developer, Danika Eamer (MCSC Impact Fellow), released a technical guide and case studies to detail these updates and the tool's functionality, as well as to showcase real-world usage scenarios and explore the methodology behind its development.
- To recognize her work on Geo-TIDE and to celebrate how the tool uses open data for impact, Danika was awarded the MIT Prize for Open Data
- The data files that Geo-TIDE integrates became accessible on Amazon Web Services (AWS) to support better information sharing.

Seia Bio

Seia Bio makes biological fertilizers to support sustainable agriculture one microbe at a time.



MCSC-Funded Research Progress

Accelerating the implementation of real-world solutions to pressing climate and sustainability challenges.

The MCSC's funded research projects have presented many opportunities for member companies to work directly with MIT faculty and make progress together. These selected MCSC-funded project updates showcase the work happening through the MCSC Seed Awards program and MCSC directed projects and include outcomes from 2025 as well as previous years.

AI and Data Centers

Hyperspectral Remote Sensing of Soil Organic Carbon Using Machine Learning

2024

Sherrie Wang
Assistant Professor
Mechanical Engineering

Evan Coleman
Research Scientist

Advancing global climate mitigation by enabling scalable, low-cost monitoring of soil carbon using satellite data and machine learning, supporting better management, verification, and long-term carbon sequestration in agricultural systems.

ECO-LENS: Mainstreaming Biodiversity Data Through AI

2022

John Fernández
Professor
Architecture

Marcela Angel
Research Associate

Norhan Bayomi
Postdoctoral Associate

Enrique Montas
Research Assistant

Demonstrating the potential of AI-driven urban biodiversity assessment tools through research across biodiversity (specifically vegetation) hotspots in the United States, Mexico, and Colombia. Establishing three technical frameworks that provide cities with new capabilities for understanding and monitoring their biodiversity and highlighting areas for future development and refinement.

Selected Outcomes & Updates:

- The team's analysis of 65 cities **revealed clear patterns** in urban vegetation trends.
- At the city level, the team's **deep learning pipeline demonstrated strong performance** in urban feature classification.
- The team's LiDAR **analysis framework** achieved varying levels of accuracy depending on the classification approach.

Employing AI to Sort Plastic Waste by Manufacturer

2024

Bradley Olsen
Professor
Chemical Engineering

Alexis Hocken
Graduate Research Fellow

Using branding marks on bottles to effectively sort plastics by manufacturer type instead of plastic type through AI image recognition, enabling manufacturers to either buy back or take back in exchange for a tax rebate their own products and use them most efficiently in recycling.

Sorting belt in-action.

Dynamic Material Flow Analysis of Data Center Hardware and Infrastructure

2024

Elsa Olivetti
Professor
Materials Science & Engineering

Anagha Belavadi Subramanya
Graduate Student Researcher

Soroush Mahjoubi
Postdoctoral Researcher

As global data center capacity rapidly expands, the materials embedded in this growth (copper, steel, concrete, and rare earths) remain poorly tracked. This project develops a dynamic material flow analysis (dMFA) framework to quantify material stocks, flows, and end-of-life outflows across the global fleet.

Selected Outcomes & Updates:

- Findings show that hardware refresh cycles dominate lifetime embodied carbon, while the global fleet is on track to embed over 1.5 million tonnes of copper by 2030, a significant latent resource.
- This work identifies opportunities for materials circularity and regional secondary materials markets co-located with major data center clusters, helping inform strategies that reduce primary material demand and close the loop on end-of-life flows.

Agriculture

Optimizing Biological Nitrification Inhibitors for the Suppression of N_2O Emissions from Agricultural Soils

2024

Darcy McRose
Assistant Professor
Civil and Environmental Engineering

Amanda Bischoff
MCSC Impact Fellow

Sandeep Mangat
Research Technician

Examining how plant-based inhibitors reduce nitrous oxide emissions from farm soils and providing guidance for using them effectively to lower agriculture's climate impact.

Selected Outcomes & Updates:

- Results show biological nitrification inhibitors can be effective in **suppressing growth and N_2O production** by a model nitrifier, and that nitrification inhibitor performance is dependent on oxygenation of the soil.
- In 2026, work will focus on **determining the threshold oxygen tensions** at which nitrifiers can escape inhibitor treatments and disseminate the findings through a perspective article.

Coatings to Protect and Enhance Diverse Microbes for Improved Soil Health and Crop Yields

2022

Ariel Furst
Professor
Chemical Engineering

Mary Gehring
Associate Professor
Biology

Removing key barriers to deploying beneficial soil microbes at scale, enabling their reliable delivery to degraded soils and advancing sustainable, microbe-based approaches to agriculture.

Selected Outcomes & Updates:

- **Start-Up Spin-Out:** Seia Bio, a start-up co-founded by Professor Furst, spun out from this research. Seia Bio makes biological fertilizer to support sustainable agriculture.

Seia Bio

- **Published Article in *JACS Au*:** Self-Assembled Nanocoatings Protect Microbial Fertilizers for Climate-Resilient Agriculture

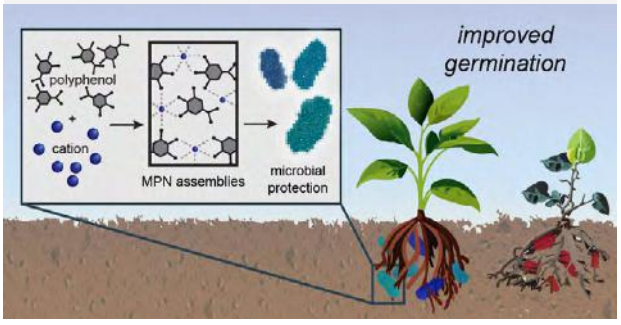


Illustration from JACS Au 2023, 3, 11, 2973-2980.

Carbon Sequestration Through Sustainable Practices by Smallholder Farmers

2022

Joann de Zegher
Research Affiliate
Sloan School of Management

Karen Zheng
Professor
Sloan School of Management

Developing an adaptable incentive design framework – designed to work across different crops, practices, and farmer behavioral patterns – and practical, cost-effective tools, such as lab-in-the-field experiments, that help practitioners identify what works best for their own supply chains.

Selected Outcomes & Updates:

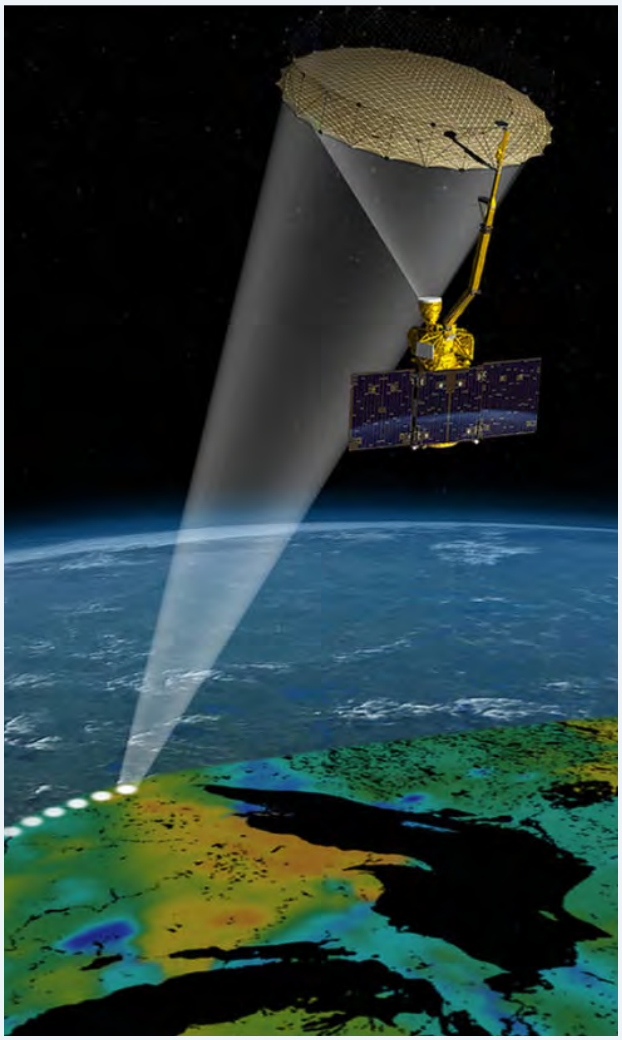
- **Key insights** derived from the framework include:
  - Linking incentives to both production and sustainability pays off.
  - Tailor incentives to how farmers actually make decisions.
  - Pair payments with the right support. Cash alone delivers diminishing returns in achieving higher compliance rates.
- **Affiliated Start-Up:** PemPem

Water

Global Mapping of Groundwater Recharge and Sustainable Aquifer Water Withdrawals Using Satellite Observations 2024

Dara Entekhabi
Professor
Civil and Environmental Engineering

Managing and restoring aquifers, which are currently being over-exploited. Providing global groundwater recharge maps using NASA's Soil Moisture Active Passive (SMAP) satellite data, developing insights and tools for sustainable groundwater management.



This artist's rendition shows NASA's Soil Moisture Active Passive (SMAP) mission collecting a swath of data from orbit. Credit: NASA.

Transportation

Powertrain and System Design for LOHC-Powered Long-Haul Trucking 2022

William Green
Professor
Chemical Engineering

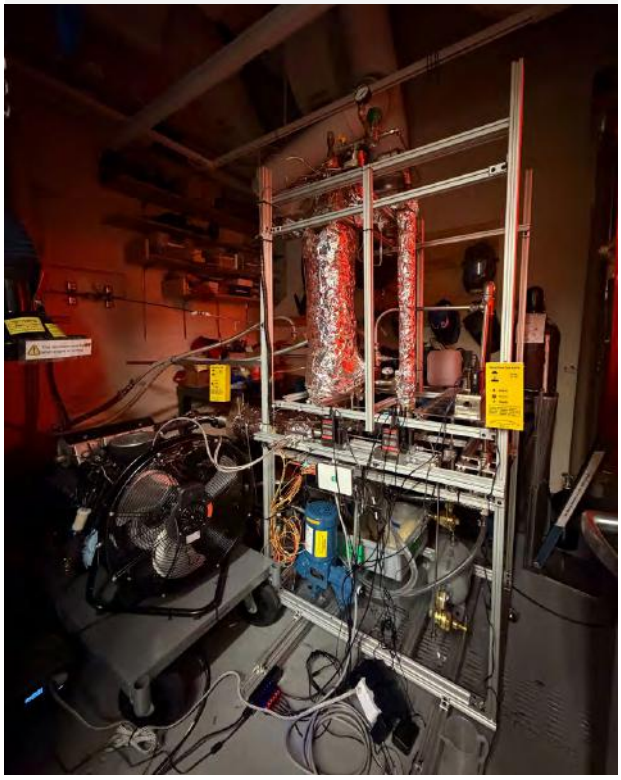
Sayandeep Biswas
Graduate Student Researcher

Kariana Moreno
Graduate Student Researcher

Developing a hydrogen-based fuel system that works with existing fuel infrastructure, enabling practical decarbonization of long-haul trucking.

Selected Outcomes & Updates:

- **Built a 10 kilowatt-scale** prototype of the system.
- **Start-Up Spin-Out:** LNK Energies unlocks a new way to move and use hydrogen – safely, affordably, and at scale.
- **Published Article in *Energy and Fuels*:** Perspective on Decarbonizing Long-Haul Trucks Using Onboard Dehydrogenation of Liquid Organic Hydrogen Carriers



10 kilowatt-scale prototype. Credit: Sayandeep Biswas.

Climate and Air Quality Impacts of Using Ammonia as Shipping Fuel

2022

Noelle Eckley Selin
Professor
Institute for Data, Systems and Society; Earth, Atmospheric, and Planetary Science

Steven Barrett
Professor
Aeronautics and Astronautics

Anthony Wong
Postdoctoral Associate

Sebastian Eastham
Principal Research Scientist

Evaluating the climate and public health implications of switching global shipping from fossil fuels to ammonia, providing evidence to guide fuel, technology, and policy choices for sustainable maritime decarbonization.

Selected Outcomes & Updates:

- The team found that while the tailpipe greenhouse gas emissions from ammonia combustion are only around 6% of that of fossil fuel combustion, **there is a large range of tailpipe air pollutant emissions from ammonia-powered ships**, depending on the technology and policy choice.
- **Published Article in *Environmental Research Letters:*** Climate and air quality impact of using ammonia as an alternative shipping fuel.

Design of Onboard Hydrogen Storage for Heavy-Duty Vehicles

2022

Amos Winter
Professor
Mechanical Engineering

Bryony DuPont
Visiting Scholar

ZhiYi Liang
Graduate Student Researcher

Informing realistic decarbonization pathways for heavy-duty trucking by clarifying the technical and economic tradeoffs of zero-carbon drivetrains and advancing hydrogen storage designs suited for long-haul applications.

Selected Outcomes & Updates:

- The team **analyzed the challenges** that stakeholders currently face in decarbonizing diesel fleets, and quantified the technoeconomic tradeoffs between diesel, battery-electric, and hydrogen drivetrains from an operational perspective.
- **Published Article in *ASME:*** Techno-Economic Outlooks for the Operation of Zero-Emission Heavy-Duty Trucks: Their Implications on Fleet Operators, Cargo Shippers, and Vehicle Designers.

Optimization and Collaboration Toward a Scalable Charging Infrastructure in Logistics

2024

Saurabh Amin
Professor
Civil and Environmental Engineering

Alexandre Jacquillat
Associate Professor
Sloan School of Management

Accelerating decarbonization of long-haul logistics by aligning electric truck charging infrastructure with collaborative, data-driven freight coordination, enabling scalable investment, efficient operations, and shared benefits across stakeholders.

Resilience Planning

Toolkit for Assessing the Vulnerability of Industry Infrastructure Siting to Climate Change

2022

Michael Howland
Assistant Professor
Civil and Environmental Engineering

Liying Qiu
Postdoctoral Associate

Equipping planners and industry with a climate-informed decision tool to identify and manage energy-related risks to critical infrastructure, supporting resilient siting and investment decisions under an uncertain future climate.

Selected Outcomes & Updates:

- **Provided guidance** on regionally tailored siting strategies for utility-scale renewable energy infrastructure.
- **Linked spatial siting to improved system-wide performance** and **quantified the value** of high-resolution energy infrastructure siting based on reliable, high-resolution meteorological modeling.
- **Published Article in *Cell Reports Sustainability:*** Decarbonized energy system planning with high-resolution spatial representation of renewables lowers cost.

Collaborative Community Mapping Toolkit for Resilience Planning

2022

Miho Mazereeuw
Associate Professor
Architecture

Nicholas de Monchaux
Professor
Architecture

Aditya Barve
Research Scientist

Empowering climate-vulnerable communities with a digital, participatory mapping toolkit that transforms local knowledge into actionable data for inclusive disaster preparedness and climate-resilient planning.

Selected Outcomes & Updates:

- **The team developed a tool, called *Copin,* for community-led mapping of resilience traits** and for coordinating adaptation action to promote preparedness to climate-related disasters in vulnerable communities.
- *Copin* is now **active in over 30 provinces in Thailand,** and has **shaped policy discussions;** the toolkit offers a customizable web interface to ensure that information is accessible for regional and national policymaking.

Community workshop of Copin tool in Chai Bat, Thailand. Credit: Aditya Barve.

Circularity: Built Environment

Reducing Embodied Carbon @ Work: Low-Carbon Cement-Based Product Strategies for Data Centers, Warehouses, and Industry

2024

Randolph Kirchain
Principal Research Scientist
Director, MIT Concrete Sustainability Hub

Hessam AzariJafari
Research Scientist

Soroush Mahjoubi
Postdoctoral Associate

Equipping companies with practical tools and guidance to measure and reduce embodied carbon in buildings and infrastructure, accelerating adoption of scalable low-carbon cement solutions across construction contexts.

Selected Outcomes & Updates:

- The team **developed a Decarbonization Playbook** based on the results of a structured survey of low-carbon cement-based product strategies applicable to data centers, warehouses, and industrial facilities. The findings are being synthesized into a practical playbook to help companies navigate these options systematically.
- The team developed a **lower carbon concrete framework** with the intention of reducing binder intensity and incorporating recycled materials. Using machine learning models, this data-driven framework for identifying concrete mix designs that simultaneously minimize binder content and carbon intensity while meeting structural performance requirements.

Pixelframe

2022

Caitlin Mueller
Associate Professor
Civil and Environmental Engineering, Architecture
Associate Director, MCSC

Inge Donovan
Research Assistant

Jenna Schnitzler
Research Assistant

Innovating a modular concrete construction system that enables disassembly and reuse of building elements, reducing the environmental impact of the structural system.

Selected Outcomes & Updates:

- **Exhibited** at the Venice Biennale's 19th International Architecture Exhibition, the largest architecture festival in the world, in May 2025. The Pixelframe showcase, entitled *From Liquid to Stone: A reconfigurable concrete tectonic against obsolescence*, reflected the festival's central themes of collaboration, invention, intelligence, and adaptability.
- **Completed fabrication** of a full-scale prototype, a Pixelframe beam designed to span 6 meters, in December 2025. The completion of the beam marks a jump from half-scale fabrication and testing in the lab spaces of MIT to industry-scale proof-of-concept prototyping.
- **Start-Up Spin-Out:** Pixelframe was formally spun out of MIT, and became its own start-up, in 2024.
- **Published Article in *Journal of Physics: Conference Series:*** PixelFrame: A reconfigurable, precast, post-tensioned concrete structural system for a circular building economy.

Inge Donovan, Jenna Schnitzler, and Professor Caitlin Mueller at the 2025 Biennale. Photo by Future Assemblies.

Gaining Green Premiums from Decarbonizing the Built Environment: A Holistic Evaluation Approach for Low-Carbon Investments

2024

Siqi Zheng
Professor
Urban and Real Estate Sustainability

Dongxiao Niu
Postdoctoral Associate

Thomas Williams
Data Analyst

Providing investors and decision-makers with a practical framework and tools to quantify when and where low-carbon buildings and infrastructure make financial sense, accelerating cost-effective pathways to net-zero in the built environment.

Selected Outcomes & Updates:

- The researchers **estimated that green-certified industrial buildings sell for about 6% more** on average than comparable non-green properties. This premium, however, is **highly uneven** across markets. It is much larger in areas where climate change concerns are stronger (especially among private buyers) while it is often weak or absent in other market segments.
- The team's findings **provide a comprehensive map** of where sustainability is priced in industrial real estate: the green premium exists on average, but it is economically concentrated in particular market environments and participant pools.

Engineering of a Microbial Consortium to Degrade and Valorize Plastic Waste

2022

Otto Cordero
Associate Professor
Civil and Environmental Engineering

Marc Foster
Graduate Student Researcher

Desirée Plata
Professor
Civil and Environmental Engineering
Director, MCSC

Advancing microbe-based solutions for plastic pollution by revealing how engineered microbial communities can efficiently break down biodegradable plastics and enable new circular pathways for plastic waste management.

Selected Outcomes & Updates:

- Results show **how bacteria break down industrial-relevant plastics** into dissolved chemicals that are then available for consumption or destruction to CO_2 – **with implications for sustainable material design** and the development of principles for engineered or natural biological remediation of industrial pollutants.
- The team **developed a comprehensive degradation scheme** illustrating bacteria that degrade the bulk polymer but do not consume all mobilized degradation products, while other bacteria further process these breakdown products and consume those products.

Cartoon showing degradation products forming from a plastic piece, bacteria eating the materials, and enzymes excreted by the bacteria degrading the plastic. Credit: Marc Foster.

Addressing End-of-Life Management Challenges for Hard-to-Break-Down Polymers

2022

Jeremiah Johnson
Professor
Chemistry

Kwangwook Ko
Graduate Student Researcher

Designing plastics with recyclability directly embedded, enabling end-of-life breakdown under mild conditions and transforming today's hard-to-recycle materials into viable circular resources.

Selected Outcomes & Updates:

- The team discovered that in **order for polymers to break down efficiently, the cleavable units they designed must be evenly distributed** through the polymer chains. This finding led them to **create a family of molecules that can incorporate into the chemical structure** of plastic and help it break down into smaller pieces without losing its durability.
- **Published Article in *Journal of the American Chemical Society:*** Mechanism-Guided Discovery of Cleavable Comonomers for Backbone Deconstructable Poly(methyl methacrylate).

High-Throughput Screening of Sustainable Polyesters for Fibers

2022

Gregory Rutledge
Professor
Chemical Engineering

Natalie Mamrol
Graduate Student Researcher

Bradley Olsen
Professor
Chemical Engineering

Katharina Fransen
Graduate Research Fellow

Accelerating textile circularity by using high-throughput tools to discover bio-based and biodegradable polyesters that can replace conventional fibers without sacrificing performance.

Selected Outcomes & Updates:

- Using a high-throughput approach, the team **identified several possible replacements for polyester,** and addressed common challenges in how they might be scaled.
- They **uncovered critical insights** into how common textile additives, such as dyes and chemical modifiers, affect the biodegradability and microbial toxicity of textile materials and their resulting microplastics.

Students Work with MCSC Researchers & Industry Through MIT's Undergraduate Research Opportunities Program (UROP)

Investigating Data Centers and Local Ecology

Wacuka Ngata, MIT Undergraduate Student

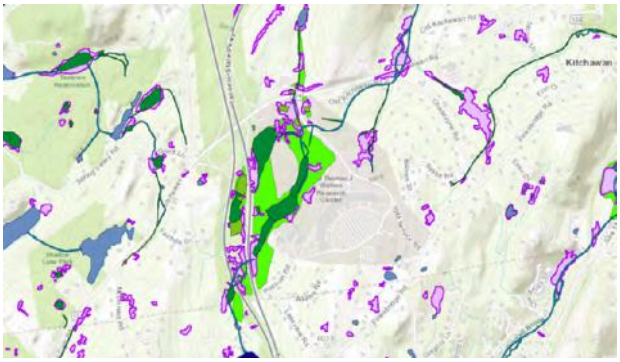
Noman Bashir
MCSC Impact Fellow

To investigate the ecological impact of data centers, Noman Bashir, MCSC Impact Fellow, worked with MIT student Wacuka Ngata, who is studying Materials Engineering. Wacuka's research interests center on the broad environmental footprints of data centers, looking beyond established research on energy use and carbon emissions to examine their localized effects.

Wacuka supported Noman in developing a comprehensive database of empirical evidence aimed at informing better decision-making for sustainable computing. The database highlights information gathered from stakeholder (local communities, environmental groups, and neighborhood coalitions) interviews, and highlight the specific concerns that communities have regarding ongoing expansive data center projects, being developed to meet growing demand and use of Gen-AI.

"Factors like water consumption, noise and air pollution, and the impact on surrounding communities are underrepresented in current research initiatives involving data centers," Wacuka explained. "The details that we capture in the database will identify specific ecological concerns that will inform next steps for reducing data centers' environmental footprints."

Read the full article.



Wetland coverage map. Source: New York Department of Conservation, Freshwater Wetlands Program.

Explorations of Biodiversity Technology, Co-Led with Industry Feedback

Alison Rufo, MIT
Undergraduate Student

Michelle Westerlaken
MCSC Impact Fellow

New digital biodiversity tools – ranging from data visualizations to integrative reporting frameworks – are becoming essential for translating vast, fragmented environmental data into insights that corporations can use to make informed, responsible decisions. To better understand the implementation of these biodiversity tools, Michelle Westerlaken, MCSC Impact Fellow, worked with MIT student Alison Rufo, who is studying Political Science and Earth, Atmospheric, and Planetary Sciences.

Together, they have been collaborating with MCSC member company IBM to identify existing biodiversity data sources, assess technical and organizational challenges in working with those datasets, and outline opportunities for future research and innovation.

"I am inspired by a passion for biodiversity and an understanding of industry's pivotal role in advancing climate action," said Alison. "Understanding the difficulties and desires of member companies in assessing their environmental impacts is important so that we can effectively collaborate on data and technology solutions."

The backdrop for Alison's biodiversity explorations were IBM's research facilities in Yorktown Heights, New York. By examining how ecological data is currently collected, accessed, and interpreted, the efforts led by both Michelle and Alison laid the groundwork for understanding how corporate biodiversity reporting tools might evolve over time. Their work brought about the opportunity to collaborate directly with industry representatives – making their explorations more meaningful and grounded in a real-world setting. Feedback from IBM was essential during this project to ensure the data being collected was useful and relevant to company needs.

Read the full article.

Photos: Gretchen Ertl.

Where We Are Heading: Upcoming Priorities and Pilots

We are eager to continue driving impact through critical industry-academia collaborations.

One area of focus as we move forward is the application of artificial intelligence for sustainability. We are interested in exploring the ways in which AI can be used to reduce impacts in areas such as agriculture, biodiversity, building structures and operations, energy systems, resilience, materials characterization and development, product design, and recycling.

Data centers are a key part of this AI conversation. We are seeing opportunities to design future data centers with new technologies, systems analysis techniques, and community engagement models. The result is data centers that have reduced embodied and operational carbon and water consumption, while making a contribution to surrounding communities. We are excited to make tangible improvements in this space by collaborating with experts, at both our member companies and at MIT, including several members of MCSC's leadership team.

We are also seeing momentum and opportunity for impact in the supply chain resilience space. Companies are developing nimble and evolving strategies to minimize disruptions, exacerbated by climate change, to their supply chains. To support these efforts, the MCSC is exploring the ways in which companies are evaluating risk for materials, energy, and facilities along their supply chains, as well as data and modeling gaps in these approaches. We will embrace opportunities to apply MIT research leveraging AI to improve risk assessments and create mitigation strategies.

These are all topic areas we recently dove into with our industry collaborators at our 2026 MCSC Member Meetings, setting the stage for another productive year.

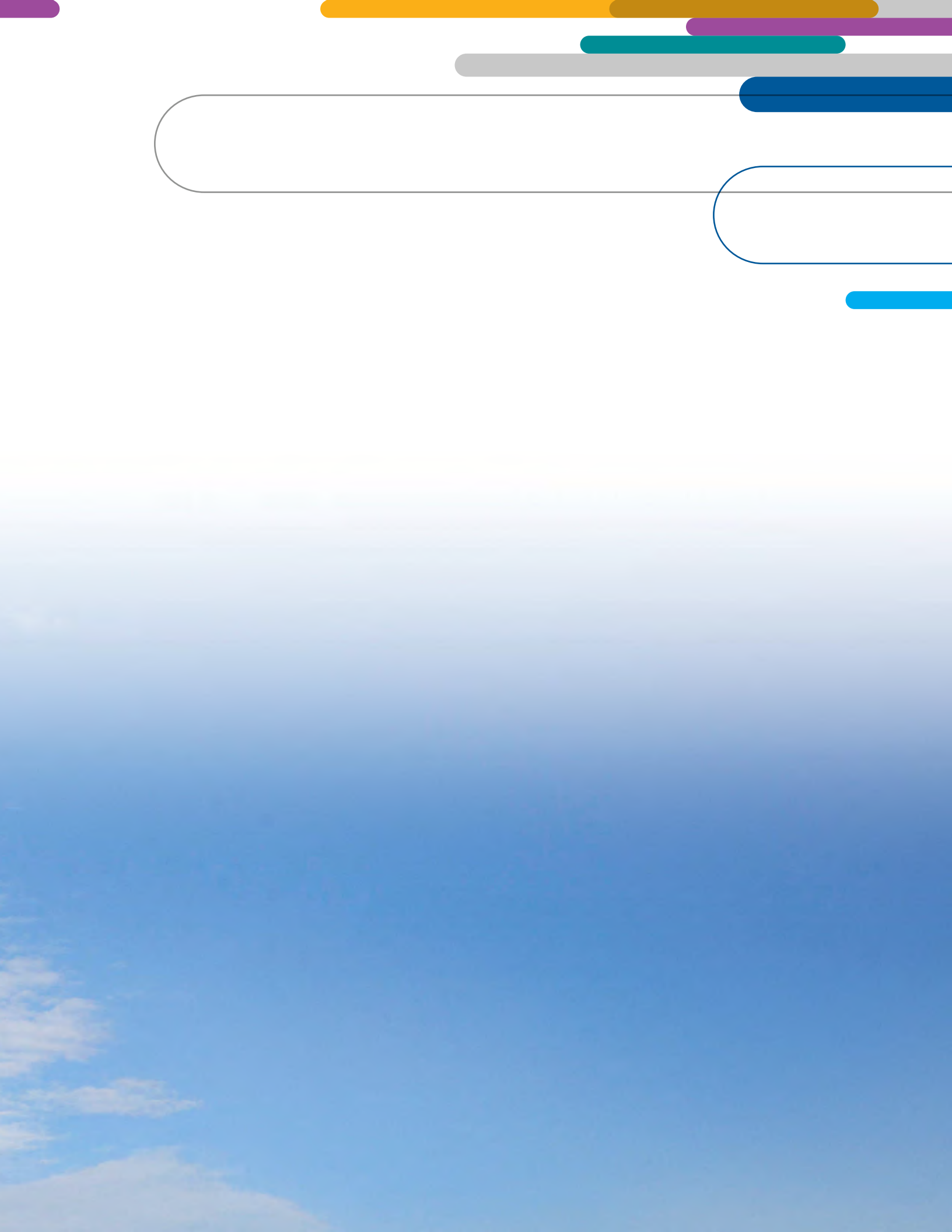
Finally, we are looking forward to piloting the tools and technologies that emerge from our funded research projects. As you have read about in this report, we are supporting a diverse group of principal investigators and their teams from across MIT. They are collaborating directly with MCSC member companies to ensure the work they are producing is implementable and scalable.

Membership Benefits

Benefits and expectations of MCSC member companies include:

- **Engage** the robust climate and sustainability ecosystem at MIT
- **Create** key research and implementation work streams in partnership with MIT faculty and MCSC Member Companies
- **Guide** the evolution of the MCSC through strategic input to the Industry Advisory Board
- **Access** and participation in MCSC seminars and workshops
- **Strengthen** competencies through professional development
- **Drive** impact by fostering systems-level solutions

Comprehensive overview of benefits:



Connect with us!

Please reach out to mcsc@mit.edu to learn more about our work.

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