

MIT Energy Initiative

The [MIT Energy Initiative \(MITEI\)](#) is MIT's hub for energy research, education, and outreach—connecting faculty, students, and staff to develop the knowledge, technologies, and solutions that will deliver clean, affordable, and plentiful sources of energy. Our mission is to develop low- and no-carbon solutions that will efficiently, affordably, and sustainably meet global energy needs while minimizing environmental impacts, dramatically reducing greenhouse gas emissions, and mitigating climate change. Within MIT, we strive to foster a sense of community through our educational programs, events, and other activities.

To advance this mission, MITEI brings together researchers from across the Institute and facilitates collaborations with industry and government. MITEI and its member companies and organizations support hundreds of research projects across the Institute, including those awarded through the MITEI Seed Fund Program for innovative, early-stage energy research projects.

The Initiative also delivers comprehensive analyses for thought leaders, policymakers, and regulators, such as the Future of study series, the latest of which is *The Future of Nuclear Energy in a Carbon-Constrained World*, published in September 2018 with the Department of Nuclear Science and Engineering. A new study, *The Future of Energy Storage*, launched in summer 2018 and will focus on the role of storage in making electricity systems cleaner, more efficient, and more affordable. The *Future of Energy Storage* study is scheduled for release in 2021.

Another series of studies, addressing questions that are most relevant to consortia members, examine rapidly changing segments of the energy sector. The first in this series was the 2016 *Utility of the Future* study examining the electricity services sector. The next in the series, *Mobility of the Future*, examines the light mobility segment of the transportation sector and was released in November 2019.

As a vital component of MIT's Plan for Action on Climate Change and MITEI's research program, the [Low-Carbon Energy Centers](#) present opportunities for faculty, students, industry, and government to advance research and development in key technology areas and energy subsector systems for addressing climate change, from solar energy to electric power systems, mobility, and other areas.

MITEI leads Institute energy education efforts and has engaged thousands of undergraduate, graduate, and postdoctoral students through sponsored research opportunities and other programs—preparing the next generation of innovators, entrepreneurs, and policymakers to collaborate on solutions to global energy challenges. Energy education programs include the energy studies minor; Undergraduate Research Opportunities Program in energy; short modules during the Independent Activities Period; a first-year preorientation program focused on energy; Society of Energy Fellows; and other initiatives, including a new series of online energy classes open to a global audience. Faculty associated with MITEI help shape energy education at both the undergraduate and graduate levels by teaching, advising, and developing new curricula.

MITEI's comprehensive outreach efforts foster dialogue within the academic research community; across the academic, industry, and government sectors; and provide the public with context on current energy issues. In addition to informing public policy through research reports, MITEI facilitates this exchange of information by hosting and sponsoring events and by supporting faculty and staff participation in external events. The MITEI communications team also develops content to highlight MIT energy researchers, students, and their work across print and digital platforms, such as *Energy Futures* magazine, MITEI's website, podcasts, and social media, as well as through media outreach.

Accomplishments and Updates

Low-Carbon Energy Centers

MITEI continues to develop and evolve its program of Low-Carbon Energy Centers, which launched in fall 2015 as part of MIT's Plan for Action on Climate Change. These research centers are dedicated to tackling the most pressing energy challenges related to climate change from key technological and economic perspectives. Each of the centers has a distinct focus: carbon capture, utilization, and storage; energy at scale; energy in the developing world; electric power systems; energy bioscience; energy storage; materials for energy and extreme environments; mobility systems; and solar energy. Fusion research is conducted in collaboration with the MIT [Laboratory for Innovation in Fusion Technologies](#), supported in part with a \$2 million grant from MITEI member Eni. The Energy at Scale Center is a research initiative with the [MIT Joint Program on the Science and Policy of Global Change](#).

To solve the pressing challenges of decarbonizing the energy sector with advanced technologies, it is vital that experts across all disciplines and sectors are engaged. Through the Low-Carbon Energy Centers, MITEI facilitates this important collaboration: enabling faculty members from across MIT to converge around specific technology research areas and work with industry and government members to advance and expand the portfolio of existing MITEI-facilitated research in these areas. Together, MIT researchers and center members are working to develop and scale the technologies that will move us toward a low-carbon energy future.

Since the launch of the Low-Carbon Energy Centers, center and other MITEI members have generated more than \$142 million in sponsored research activity related to the development of low- and no-carbon technologies. To date, 26 new, former, and current MITEI members have committed support for the centers—with some members supporting multiple centers—and interest continues to grow.

To date, MITEI has raised over \$850 million to support MIT and MITEI.

Read more about new center members in the Members section.

Research

MITEI's research portfolio reflects the Initiative's goal of advancing low-carbon energy via diverse channels, from renewable energy and energy efficiency to carbon management technologies. An important component of the portfolio includes research

and analysis on the energy systems—power, transportation, industry, and building—into which new technologies need to fit to provide needed energy services to society. Areas that garnered the highest amount of new research support this year are renewable energy, climate and environment, and fusion (each received between \$4 million and \$5 million in sponsored research in FY2020). Recognizing the long-time horizons involved in energy transition, MITEI also includes projects geared toward meeting contemporary energy needs through more efficient and environmentally responsible use of conventional energy systems.

MITEI and its members have supported a consolidated total of more than 840 projects through FY2020; some projects have been combined over the years.

MITEI Research Program Highlights

Funding for early-stage research

One of MITEI's core tenets is supporting promising energy research across a wide range of disciplines. MITEI awarded eight early-stage MITEI seed research projects this spring for a total of approximately \$1 million. Including the 2020 grants, MITEI has supported 185 energy-focused seed projects with grants totaling approximately \$24.9 million. These projects have covered the full spectrum of energy research areas, from fundamental physics and chemistry to policy and economics, and have drawn from all five MIT schools and 28 departments, labs, and centers.

Studies and reports

In November 2019, the final report of the *Mobility of the Future* study, led by William H. Green—faculty chair and professor of chemical engineering—and Randall Field, executive director of the study at MITEI—was rolled out in Cambridge, Massachusetts and Washington, DC. This study explores how consumers and markets will respond to technologies, business models, and government policies in the transportation sector, with a focus on the uptake of alternative fuel vehicles for passenger travel. The *Future of Energy Storage* study, launched in summer 2018 and scheduled for release in spring 2021, will focus on the role of storage in making electricity systems cleaner and more efficient. The *Future of Energy Storage* study is part of MITEI's Future of study series, which provides comprehensive analyses for policymakers and regulators. See more details on each of these studies in the MITEI Studies section.

Low-Carbon Energy Center meetings

The Centers for Carbon Capture, Utilization, and Storage; Energy Storage; Electric Power Systems; and Mobility Systems each held several workshops and meetings to discuss the latest research results and new directions of technology development with their members. The Electric Power Systems Center subdivided their spring workshop as virtual sessions over three successive Wednesdays in late May. This new format proved effective, and enabled a broader range of stakeholders from member companies to participate. The Carbon Capture, Utilization, and Storage Center also selected two new seed projects to fund, totaling \$900,000. The winning project will receive \$750,000 and aims to produce hydrogen without carbon dioxide (CO₂) emissions while creating a second revenue

stream related to the value of solid carbon produced. The additional project will receive \$150,000 and seeks to expand understanding of new processes for storing CO₂ in basaltic rocks by converting it from an aqueous solution into carbonate minerals.

New Low-Carbon Energy Centers

Based on positive member feedback on the *Mobility of the Future* study, MITEI launched a new Low-Carbon Energy Center on mobility systems. The center expands the scope of MITEI's mobility research to include unique challenges facing mobility in high-growth developing countries and freight ground transportation, in addition to its continued focus on clean propulsion systems and fuels, and disruptive technologies for passenger transport. The Mobility Systems Center launched its first annual call for proposals for projects in July 2019, awarding four projects related to on-demand urban passenger mobility services, long-haul trucking, and urban delivery of goods. The center just completed its second annual call for proposals, awarding an additional four projects to start on September 1, 2020. MITEI also launched the Energy at Scale Center, a joint research initiative with the MIT Joint Program on the Science and Policy of Global Change, to assess the economic, environmental, and geopolitical impacts of scaling up low-carbon technologies; and the Center for Energy in the Developing World, which aims to expand access to modern energy and address climate change by guiding the transformation of energy systems, regulatory structures, and business models and informing public policy in developing countries and underserved areas.

Low-Carbon Energy Center webinars

MITEI's new Low-Carbon Energy Center webinars have been held via Zoom, and have provided an opportunity to engage a broad spectrum of stakeholders across MITEI's member organizations. To date, MITEI has held five Low-Carbon Energy Center webinars (one per month), beginning in February 2020.

- February 2020, "New Nuclear: Small, Robust, Cheap, and Versatile," presented by Jacopo Buongiorno (Nuclear Science and Engineering)
- March 2020, "Insights into Future Mobility: A Report from the *Mobility of the Future* study," presented by Randall Field and Joanna Moody (MITEI)
- April 2020, "New Technologies for CO₂ Capture," presented by T. Alan Hatton (Chemical Engineering)
- May 2020, "Offshore Wind Turbines," presented by Paul Sclavounos (Mechanical Engineering and Naval Architecture)
- June 2020, "Progress on the SPARC Fusion Experiment," presented by Dennis Whyte (MIT Plasma Science and Fusion Center)

In July 2020, MITEI will hold its sixth webinar in the series; Dharik Mallapragada (MITEI) will present "The Role of Hydrogen in Future Low-Carbon Energy Systems."

Faculty Research Highlights in the News

Materials science

- Julia Ortony (Materials Science and Engineering) [discusses](#) her work on water purification with textiles created from nanofibers and the creation of chemical fuels from solar energy.
- A team of chemical engineering researchers, including Karthish Manthiram (Chemical Engineering), are [devising](#) new methods of synthesizing epoxides, a group of chemicals used in goods from clothing, detergents, and antifreeze to pharmaceuticals and plastics.

Energy storage

- Electrical storage devices known as supercapacitors require a layer of electrolyte to function. A novel class of ionic liquids [developed](#) by researchers in the Department of Chemical Engineering—including T. Alan Hatton—may store more energy than traditional electrolytes and are less likely to catch fire.
- Yet-Ming Chiang (Materials Science and Engineering) [discusses](#) the future of battery technology.

Nuclear energy

- PhD candidate Nestor Sepulveda [discusses](#) his experiences at MIT, including the creation of a computational model that analyzes the potential impacts of increasingly complex energy technology scenarios on achieving deep decarbonization. The results made a strong case for the use of firm electricity sources, such as nuclear energy, as the least costly route to a low-carbon grid. Sepulveda's results helped to inform MITEI's *Future of Nuclear Energy in a Carbon Constrained World* study and has attracted the attention of Bill Gates and the *New York Times*, among others.
- Commonwealth Fusion Systems (CFS), a startup spun off of MIT's Plasma Science and Fusion Center in 2018, has raised \$84 million in the most recent round of funding, bringing the total to over \$200 million. CFS aims to have a demonstration nuclear fusion reactor by 2025 and a commercial reactor operational in the 2030s.
- Jacopo Buongiorno (Nuclear Science and Engineering) [discusses](#) the role of molten salt reactors in the power industry. MITEI's *Future of Nuclear Energy in a Carbon-Constrained World* study found that, although more mature concepts, such as the light-water small modular reactor designs, are ready for commercialization well within this decade, molten salt reactors will not be commercially viable within the next several decades.

Solar energy

- A [study](#) authored by Tonio Buonassisi (Mechanical Engineering) and researchers from MIT and the National Renewable Energy Laboratory finds that slimming down silicon solar cells will lower costs and potentially allow for a rapid expansion of solar panel manufacturing capacity.
- A technoeconomic [analysis](#) of perovskite manufacturing by Tonio Buonassisi (Mechanical Engineering), Marius Peters (MIT Photovoltaics Research Laboratory), and others finds that by starting with higher-value niche markets, solar panel manufacturers could avoid the steep up-front costs of perovskite-based panels.
- Vladimir Bulović (Electrical Engineering and Computer Science; Organic and Nanostructured Electronics Laboratory; and MIT.nano), Joel Jean (former MIT postdoc and Swift Solar founder), and Michael Woodhouse (National Renewable Energy Laboratory) [find](#) that new kinds of solar panels do not necessarily have to last 25 or 30 years to be economically viable.
- A team at MIT, including Evelyn Wang (Mechanical Engineering), can now [fabricate](#) a transparent version of a silica aerogel, an ultralight material that blocks heat transfer. This new material can be used as an inexpensive solar thermal collector for heating, as an insulator for windows, and much more.
- MITEI postdoc Patrick Brown and Francis O’Sullivan (Sloan School of Management) developed a methodology to assess the costs and benefits of photovoltaic power across the US grid from 2010 to 2017. Their [results](#) show that by 2017, the total benefits outweighed the cost at the majority of the locations modeled.

Mobility

- In a [study](#) on transportation policy making in the often-overlooked, midsized Chinese cities, Jinhua Zhao (Urban Studies and Planning; JTL Mobility Lab; MITE Mobility Systems Center; and MIT Mobility Initiative), and Joanna Moody (MITEI Mobility Systems Center) found that cities with similar urban development trends tend to adopt the same types of transportation policies.
- MITEI’s most recent multidisciplinary report, *Insights into the Future of Mobility*, explores how individual travel decisions are shaped by complex interactions between technologies, markets, business models, government policies, and consumer preferences—and the potential consequences as personal mobility undergoes tremendous changes in the years ahead.
- Christopher Zegras (Urban Studies and Planning) and others have [created](#) a new typologization spanning 331 cities in 124 countries that presents up-to-date and relevant information for sustainable urban mobility analyses.
- Researchers from MITEI and the National Renewable Energy Laboratory [find](#) that while battery electric vehicle financial incentive programs boost electric vehicle

adoption, regional electricity grids play a significant role in dictating whether these programs are cost-effective when it comes to reducing carbon emissions.

- The Mobility Systems Center [awarded](#) four new research projects on topics including hydrogen-based transportation, the economics of electric vehicle charging networks, and the impact of COVID-19 on urban mobility. These projects will complement the center's ongoing portfolio of research into the technological, economic, and political aspects of decarbonizing the transportation sector.

Energy and climate economics and policy

- Valerie Karplus (Sloan School of Management) [evaluated](#) the effectiveness of air pollution standards implemented by China in 2014, and she found that although not all plants and factories complied with the new standards, they still reduced their emissions.
- In the absence of federal adoption of climate change policy, it is up to states and local municipalities to take their own action. Renewable portfolio standards (RPSs) are a key component of more localized climate policy. Currently many states are relaxing their RPSs or even repealing them. A [study](#) led by Noelle Eckley Selin (Institute for Data, Systems and Society; Earth and Planetary Sciences) finds that RPSs not only save states money, but, due to improved air quality, saves lives as well.

Carbon capture

- T. Alan Hatton (Chemical Engineering; and MITEI Center for Carbon Capture, Utilization, and Storage) has worked with Sahag Voskian SM '15, PhD '19 to [develop](#) a new system that captures carbon dioxide from various exhaust streams—from power plants to home furnaces—and even retrieve it from ambient air.
- Howard Herzog (MITEI senior research engineer) and T. Alan Hatton (Chemical Engineering; and MITEI Center for Carbon Capture, Utilization, and Storage) [discuss](#) the potential role that carbon capture and sequestration could play in reducing global greenhouse gas emissions.

Energy in the developing world

- The Global Commission to End Energy Poverty, a worldwide initiative established by MITEI and the Rockefeller Foundation, [plans](#) to bring together leading investors, utilities, and policymakers to tackle energy poverty.

Additional low-carbon energy research

- MIT researchers, including Karthish Manthiram (Chemical Engineering), are working to [develop](#) a smaller-scale alternative to traditional, industrially produced fertilizer—which requires immense amounts of energy to produce. In a step toward achieving small-scale fertilizer production, the team has figured out how to combine hydrogen and nitrogen using an electric current to generate a lithium catalyst. Their method could help avoid the most energy intensive parts of traditional manufacturing. The researchers envision this new process being used to locally produce fertilizer for farmers in remote areas.
- The lab of Yogesh Surendranath (Chemistry) is a tight-knit community that is conducting ground-breaking [research](#) in electrochemistry to open up new paths to a low-carbon future. A key focus of the lab is to find useful applications for carbon dioxide.

MITEI Studies

Mobility of the Future study

The multidisciplinary *Mobility of the Future* study was completed and the resulting report, *Insights into Future Mobility*, was launched in November 2019. This study explores how consumers and mobility markets will respond to technologies, business models, and government policies. The research group and the consortium of MITEI members, which met from August 2016 through November 2019, defined the scope of the study as ground transportation with an emphasis on the movement of people. The study is part of MIT's Plan for Action on Climate Change.

The study was led by faculty chair William H. Green, professor of chemical engineering, and Randall Field of MITEI, the study's executive director. It was supported by energy, automotive, and infrastructure companies (Alfa, BP, Chevron, Equinor, ExxonMobil, Ferrovial, General Motors, Saudi Aramco, Shell, and Toyota Mobility Foundation) whose representatives provide industry perspectives on mobility problems.

The study team—composed of faculty, researchers, graduate students, and postdocs—analyzed many important areas of passenger mobility in response to key questions identified by MIT researchers and consortium members. These analyses included projection of the future cost of battery packs for electric vehicles, assessment of fuel consumption and fleet composition under various climate policy scenarios, and exploration of the impacts of new (autonomous) on-demand mobility services on mode choice for different cities around the world.

The Future of Energy Storage study

The *Future of Energy Storage* study, which launched in fall 2018 and scheduled for release in spring 2021, focuses on the role of storage in making electricity systems cleaner and more efficient. Robert Armstrong—MITEI director and Chevron Professor of Chemical Engineering, and Yet-Ming Chiang—Kycocera Professor of Materials Science and Engineering, are co-chairs of the study. Howard Gruenspecht, a senior energy economist

at MITEI, serves as its executive director. Although multiple resources and technologies can provide clean generation, variable renewable energy (VRE) resources such as wind and solar are of particular interest given their widespread availability, public acceptance, scalability, and increasingly attractive cost. Traditional electric systems are built on a paradigm where generation is adjusted by system operators to follow load. However, unlike generation sources that can follow load, VRE resources cannot be dispatched at will. Therefore, the feasibility of a future electricity system in which VRE resources play a leading role depends directly on the future availability and cost of energy storage technologies suitable for large scale deployment.

The study considers storage technologies; the economics of storage; practical system transformation pathways for industry; and possible government roles in market design and regulation, research, and deployment support for storage in the 2020 to 2040 time frame. The multidisciplinary study team's focus is on "electricity to electricity" storage systems in four broad categories: electrochemical storage (batteries), kinetic storage (including pumped hydro and compressed air energy storage), hydrogen and other chemical storage, and heat storage. The study also considers how storage interacts with such strategies as increased load flexibility, expanded transmission networks, and overbuilding of VRE generation capacity as part of a cost-effective approach to accommodate a VRE-rich generation mix.

Following meetings among faculty through mid-2019 to set the study's focus, research activities involving faculty, MITEI staff, postdocs, and students began in summer 2019 and fall 2019. The study's External Advisory Committee (EAC) has met three times, including a May 2020 meeting via Zoom where initial research results were presented. Research is continuing and initial writing has begun. A final EAC meeting is planned for December 2020 to review the study's main findings and recommendations, to support the planned report release in spring 2021.

Global Commission to End Energy Poverty

In collaboration with the Rockefeller Foundation, MITEI initiated an ambitious new effort in late 2018 to bring electricity to the remaining billion people across the globe who currently lives without it. The Global Commission to End Energy Poverty is led by Robert Stoner, MITEI deputy director and director of the Tata Center for Technology and Design; and co-chaired by Ernest Moniz, special advisor to the MIT president, professor emeritus, and former US Secretary of Energy; Rajiv Shah, president of the Rockefeller Foundation; and Akinwumi Adesina, president of the African Development Bank. The commission convened for the first time in September 2019 in Italy, and will publish its findings and recommendations at the United Nations General Assembly in 2020. The Global Commission's leaders hope to define an actionable, long-term agenda underpinned by commitments by the major development banks, private firms and investors, governments, and national utilities that will make universal electrification a reality by 2030.

Education

MITEI's role as an educator of future energy change agents is critical to its mission as a catalyst for tomorrow's low-carbon energy solutions. Through programs created for

graduate and undergraduate students, MITEI provides a robust educational tool kit to MIT students who want to contribute to the energy transition. These programs allow students to take classes; conduct research in diverse areas, from energy science and social science to technology and engineering; practice their skills; and network with peers and professionals. MIT faculty members work with MITEI's education team to develop the curriculum and act as advisors to aspiring and current energy students.

Students interested in energy at MIT can start as soon as they step onto campus: MITEI runs the Discover Energy First-Year Pre-Orientation Program at the end of the summer before classes begin. The journey continues in the classroom, where undergrads can take interdisciplinary courses through the energy studies minor and participate in laboratory research through the MITEI Undergraduate Research Opportunities Program (UROP). After completing their first year at MIT, students have the opportunity to attend a 10-day field trip to experience practical examples related to the energy transition through visits to energy companies, demonstration projects, and research facilities. Unfortunately, the 2020 field trip was cancelled due to the COVID-19 pandemic.

Students participating in MITEI's Solar Spring Break program have the opportunity to immerse themselves in energy practice by installing solar panels in underserved communities. In 2020, MITEI partnered with MIT's Priscilla King Gray Public Service Center and the University of Puerto Rico for a service-learning trip in Puerto Rico. However, due to severe weather in the area, the trip was cancelled on short notice to protect the health of our students.

Graduate students and postdocs receiving funding from MITEI through the member education fund are an equally important part of the initiative's energy education ecosystem. In addition to contributing their own research to MITEI's areas of inquiry and collaborating with researchers on white papers and studies, graduate students mentor UROP students and contribute to the development of the energy studies minor curriculum. Through the Society of Energy Fellows, MITEI also hosts activities for graduate student fellows, including dinner meetings with sponsors at MITEI's Annual Research Conference, energy talks, and a range of informational gatherings and networking events.

MITEI Education Program Highlights

Graduate fellows

MITEI welcomed 37 new graduate students and postdocs to the Society of Energy Fellows in AY2020. The Energy Fellows network now totals more than 470 current and former graduate students and postdoctoral fellows, spanning 20 MIT departments and divisions and all five MIT schools. This year's fellowships were made possible through the generous support of the following MITEI member companies: Chevron, Commonwealth Fusion Systems, Eni, ExxonMobil, and Shell.

Online energy courses

To help train the global network of professionals needed to realize a low-carbon energy future, the MITEI education team has organized a new series of masters-level, online

energy courses based on interdisciplinary MIT graduate classes currently taught on campus. The courses will be open online MITx courses offered on the edX platform. The MITx courses will engage four critical aspects of future electricity systems: load and demand-side management; economics and regulation; production; and distribution and transmission. The first class, Professor Christoph Reinhart's 4.464 Environmental Technologies in Buildings, launched in January 2020 and attracted over 17,000 enrolled learners. The next course, Michael Golay's 22.811 Sustainable Energy Systems, will launch in September 2020.

Chevron Fellows

In 2019, MITEI partnered with the Systems Design and Management (SDM) program to provide more resources and educational opportunities for students interested in the energy transition and working to complete a master's degree in SDM with an energy concentration. Chevron sponsored 16 of their employees to take part in this program in AY2020. The goal for this additional training is to prepare them for a future in which the energy industry increasingly applies digital tools, such as machine learning, artificial intelligence, and blockchain. The MITEI education team supported the cohort's transition to MIT, helped introduce each participant to faculty doing energy-related research to serve as thesis advisors, and welcomed them into the Society of Energy Fellows. Since the Chevron Fellows' time at MIT is condensed to 12 months rather than the typical 18 to 24 months, MITEI's support has been critical to help them complete their theses in this short time frame.

Energy studies minor

In the spring of 2020, 13 students graduated with an energy studies minor. The MITEI education team hosted a virtual toast over Zoom for the new graduates on the afternoon of Commencement.

Undergraduate energy research

MITEI supported 60 student projects through the MITEI UROP during AY2020, bringing its total number of sponsored projects up to 591. During the 2020 summer term, MITEI funded 20 UROP students, all of whom worked on remote projects as MIT continued to practice social distancing to slow the spread of COVID-19.

First-Year Pre-Orientation Program

MITEI's summer 2019 energy pre-orientation program sent 20 first-year students to on- and off-campus locations to learn about opportunities for energy research and education at MIT. Activities included a meeting with representatives from the Institute's Undergraduate Energy Club; a tour of a wind turbine blade testing facility; a tour of Ørsted's off-shore wind farm off of Block Island, Rhode Island, and a lecture with the site's manager; a visit to and panel with employees of Shell TechWorks; an energy economics workshop with Professor Jing Li (Sloan School of Management); and a workshop on building DC motors with Professor Steven Leeb (Electrical Engineering and Computer Science). Students also met with professors in informal settings, including Valerie Karplus (Sloan School of Management) and David Hsu (Urban Studies and Planning).

Annual Research Conference

At MITEI's November 2019 Annual Research Conference, 25 undergraduates and one graduate student presented posters of energy-related work in a wide range of disciplines, from electrochemistry to architecture. The students, most of whom were MITEI-sponsored participants in the Undergraduate Research Opportunities Program, had the opportunity to network with energy professionals while showcasing their research.

Spring teaching

Due to the COVID-19 outbreak, MIT's faculty had to switch from in-person to virtual teaching overnight. The MITEI education team served as an important resource for MITEI's faculty by quickly putting together and sharing an online teaching resource document.

High school curriculum

MITEI Education is supporting Professor Christopher Knittel (Sloan School of Management) in developing the Climate Action through Education program, which is focused on developing free digital classroom resources and lesson plans that explore climate change science and policy-based solutions for high school students and teachers. The final product will have components for English/language arts, math, history, and science teachers alike.

Outreach

MITEI's fact-based analysis of current energy topics informs public policy, fosters dialogue within the academic research community, and provides the public with context on vital issues. Convening events throughout the year, MITEI hosts thought leaders from across the energy value chain. MITEI staff, faculty affiliates, and graduate students share their research and perspectives at domestic and international events. Staff members also participate in Institute-wide efforts focused on addressing climate change. MITEI's communications team highlights the research and achievements of faculty and students through articles, media outreach, social media, podcasts, and other digital and print platforms to reach a diverse audience.

Outreach Program Highlights

MIT Climate Symposia

During AY2020, MIT planned to host six symposia to examine the urgent challenge of climate change. Due to the COVID-19 campus closure and in-person event cancellations, only four of the six symposia happened during the academic year. The remaining two symposia will be rescheduled for AY2021. The series draws upon MIT's work to date on the MIT Plan for Action on Climate Change and considers the current state of knowledge on key aspects of this global problem. These discussions provide an important opportunity for engagement among members of the MIT community, other leading researchers, industry leaders, and policymakers to explore options for facilitating the necessary transition to a low-carbon economy. MITEI-affiliated faculty and staff are providing support for the six symposia.

MIT and industry engagement

MITEI and others at MIT, led by the Office of the Vice President for Research, have been engaging with industry around how to report climate-related risks in the financials of oil and gas companies. This 2018–2019 effort engaged institutional shareholders, who are important allies in the effort to put pressure on companies to transition their businesses. An MIT team published a report in fall 2019 (“Climate-Related Financial Disclosures: The Use of Scenarios”) that grew out of a workshop, identifying shortcomings in oil and gas companies’ current climate-related disclosures and made recommendations for making their disclosures more complete, more comparable across companies, and more transparent.

MIT Plan for Action on Climate Change

MITEI continues to support MIT’s Plan for Action on Climate Change with the ongoing development of its interdisciplinary Low-Carbon Energy Centers, which include new types of member companies, energy systems analysis and studies, work in developing countries, and education.

Guest speakers

Leading executives in policy, academia, and industry gave talks at MITEI-hosted events. Speakers included Brian Anderson, director of the National Energy Technology Laboratory of the US Department of Energy; Tiziano Destefano, research fellow, University of Pisa, Italy; Susan Hockfield, president emerita and professor, MIT; Santosh Raikar, managing partner, Silverpeak Renewables Investment Partners; Karen Scrivener, professor and head of the laboratory of construction materials, École polytechnique fédérale de Lausanne, Switzerland; and Andy Sun PhD ’11 associate professor and Anderson-Interface Early Career Professor, H. Milton Stewart School of Industrial and Systems Engineering at Georgia Tech.

IHS Markit seminar series

IHS Markit sponsored several seminars in FY2020, including “More or Less than Zero: Can Electricity Markets Survive Deep Decarbonization?” with James Bushnell—UC Davis professor and National Bureau of Economic Research (NBER) research associate; “The Optimum Allocation of Available Budget to Joint Climate Control Mechanisms,” with John Deutch—Institute Professor Emeritus, MIT Department of Chemistry; “Policy Options to Promote Electric Vehicles: Evidence from China,” with Shanjun Li—Kenneth L. Robinson Professor of Applied Economics and Public Policy, Cornell University; and “Atomically Thin Canvas for Quantum Optoelectronics: Enhancing All-Optical Integrated Circuits to Allow Ultra-Fast Computing with Ultra-Low Power Consumption,” with Hongkun Park—Mark Hyman Jr. Professor of Chemistry and Harvard University professor of physics.

Annual Research Conference 2019

The event brought together energy researchers, policymakers, and industry members working on cutting-edge technologies and business models for the transition to a low-carbon future. The three-day conference and workshop program wove together panels on topics including engagement with industry and government, energy at

scale, integrating renewables into the grid, and decarbonizing the built environment and industry to illustrate how academia, industry, and policymakers can bring their unique perspectives and capabilities to bear on achieving a safer future for the planet. Conference speakers included Barbara J. Burger, Chevron Technology Ventures president; Jake Jurewicz, Exelon manager of corporate strategy; Melanie Kenderdine, principal at Energy Futures Initiative and former US Department of Energy director of the Office of Energy Policy; Traci Kraus, Cummins director of government relations; Yueh-Lin “Lynn” Loo, Andlinger Center for Energy and the Environment director and the Princeton University Theodora D. ’78 and William H. Walton III ’74 Professor in Engineering; Massimiliano Pieri, Eni Next clean-tech director and Eni VP of Cooperation with MIT; Jacob J. Thiart, ExxonMobil Research and Engineering manager of the Catalyst and Process Technology Division; Eric A. Thumma, Avangrid Renewables director of New Business Offshore Wind; MITEI researchers; and MIT faculty members.

C3E 2019 Women in Clean Energy Symposium

In November 2019, the eighth annual Clean Energy, Education, and Empowerment (C3E) Women in Clean Energy Symposium and Awards was hosted by Texas A&M Energy Institute in collaboration with the US Department of Energy, MITEI, and Stanford Energy. The conference featured award presentations to midcareer women (including Valerie Karplus of the Sloan School of Management, who received the Education award) and a lifetime achievement award presentation, as well as diverse speakers—including Antje Danielson, MITEI’s director of education—and rich conversations on strategies and technologies to enable the transition to a low-carbon future. The US C3E Initiative aims to advance clean energy by closing the gender gap and enabling the full participation of women in the clean energy sector. MITEI will host a virtual symposium in 2020 (due to COVID-19), followed by an in-person event in 2021.

Podcasts

MITEI produced and released a number of podcasts that explore energy from a variety of angles to make its research more accessible to a large audience and to illustrate how energy impacts our everyday lives. Subjects covered this year include energy entrepreneurship, corporate climate strategy, the economics of rooftop solar, and transportation.

Organization

MITEI Leadership Team

Director Robert Armstrong’s leadership team continues to build on MITEI’s strong foundation and bold, multidisciplinary approach to deliver global energy solutions. In addition, the team is broadening MITEI’s membership base, seeking out potential members for the Low-Carbon Energy Centers, increasing opportunities for faculty research, strengthening operations, and playing a lead role in energy education and outreach at MIT.

- Robert C. Armstrong, director
- Robert Stoner, deputy director, Science and Technology

- Martha Broad, executive director
- Louis Carranza, associate director
- Emily Dahl, director, Communications
- Antje Danielson, director, Education
- Robert Tolu, manager, Financial Operations

MITEI Energy Council

The Energy Council helps shape MITEI's research, education, and outreach directions. Armstrong, Stoner, and Broad are members of the council, which also includes faculty from all five MIT schools.

Energy Education Task Force

MITEI's Energy Education Task Force (EETF) guides the development of energy education at MIT. Bradford Hager, Cecil and Ida Green Professor of Earth Sciences in the Department of Earth, Atmospheric and Planetary Sciences, serves as chair of the task force. The task force meets regularly throughout the academic year and includes faculty from all five schools at MIT as well as graduate and undergraduate student representatives. MITEI's education team members support the EETF by implementing energy education programs.

MITEI Members

MITEI's members are critical in the energy innovation chain, linking MIT's world-class research teams with innovators in industry and government to address pressing energy challenges and move solutions into the marketplace. Along with delivering valuable industry perspectives on current technology challenges, members offer research opportunities and critical funding for next-generation energy technologies and for analysis of integration of these into existing and future energy systems.

MITEI draws on MIT's research capabilities, innovation, expertise, and experience to create successful industry collaborations to meet its research partners' key strategic objectives. A multitiered membership structure enables diverse private-sector partners to sponsor multidisciplinary flagship research programs with MIT faculty; contribute to energy-focused labs, programs, and centers at MIT; fund critical energy fellowships; support innovative energy concepts from proposals solicited across the campus; and participate in MITEI's seminars, lectures, and colloquia.

Member Highlights

New Low-Carbon Energy Center members in FY2020 include Eneva, Enerjisa Başkent Elektrik Dağıtım A.Ş., Copec, ExxonMobil, Equinor, and Eni. These new center members include companies that are expanding on their current MITEI memberships and others that are joining MITEI as first-time members.

Building on the success of the *Mobility of the Future* study, MITEI launched the Mobility Systems Center as a new Low-Carbon Energy Center. The center's inaugural meeting was held in September 2019.

MITEI hosted its Annual Research Conference focused on driving deep decarbonization across major systems, including power, mobility, buildings, and industry on November 5–7, 2019. On the third day, MITEI held the first combined meeting of the Low-Carbon Energy Centers, which brought together members of the different centers—including the new Mobility Systems Center—for shared plenaries that focused on systems modeling and technoeconomic analysis. The individual centers also held invitation-only sessions for members and guests.

From FY2019 through FY2020, Member Services worked on renewal agreements for three of MITEI's founding members (Eni, ExxonMobil, and Shell), two sustaining members (Total and Chevron), and one Carbon Capture, Utilization, and Storage Low-Carbon Energy Center member (Cenovus Energy). In addition to renewing as founding members, Eni and ExxonMobil renewed their memberships in multiple Low-Carbon Energy Centers and joined the newly created Mobility Systems Center. Fall 2020 will bring several additional renewals with members of the Electric Power Systems Low-Carbon Energy Center, as well as for associate member Ferrovial.

MITEI collaborated with IHS Markit on two webinars as part of the CERAWEEK Agora conversations. These webinars focused on the energy-climate challenge and were titled “Energy Innovation Is a Marathon, Not a Sprint,” and “Making Better Decisions for the Energy Transition.” MITEI has also partnered with MIT's Industrial Liaison Program to create and deliver a webinar series focused on the energy transition, called the Energy Innovation Webinar Series. To date, the series has produced four webinars: “Energy Transitions and Economics”; “Innovations in Critical Low-Carbon Technologies”; “Energy Storage Systems”; and “Scaling up Low-Carbon Energy: Economic, Geopolitical, and Environmental Impacts.”

In response to COVID-19, MITEI has been working in close partnership with MIT PIs and members to manage the impact of initially scaling-down and now ramping-up research for over 200 active sponsored research projects.

A complete list of members is available on the MITEI [website](#).

Affiliated Groups

MITEI is affiliated with faculty members in a number of MIT departments, laboratories, and centers pursuing interdisciplinary energy and environmental activities. MITEI supports the financial administration of certain projects and collaborates on research and education activities with these organizations.

Center for Energy and Environmental Policy Research

Established in 1977, the Center for Energy and Environmental Policy Research (CEEPR) promotes research on energy and environmental policy to support improved decision making by government and industry. It is directed by Professor Christopher Knittel

(Sloan School of Management) and jointly sponsored by MITEL, the Department of Economics, and the MIT Sloan School of Management.

Affiliated faculty and research staff as well as international research associates contribute to empirical research on policy issues related to coal, oil, gas, and electricity markets; nuclear power; transport; energy infrastructure; investment finance and risk management; and environmental and carbon constraints. CEEPR cooperates closely with associates in government and industry from around the globe to enhance the relevance of its research.

CEEPR produces working papers, policy briefs, and research input to larger, interdisciplinary studies; two annual research workshops in Cambridge, Massachusetts; and an international energy policy conference organized jointly with the Energy Policy Research Group at the University of Cambridge in the United Kingdom. CEEPR is also involved in a number of collaborative research projects.

The E2e Project is a joint initiative founded by Professor Christopher Knittel, Professor Michael Greenstone (formerly at MIT, now at the University of Chicago), and Professor Catherine Wolfram of the University of California at Berkeley, to leverage cutting-edge scientific and economic insights on the causes of the persistent energy-efficiency gap. E2e focuses these talents on solving one of the most perplexing energy questions today and communicating those findings to policymakers and the public. E2e's research generates rigorous and accurate evaluations of energy-efficiency technologies and programs using state-of-the-art empirical methodologies.

The Roosevelt Project takes a multidisciplinary approach to examine the transitional challenges associated with progress toward a deeply decarbonized US economy. The project aims to chart a path forward through the transition that minimizes worker and community dislocations and enables at-risk communities to sustain employment levels by taking advantage of the economic opportunities present for regional economic development. The first phase of the project involves an assessment of crosscutting topics related to the transition. The second phase of the project involves developing regional action plans for individual case studies, working with local partners on the ground in specific transition contexts. The project was initiated by former Secretary of Energy Ernest J. Moniz and engages a breadth of MIT and Harvard faculty and researchers across academic domains, including economics, engineering, sociology, urban studies and planning, and political science.

Joint Program on the Science and Policy of Global Change

Led by co-directors Professor Ronald G. Prinn (Earth, Atmospheric and Planetary Sciences) and Senior Lecturer John Reilly (Sloan School of Management), the joint program's integrated team of natural and social scientists produces comprehensive global change projections under different environmental, economic, and policy scenarios. These projections enable decision makers in the public and private sectors to better assess impacts and the associated costs and benefits of potential courses of action.

This mission is accomplished through the following:

- The combination of scientific research with risk and policy analyses to project the impacts of, and evaluate possible responses to, the many interwoven challenges of global socioeconomic, technological, and environmental change
- Communication of research findings through the joint program’s website, publications, workshops, and presentations around the world, as well as frequent interactions with decision makers, media outlets, government and nongovernmental organizations, schools, and communities
- Cultivation and education of the next generation of interdisciplinary researchers with the skills to tackle ongoing and emerging complex global challenges

Building on the twin pillars of science and policy, the joint program was founded in 1991 as a joint effort of two distinct groups: the MIT Center for Global Change Science and the MIT Center for Energy and Environmental Policy Research.

Office of Sustainability

The mission of the Office of Sustainability (MITOS) is to transform MIT into a powerful model that generates new and proven ways of responding to the unprecedented challenges of a changing planet via operational excellence, education, research, and innovation on campus. Established in 2013 under the Executive Vice President and Treasurer’s Office, MITOS works to integrate sustainability across all levels of campus by engaging the collective brainpower of students, staff, faculty, alumni, and partners. MITOS has set out to have an impact across scales, from the individual to the global.

MITEI staff and faculty affiliates collaborate with the Office of Sustainability through such initiatives as the Campus Sustainability Task Force, living lab projects, and the MIT Climate Action Advisory Committee.

Robert Armstrong
Director
MIT Energy Initiative