

MIT Energy Initiative

Overview and Mission

The MIT Energy Initiative (MITEI) is MIT's hub for energy research, education, and outreach. Through these three pillars, MITEI plays an important and catalytic role in accelerating responses to the many challenges facing our global energy system—developing technologies and solutions to deliver clean, affordable, and plentiful sources of energy. The Initiative's mission is to create low- and no-carbon solutions that will efficiently and sustainably meet global energy needs while minimizing environmental impacts, dramatically reducing greenhouse gas emissions, and mitigating climate change.

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 MIT Energy Initiative delivers comprehensive analyses for policymakers and regulators, such as the “Future of” study series, which includes the 2015 *The Future of Solar Energy* report, and the September 2018 report *The Future of Nuclear Energy in a Carbon-Constrained World*, which was produced together with the Department of Nuclear Science and Engineering. A new series of studies by MITEI examines rapidly changing segments of the energy sector. The first in this series was the 2016 [Utility of the Future](#) study and report examining the electricity services sector. The [Mobility of the Future](#) report and study examines the light mobility segment of the transportation sector.

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 for addressing climate change—from solar energy to electric power systems, fusion, 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, the Undergraduate Research Opportunities Program in energy, short modules during the Independent Activities Period, an energy-focused freshman pre-orientation program, the graduate Society of Energy Fellows, and other initiatives. 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 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 on campus and by supporting faculty and staff participation in external events. The MITEI communications team also develops content to highlight MIT energy researchers and students, along with their work, across print and digital platforms such as *Energy Futures* magazine, MITEI's website, other media outreach, and social media platforms.

Accomplishments and Updates

Low-Carbon Energy Centers

MITEI continues to develop the eight Low-Carbon Energy Centers 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 eight centers focuses on a different area, such as: carbon capture, utilization, and storage; electric power systems; energy bioscience; energy storage; materials for energy and extreme environments; advanced nuclear energy systems; fusion and magnets; and solar energy.

To solve the pressing challenges of decarbonizing the energy sector with advanced technologies, it is vital to engage experts across all disciplines and sectors. Through the Low-Carbon Energy Centers, MITEI facilitates this important collaboration, allowing 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. Together, MIT researchers and center members work to develop and scale the technologies that will move us toward a low-carbon energy future.

As of the end of FY2018, MITEI has generated more than \$85 million in sponsored research activity related to the Low-Carbon Energy Centers. To date, 19 new and current MITEI members have committed support for the centers—with some members supporting multiple centers—and interest continues to grow.

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. Solar energy technology and policy is the largest single area of funded research. The portfolio also includes projects geared toward meeting contemporary energy needs through the efficient use of conventional energy sources.

MITEI members have sponsored approximately 900 projects to date, many involving collaboration between MIT researchers and member researchers. Approximately 30% of MIT faculty has engaged with MITEI's programs.

Research Program Highlights

- Funding for early-stage research: Supporting promising energy research across a wide range of disciplines is one of MITEI's core tenets. This spring, MITEI awarded nine early-stage MIT energy research projects with \$150,000 each, for

a total of \$1.35 million. Including the 2018 grants, MITEI has supported 170 energy-focused projects with grants totaling \$22.75 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:** This year, a team of researchers led by TEPCO Professor of Nuclear Science and Engineering Jacopo Buongiorno have finalized the multidisciplinary study *The Future of Nuclear Energy in a Carbon-Constrained World*, the eighth in MITEI's "Future of" report series. The study is being released in Europe on September 3, 2018, with Asia and US rollouts to follow. The *Mobility of the Future* study is steadily progressing as well. This study is exploring how consumers and markets will respond to potentially disruptive technologies, business models, and government policies in the transportation sector.
- **Working papers:** The Institute also released working papers written by MITEI staff, faculty affiliates, and graduate students on subjects ranging from energy storage to the changing structure of the electricity grid.
- **Low-Carbon Energy Centers meetings:** The Centers for Carbon Capture, Utilization, and Storage; Energy Storage; and Electric Power Systems each held several workshops and meetings to discuss with their members the latest research results and new directions of technology development.

Faculty Research Highlights

Materials Science

- *Understanding drop coalescence.* A new study by MIT researchers offers a detailed, mathematical understanding of drop coalescence, which may help researchers understand how biological or chemical substances are spread by rain or other sprays in nature. They could also serve as a guide for droplet-based designs, such as microfluidic chips.
- *A new way to mix oil and water.* A condensation-based method from the Varanasi Research Group could create stable nanoscale emulsions, with applications in pharmaceuticals, cosmetics, processed foods, and other areas.
- *Fabrication of new materials.* MIT researchers Stefanie Jegelka and Elsa Olivetti have demonstrated a novel system using artificial-intelligence techniques to help identify methods of fabricating materials, especially those that look promising in computer simulations.

Energy Storage

- *New approaches to thermal storage.* A chemical composite developed by MIT postdocs Grace Han and Huashan Li and Professor Jeffrey Grossman could be used to store heat and release it on demand.

- *Optimizing carbon nanotube electrodes.* Professor Evelyn Wang and Heena Mutha PhD '17 have developed a nondestructive method of quantifying the detailed characteristics of carbon nanotube samples—a valuable tool for optimizing these materials for use as electrodes in a variety of practical devices.

Nuclear Energy

- *A new era in fusion research at MIT.* With the goal of developing a working fusion power plant within the next 15 years, Italian energy company and MITEI founding member Eni SpA has reached an agreement with MIT to fund fusion research projects run out of the MIT Plasma Science and Fusion Center's newly created Laboratory for Innovation in Fusion Technologies. Eni also announced a commitment to a \$50 million investment in a new private company with roots at MIT, Commonwealth Fusion Systems.
- *Flexible nuclear operation.* An optimization model developed by researchers at MITEI and Argonne National Laboratory shows operating nuclear power plants can reduce electricity costs, increase revenue, and cut CO₂ emissions in electric power systems.
- *From coolants to a carbon-constrained world.* Undergraduate Ka-Yen Yau is helping to improve computational modeling that could significantly speed up the licensing of new types of nuclear reactors.

Solar Energy

- *Technique allows rapid screening for new types of solar cells.* An approach developed by Associate Professor Tonio Buonassisi could bypass the time-consuming steps currently needed to test new photovoltaic materials.
- *Optimizing nanostructures for energy devices.* MIT researcher William Tisdale and colleagues have created quantum dot films that provide unprecedented high performance in solar cells, light-emitting diodes (LEDs), and thermoelectric systems.

Electric Power Systems

- *The future of the electric utility.* Francis O'Sullivan, director of research for MITEI, discussed the future of the electric grid and clean energy technologies.

Transportation

- *Getting the world off dirty diesels.* Using computer simulation analysis, MIT researchers have developed a conceptual design for a half-sized gasoline engine that would be as efficient and powerful as the full-sized diesel engines now used in heavy-duty trucks—without their high emissions of air pollutants and greenhouse gases.

Energy and Climate Economics and Policy

- *Natural resource negotiations for mutual gains.* Bruno Verdini, MIT researcher and professor of urban planning and negotiation, has produced step-by-step guidelines for performing high-stakes resource negotiations that succeed—even after decades of mistrust, confrontation, and deadlock.
- *Charting gas and oil's future in a decarbonizing world.* A new analytical method from the MIT Joint Program on the Science and Policy of Global Change addresses the dynamic nature of the petroleum industry, enabling more accurate predictions for changes in oil production costs.
- *Study: Health benefits will offset cost of China's climate policy.* A study led by professors Noelle Eckley Selin and Valerie Karplus projects that a 4% reduction per year in China's CO₂ emissions should net \$339 billion in health savings in 2030.
- *Carbon taxes could make significant dent in climate change.* An analysis by researchers including former MIT postdoc Justin Caron, MIT Joint Program on the Science and Policy of Global Change Co-Director John Reilly, and National Renewable Energy Laboratory researchers compared carbon-pricing approaches to determine which could be most effective in helping reduce emissions, and which would be most equitable and have bipartisan appeal.
- *Ernest Moniz on the Vatican climate dialogue.* Ernest Moniz, special advisor to the MIT president, professor emeritus, and former US energy secretary, met with Pope Francis and energy and finance leaders to discuss moral and ethical dimensions of the energy transition.

Additional Low-Carbon Energy Research

- *Cooling buildings worldwide.* A fundamental analysis by MIT researchers confirms that proposed new approaches to air conditioning could significantly reduce the energy required to cool and dehumidify indoor spaces—an escalating need as populations grow and the climate warms.
- *Projecting the impacts of climate change.* Researchers at the MIT Joint Program on the Science and Policy of Global Change propose a self-consistent modeling framework to assess climate impacts across multiple regions and sectors.

Energy in the Developing World

- *Making appliances and energy grids more efficient.* The Tata Center for Design and Technology is building a high-efficiency, affordable electric motor that could have a huge impact in India, home to as many as half a billion ceiling fans.
- *Tata Center adds eight new projects to its 2018–2019 portfolio.* MIT principal investigators will receive funding and support for projects seeking an impact in the developing world.

MIT Energy Initiatives Studies

Mobility of the Future Study

The multidisciplinary Mobility of the Future study is exploring how consumers and markets will respond to potentially disruptive technologies, business models, and government policies. The research group, which has been meeting since August 2016, defines 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 is led by faculty chair and professor of chemical engineering William H. Green and executive director Randall Field of MITEI. It is supported by energy, automotive, and infrastructure companies whose representatives are providing industry perspectives on mobility problems that require solutions. Sponsors include Alfa, BP, Chevron, ExxonMobil, Ferrovial, General Motors, Saudi Aramco, Shell, Statoil, and Toyota Mobility Foundation.

The study has undertaken analyses in many important areas of mobility, including projection of the future cost of battery packs for electric vehicles, assessment of fuel consumption and fleet composition under various climate policy scenarios, and impact of assorted mobility services on mode choice for different types of cities. The study team—which includes faculty, researchers, graduate students, and postdoctoral researchers—is in the process of completing, compiling, and analyzing the work of all eight workstreams to develop a final report on the findings in late 2019.

The Future of Nuclear Energy in a Carbon-Constrained World

A team of researchers finalized the multidisciplinary study, *The Future of Nuclear Energy in a Carbon-Constrained World*. The team consists of seven MIT faculty members from across the Institute, two Harvard University faculty members, and four external consultants. The study provides an assessment of the opportunities and challenges affecting the ability of nuclear energy technologies to meet US and global energy needs in the context of the imperative to dramatically reduce carbon emissions and address climate change.

The Future of Energy Storage

A team of researchers began meeting in FY2018 to prepare for developing a comprehensive, multidisciplinary Future of Storage study. The study will consider key storage technologies that could support future electricity systems heavily reliant on variable renewable energy (VRE) resources such as wind and solar photovoltaic generation. The study will focus on practical system transformation pathways and the role of government in market design and regulation, research, and deployment support to advance storage technologies over the next two decades. It will also consider how storage interacts with other strategies—such as increased load flexibility and expanded transmission networks—that might be part of a cost-effective approach to accommodate a VRE-rich generation mix.

Tata Center for Technology and Design

Now in its sixth year, the Tata Center for Technology and Design currently supports 47 master's and PhD students who travel abroad at least twice a year to immerse themselves in the social, political, and economic aspects of their research in the developing world. So far, students have worked extensively throughout India, as well as in Nepal, Kenya, Nigeria, Tanzania, Uganda, Rwanda, Brazil, Colombia, and Venezuela. The students' experiences abroad inform their ongoing research, with the goal of catalyzing positive social impact in the form of policy support and affordable products and services. Through support for these students, and through thoughtfully crafted research projects in the fields of energy, water, the environment, housing, health, and agriculture, the Tata Center advances its mission of bringing technical talent and experience to bear on the challenges of the developing world.

Many Tata students have had noteworthy accomplishments in the past years. Examples include three Lemelson-MIT awards. These were given to Maher Damak for his work on "sticky agricultural sprays" designed to reduce human exposure to air- and water-borne chemicals; Natasha Wright for designing solar-powered desalination systems; and Katy Olesnavage for developing a prosthetic foot. Maher Damak and Karim Khalil together won first prize at the Rice Business Plan Competition for their work in reducing water consumption at power plants. Arun Singh won the 2017 prize for best master's thesis in the Technology and Policy Program, which developed an economic model to inform India's energy and climate policies.

To date, center-funded projects have led to more than 45 patent disclosures to MIT's Technology Licensing Office. Several projects are on the path to commercialization through startups and licensing arrangements, and many others have attracted follow-on funding from government agencies and commercial sponsors. As projects continue to mature, the Tata Center is developing detailed plans to translate these projects into practice in close cooperation with the Tata Trusts and the Foundation for Innovation and Social Entrepreneurship, a nonprofit incubator established in Bangalore by the Tata Trusts with the government of India.

The Tata Center hosted its third annual symposium at MIT in 2017. Distinguished guests from India, seasoned entrepreneurs, members of nongovernmental organizations, as well as vital partners of the Tata Center gathered to discuss the question, "Does the developing world need a new model for entrepreneurship?" Speakers with diverse perspectives on entrepreneurship held panel discussions. The event also featured poster sessions and presentations that introduced guests to the center's newest projects in agriculture, energy, environment, health, housing, and water.

Education

MITEI's role as an educator of future energy innovators 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 toolkit for MIT students to complete a robust, multidisciplinary energy education. These programs allow students to take classes and conduct research in diverse areas, from energy science and social science to technology and engineering. MIT faculty members work with MITEI's

education team to develop this curriculum and to act as mentors and role models for 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 Freshman Pre-Orientation Program at the end of the summer before classes begin. The journey continues in the classroom, where undergraduates can take interdisciplinary courses through the energy studies minor, founded by MITEI in 2009, and participate in the Energy Undergraduate Research Opportunities Program (UROP).

Graduate students and postdocs hosted at MITEI through the member-supported Society of Energy Fellows are an equally important part of the Initiative's energy innovation and education ecosystem. In addition to contributing their own research to MITEI's areas of inquiry and collaborating with researchers on white papers, graduate students spend time mentoring UROP students and contributing to the development of the minor curriculum. MITEI also hosts activities for its fellows, including dinner meetings with sponsors at MITEI's annual research conference and a range of informational gatherings and networking events.

Education Program Highlights:

- **Solar Spring Break:** In March 2018, 12 undergraduate students participated in MITEI's Solar Spring Break program in partnership with the nonprofit GRID Alternatives. Over the course of a week, the students installed solar panels on the home of a low-income family in Los Angeles, California. Participants were able to meet the homeowner and hear firsthand about the impact of their work, as well as to attend various networking and educational events.
- **Energy Studies Minor:** The Energy Studies Minor Oversight Committee continues to work on several changes to the minor. These updates include improving curriculum flexibility across fall and spring offerings, as well as increasing the number of advisors across academic departments to provide a go-to resource for students planning their course schedules.
- **Undergraduate energy research:** MITEI supported 55 student projects through MITEI's Energy UROP during the 2018 academic year, bringing its total number of sponsored projects up to 475, including Tata Center and Center for Energy and Environmental Policy Research projects. This cohort's research spanned a breadth of unique subjects, among them sustainable solutions to the burning of biomass in the developing world, improvements to the comfort conditioning of workspaces, and analysis of how best to commercialize photovoltaic materials for early-stage cleantech startups.
- **Graduate Fellows:** MITEI welcomed 24 new graduate students to the Society of Energy Fellows in AY2018. The Energy Fellows network now totals almost 400 graduate students and postdoctoral fellows, spanning 20 MIT departments and divisions, and all five MIT schools. This year's fellowships are made possible through the generous support of eight MITEI Member companies: Bosch, BP, Chevron, Eni SpA, ExxonMobil, GE, Shell, and Total.

- **Textbooks:** *The Physics of Energy*, a new textbook by Professors Robert Jaffe and Washington Taylor, both of the MIT physics department, is now available for purchase. John Heywood, the Sun Jae Professor Emeritus of Mechanical Engineering at MIT, has also completed a second edition of his seminal book, *Internal Combustion Engine Fundamentals*.
- **Freshman Pre-Orientation Program:** The Summer 2017 energy preorientation program sent 20 freshman 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 visit to the Fraunhofer Center for Sustainable Energy Systems, and a workshop on building DC motors with Steve Leeb, professor of electrical engineering and computer science and associate director of the Research Laboratory of Electronics.
- **Career Insights Speaker Series:** Energy industry professionals from BlueWave Solar, Embr, and Maxim Integrated visited MITEI to share their career journeys with undergraduates and graduate students.
- **Conversations with energy leaders:** Harry Brekelmans, the projects and technology director for Royal Dutch Shell PLC (a MITEI founding member company), met with groups of MIT students and faculty members in September 2017 to discuss their work before taking part in a public discussion about energy issues with MITEI director Robert Armstrong.
- **Annual Research Conference:** At MITEI's December 2017 annual research conference, 15 undergraduate students presented posters of energy-related work in a wide range of disciplines, from electrochemistry to architecture. The students, all MITEI-sponsored UROP participants, had the opportunity to network with energy professionals while showcasing their research.

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, and other digital and print platforms.

Outreach Program Highlights

- **MIT Plan for Action on Climate Change:** In January 2018, an ad hoc Climate Action Plan Review Committee submitted a report assessing MIT's progress on its five-year climate action plan and identifying new opportunities for growth. MITEI continues to support these efforts with the ongoing development of its eight Low-Carbon Energy Centers, which are evolving to become more accessible to new types of member companies.

- Guest speakers: Leading executives in policy, academia, and industry gave talks at MITEI-hosted events. Speakers included: Harry Brekelmans, projects and technology director at Royal Dutch Shell; Becca Jones-Albertus, acting deputy director of the US Department of Energy Solar Energy Technologies Office; Norman Augustine, retired chairman and CEO of Lockheed Martin Corporation; and others.
- 2017 Annual Research Conference: Marking ten years since the inaugural MITEI research conference, the event featured panels offering industry perspectives, faculty research, and undergraduate poster presentations. The conference focused on decarbonization, digitization, and decentralization of the energy sector. Speakers included: Agustín Delgado, chief innovation and sustainability officer of Iberdrola SA; Eric Gebhardt, vice president of systems and innovation at GE Power; Pratima Rangarajan, CEO of Oil and Gas Climate Initiative Climate Investments; and MIT faculty members.
- Women in Clean Energy Symposium: MITEI hosted the 2017 Clean Energy, Education, and Empowerment (C3E) Women in Clean Energy Symposium and Awards, Transforming Our Energy Infrastructure to Enable the Clean Energy Transition,” in collaboration with the US Department of Energy and the Stanford University Precourt Institute for Energy. The conference featured diverse speakers and rich conversations on strategies and technologies to enable the transition to a low-carbon future. It also included award presentations to mid-career women and a lifetime achievement award presentation. 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.
- Together in Climate Action—Northeast North America Policy Summit: In December 2017, MIT hosted a summit on climate policy and action in northeastern North America. The summit brought together policymakers, researchers, and industry and nonprofit leaders from New England, New York, Atlantic Canada, and Québec to explore new opportunities for regional collaboration to address climate change. Michael Bloomberg, the founder of Bloomberg LP and Bloomberg Philanthropies, three-term mayor of New York City, and the United Nations Secretary-General’s Special Envoy for Cities and Climate Change, delivered the summit’s keynote address. MITEI staff provided programming and event logistics support.
- Caribbean Reconstruction Conference: At a two-day conference at MIT in December, leaders from the Caribbean Islands brainstormed with researchers from MIT and elsewhere to develop strategies for not just rebuilding the islands’ extensively damaged infrastructure, but also improving its resiliency in the face of the ever-growing threat of powerful hurricanes. The conference was co-hosted by the MIT Energy Initiative and the MIT Environmental Solutions Initiative.
- Support for campus energy events: MITEI sponsored and provided staff support for numerous campus energy events, including the student-run MIT Energy Conference, the Undergraduate Energy Research Fair, the Energy Career Fair, and the Energy Hackathon.

Organization

Leadership Team

Robert Armstrong's leadership team continues to build on MITEI's strong foundation and multidisciplinary approach to deliver global energy solutions. In addition, the team is broadening MITEI's membership base, seeking out potential new 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. The leadership team includes:

Robert Armstrong, director

Robert Stoner, deputy director for technology and science;
director, Tata Center for Technology and Design

Martha Broad, executive director

Louis Carranza, associate director

Emily Dahl, director, communications

Antje Danielson, director, education

Francis O'Sullivan, director, research and analysis

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 professors Angela Belcher (Biological Engineering and Materials Science and Engineering), John Deutch (Chemistry), Leon Glicksman (Architecture and Mechanical Engineering), Bradford Hager (Earth, Atmospheric, and Planetary Sciences [EAPS]), Christopher Knittel (MIT Sloan School of Management), and Yang Shao-Horn (Mechanical Engineering).

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, and Rajeev Ram, professor of electrical engineering and computer science in the Research Laboratory of Electronics, serve as the task force's co-chairs. 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.

Members

MITEI's members are critical in the energy innovation chain, linking MIT's 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, members offer research opportunities and critical funding for next-generation energy technologists.

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

MITEI's Low-Carbon Energy Centers offer a "commons" approach, multiplying benefits for participating members. With the opportunity to pool resources and increase the overall understanding of research and analysis for their organizations, members benefit individually and contribute to the collaborative effort.

Member Highlights

This year, MITEI's members helped facilitate huge strides in nuclear fusion, undergraduate energy education, and the global energy transition.

- New Low-Carbon Energy Center members in FY2018 include: Chevron, Citizens Utility Board, Duke Energy, Engie, Environmental Defense Fund, IHI Corporation, Magnolia Quality Development Corporation Limited, and National Grid. These new Center members include companies that are expanding on their current MITEI memberships and others that are joining MITEI as first-time members.
- MITEI helped facilitate a new, first-of-its kind collaboration to move the carbon-free promise of fusion power closer to reality. As announced in March 2018, Italian energy company Eni SpA, a founding member of MITEI, has committed to funding a new private company founded and run by former MIT staff and students—Commonwealth Fusion Systems (CFS). CFS will use some of the funding to support MIT fusion research efforts. Eni is also supporting fusion research projects through the MIT Plasma Science and Fusion Center's newly created Laboratory for Innovation in Fusion Technologies. The goal of this collaboration is to advance research that could enable fusion energy to reach commercialization within the next 15 years.
- MITEI has developed a new membership category specifically designated for energy startups. The aim is to accelerate the commercialization of new low-carbon technologies by both forging connections between these entrepreneurial companies and more established energy companies, and providing these startups access to talent and facilities at MIT. Commonwealth Fusion Systems is the first startup member.
- An agreement between Saudi Aramco and MITEI, signed at the MIT-hosted "Innovation to Impact" forum in March, establishes a new, five-year collaboration to develop breakthrough solutions for global energy and climate challenges. The funds will support wide-ranging areas of research, including sustainable and renewable energy; carbon capture, utilization, and storage; environmental sciences; energy storage; water conservation and reuse; advanced materials; and computational modeling, artificial intelligence, robotics, and nanotechnologies.

- In partnership with the MIT International Science and Technology Initiatives, eight MIT undergraduates interned abroad in summer 2017 with MITEI member companies: six at Shell in India, one at Shell in Germany, and one at Iberdrola in Spain. During their internships, students were given opportunities to work on a wide range of energy projects, from analyzing fuel additives to evaluating how new technologies might transform energy markets.

Affiliated Groups

MITEI is affiliated with faculty members in a number of MIT centers, departments, and laboratories 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 (MIT Sloan) and jointly sponsored by MITEI, 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 into larger, interdisciplinary studies; two annual research workshops in Cambridge, MA; and a European energy policy conference organized jointly with the Energy Policy Research Group at the University of Cambridge in the UK.

The E2e project is a collaborative project initiated by Knittel, former MIT professor Michael Greenstone (now at the University of Chicago), and Professor Catherine Wolfram of the University of California, Berkeley, to leverage cutting-edge scientific and economic insights on the causes of the persistent energy efficiency gap. E2e focuses on solving some of the most perplexing energy questions today, and on communicating those findings to policymakers and the public. E2e's research generates rigorous evaluations of energy-efficiency technologies and programs using state-of-the-art, empirical methodologies.

Joint Program on the Science and Policy of Global Change

Led by co-directors Ronald Prinn (EAPS) and John Reilly (MIT Sloan), the Joint Program's integrated team of natural and social scientists studies the interactions among human and Earth systems to provide a solid foundation of scientific knowledge to aid decision-makers in confronting interwoven challenges such as future food, energy, water, climate, and air pollution.

This mission is accomplished through the following tools:

- Quantitative analyses of global changes and their social and environmental implications, achieved by employing and improving an Integrated Global System Modeling framework
- Independent assessments of potential responses to global risks through mitigation and adaptation measures
- Outreach efforts to analysis groups, policymaking communities, and the public
- Cultivation of a new generation of researchers with the skills to tackle complex global challenges in the future

Building on the twin pillars of science and policy, the 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.

MultiScale Materials Science for Energy and Environment Laboratory

MITEI continues to host the MultiScale Materials Science for Energy and Environment Laboratory, an international joint unit (Unités Mixtes Internationales [UMI]) between France’s National Center for Scientific Research (CNRS) and MIT, at the center of a strategic association covering research, training, and education in partnership with industry. The UMI aims at “bottom up” simulation and experimental verification of properties of complex multiscale materials—from atomic scale to microns, and from nanoseconds to years. Materials with important technological, economic, energy, and environmental applications are addressed, including cement, ceramics, nuclear fuels, steels, and geo-materials. The UMI hosts French researchers at MIT, each for multiple years, and is seen as a gateway to further collaboration between CNRS and MIT. The UMI, which is housed at MIT under the auspices of MITEI, has been designated by the CNRS as the lead unit of an international research network consisting of multiple institutions engaged in materials science in the US as well as in Europe.

Office of Sustainability

The mission of the MIT 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 MITOS through initiatives such as the Campus Sustainability Task Force, living lab projects, and the MIT Climate Action Advisory Committee.

Robert Armstrong
Director