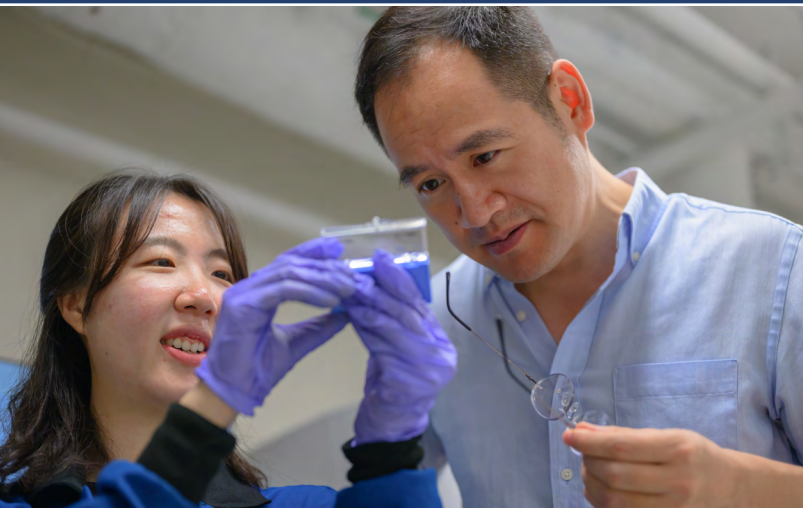


MIT ENERGY INITIATIVE External Advisory Board Briefing Book

October 2025



MIT*ei*
MIT Energy Initiative

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Please note that this report includes hyperlinks to more information and articles in blue, underlined text. To access the links in this document, visit the External Advisory Board Briefing Book at: energy.mit.edu/eab/2025

Letter from the Director

Dear External Advisory Board Members,

As I complete my first 18 months as MITEI's director, I am excited to report that MITEI is on solid footing, with a renewed sense of mission, healthy membership numbers, increased campus engagement, and strong support from MIT's administration.



The past year has seen important changes in the landscape for climate and energy research at MIT. As I wrote to you in April, Professor Evelyn Wang returned to campus from directing ARPA-E and became the inaugural vice president for energy and climate, assuming leadership of the Climate Project. MITEI's work is complementary to the Climate Project's; we have some faculty researchers in common and are delighted to coordinate on campus events and initiatives. In another development, GE Vernova partnered with MIT to launch an alliance that has brought more energy research funding to campus, a new member to MITEI, and GE Vernova's Roger Martella (welcome Roger!) to the External Advisory Board.

Shifting priorities for federal energy funding have posed some challenges for MIT researchers this year, but MITEI's industry-sponsored model has proved resilient. MITEI is more important than ever as a sponsor of energy transition research on campus. To ensure that MIT can continue to train the next generation of energy innovators and leaders, MITEI is placing special emphasis on raising member and donor funds to support graduate students.

With the MITEI leadership team now fully staffed, MITEI has turned its attention to launching several new initiatives. The Data Center Power Forum offers our members access to the combined expertise of MITEI and the Center for Energy and Environmental Policy Research (CEEPR) on topics such as data center energy supply and storage, grid management, infrastructure, and policy. In early 2026 MITEI will launch a two-year study on sustainable fuels with myself as the study director, MITEI's Director of Research Randall Field as executive director, and experts from across MIT as contributors. The Future Energy Systems Center is starting a focused effort on long-duration energy storage, forging a new research model that will be adaptable to other high-priority energy topics. I can also report progress

on last year's EAB discussion of a harmonization project for techno-economic analysis and life cycle assessment of energy solutions. MITEI has now convened an international group of experts that will start a more intense phase of work in the coming months.

MITEI continues to have an outsized impact at MIT and beyond. In April, MITEI partnered with MIT Sloan School's Climate Policy Center and the MIT Washington Office to co-host the multi-day Senior Congressional Staff Seminar, which was attended by a bipartisan group of 27 staffers. During the last academic year, the MITEI Presents: Advancing the Energy Transition seminar series hosted such luminaries as the leader of the U.S. Energy Information Administration and the presidents and CEOs of the Natural Resources Defense Council and of The Engine, MIT's nonprofit incubator and tough-tech accelerator. MITEI's 2025 Spring Symposium, "AI and energy: Peril and promise," explored how AI is accelerating the energy transition while also dramatically increasing energy demand. MITEI reaches the world through our online open learning courses, with enrollment nearing 27,000 in FY25. And MITEI's newly-launched energy transition podcast, *What if it works?*, attained more than 1,000 subscribers in its first year.

Although MITEI and some components of the broader MIT energy ecosystem have thrived over the past 18 months, uncertainty remains about broader and longer-term support for innovation that supports the energy transition. We value your advice as MITEI seeks to sustain its momentum and increase its impact.

Sincerely,

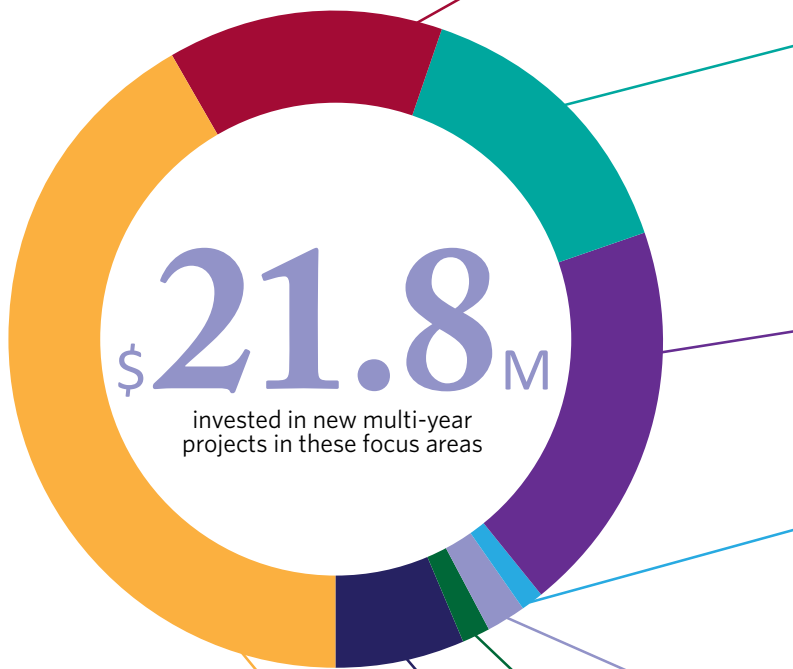
A handwritten signature in blue ink, appearing to read "William H. Green".

William H. Green
Director, MIT Energy Initiative
Hoyt C. Hottel Professor of Chemical Engineering

MITEI by the Numbers, FY25

Research

How MITEI invested in energy-transition research across MIT in FY25



38
MITEI members

69
Research projects launched*

*Includes 3 projects awarded through the MITEI Seed Fund in previous years and launched in FY25, 11 projects that were awarded and launched through the MITEI Seed Fund in FY25, and 20 projects through the Future Energy Systems Center.

Energy storage **\$2.93M**

Developing and evaluating technologies that can store excess energy and save it for use when it is needed, enabling systems that rely on intermittent energy generation and improving resilience against weather and cybersecurity events and physical threats.

Low-carbon fuels **\$3.17M**

Analyzing the techno-economics and lifecycle emissions of fuels derived from non-fossil sources that can have lower greenhouse gas emissions, including pathways to produce hydrogen, biofuels, methanol, and ammonia. Analyzing use-case scenarios for trucks, ships, and airplanes, and the role of low-carbon fuels in supporting grid reliability.

Carbon management **\$4.23M**

Examining new technologies and scenarios for preventing greenhouse gases from being emitted into the atmosphere and for removing CO₂ from the air and oceans.

Buildings & infrastructure **\$275K**

Developing decision-making tools to support energy-efficient building retrofits and examining how to scale up heat electrification using low- and no-carbon technologies for new and existing building stock.

Industry **\$408K**

Decarbonizing industrial processes with electrified thermal and electrochemical processes, combined with novel feedstocks and catalysts.

Transportation **\$275K**

Working to replace ground, marine, and air transportation fossil fuel-dependence with electrification and/or low-carbon fuels.

Policy & economics **\$1.39M**

Evaluating the impacts of policies related to the intersection of energy and climate, including clean technology adoption and impacts on consumers, and use modeling to determine the most effective emissions reduction strategies to get to net-zero.

Electric power **\$9.16M**

Covering generation, transmission, distribution, demand, and regulation. Improving the performance of renewable technologies and characterizing their integration into the grid.

Education

How MITEI educated future energy leaders in FY25

85 projects funded through the Undergraduate Research Opportunities Program

14 new members of the Society of Energy Scholars (formerly the Society of Energy Fellows)

3 IAP courses in January 2025, including "Information and Entropy: Energy and Exergy," "AI for Energy Solutions," and "Computational Modeling for Clean, Reliable, and Affordable Electricity"

6 undergraduate and graduate students traveled on a MITEI field trip to Denmark to explore renewable energy startups and visit the Danish Tech University in Copenhagen

26,731 learners took MITEI open online courses

4 undergraduate students completed the Energy Studies Minor

Outreach

How MITEI convened leaders in energy in FY25

86 speakers MITEI brought to campus

270 attendees at 2024 Annual Research Conference

25 news articles MITEI published about energy-related research, education, and outreach

10 seminars hosted

31 webinars presented

18 episodes released of the new MITEI-produced podcast, *What if it works?*

Overview and Mission

The MIT Energy Initiative (MITEI), MIT's hub for energy research, education, and outreach is advancing zero- and low-carbon solutions to expand energy access and combat climate change. MITEI is a crucial rallying point for MIT researchers and educators who share our vision and commitment to dramatically reduce emissions through the development of novel technologies and delivery of science-based analysis. Together we are dedicated to decarbonizing global energy systems and building upon MIT's long tradition of working collaboratively and transparently with industry, government, and civil society.

With a significant change in leadership—the naming of a new director, new deputy director, and eight of the 11 leadership team members being new to MITEI or new in their current roles within the last three years—MITEI identified five new priorities in FY25:

1. Engage more broadly with campus
2. Encourage and help MITEI's sponsors to fund more energy research with MIT faculty
3. Make a plan to revitalize energy education at MIT
4. Address the challenge of data centers' energy demand
5. Organize the engineering community to do better assessments of new energy technologies

This report provides more detail about progress on each of these priorities.

William H. Green, the Hoyt C. Hottel Professor at MIT, was named as MITEI's fourth director in April 2024, making FY25 his first full year in that role. Carolyn Ruppel (SB, SM '86, PhD '92), who had a long research career in energy and climate, most recently at the U.S. Geological Survey (USGS), joined MITEI as deputy director of science and technology in March 2025. For a full list of team members, please see the **Governance section**.

FY25 Highlights





A modeling study by an MIT team has shown that electrifying residential heating can be a substantial step toward reducing carbon emissions as well as costs over the combined electricity and natural gas sectors.

Photo: Gretchen Ertl

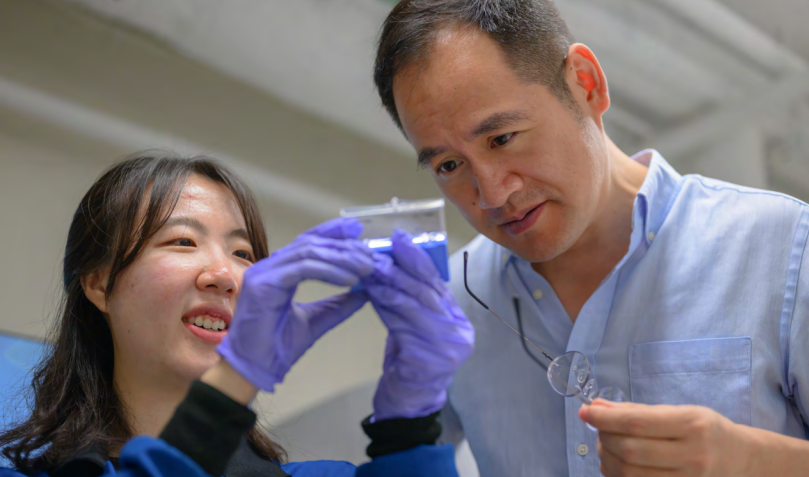


At the 2025 MIT Energy Initiative Spring Symposium, Evelyn Wang, the MIT vice president for energy and climate, joined MITEI Director William H. Green to discuss how collaborations across campus can help solve the data center challenge. *Photo: Jake Belcher*

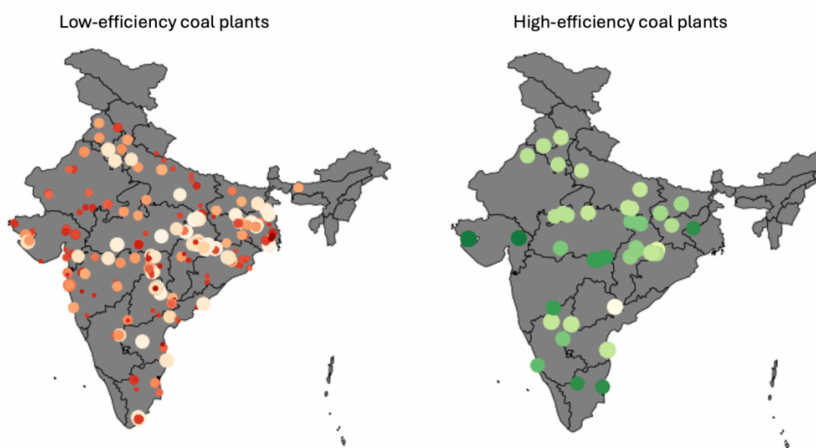
Research & Analysis

In July 2024, Randall Field was named director of research to guide MITEI's energy systems research and strengthen collaboration with other MIT research teams. Field is the former director of MITEI's research consortium, the [Future Energy Systems Center](#), and was one of the first employees of MITEI at its inception in 2006. Three of MITEI's FY25 priorities are directly related to our research efforts—encouraging MITEI sponsors to fund more research, addressing the data centers energy problem, and improving assessments for new energy technologies. MITEI's research portfolio reflects our primary objective of decarbonizing the global economy with low-carbon technologies and through integrated energy systems supported by effective policy. Our work is guided by the use of advanced system modeling and analysis techniques to assess the feasibility of decarbonization technologies and pathways, against the backdrop of the energy system as a whole, from an economic and technical standpoint. MITEI also assesses the total lifecycle emissions of these technologies.

With both member and philanthropic funding, MITEI launched 69 research projects in FY25 totaling about \$22 million. The focus area that garnered the most new research support this year was electric power, with funding of \$9.16 million. The balance of FY25's research funding was allocated to support a range of other energy topics, including carbon management, low-carbon fuels, and energy storage. With support from its members, as well as numerous foundations, donors, various state and federal government entities, and university partners, MITEI has supported 1,078 projects from its inception through FY25. A list of [active FY25 projects](#) and [journal articles published in FY25](#) can be found on the MITEI website.



MIT engineers have demonstrated that adding nanoparticles of certain ceramics to the metals inside fusion reactors can protect them from damage and significantly extend their lifetime. Above: Professor Ju Li (right) and postdoc So Yeon Kim examine samples of the composite they have fabricated for their demonstrations. Photo: Gretchen Ertl



India has pledged to reduce its carbon emissions, a difficult task as the country's electric power system relies on many coal-burning power plants. MITEI researchers studied the efficiency of each of India's 106 coal plants and explored decarbonization options. They have published their methods and results to be used by other countries in the midst of similar energy transitions.

Priority update: Encourage and help MITEI's members to fund more energy research with MIT faculty

In FY25, MITEI raised more than \$30 million in multi-year commitments from new and renewing members. This funding supports MIT researchers in advancing MITEI's mission of accelerating the energy transition, and also sponsors research by undergraduate and graduate students and postdocs. Our Member Relations team actively seeks to grow research funding by bringing in new members, and by working closely with existing members to conceive, execute, and grow new research projects.

MITEI has a regular process of engagement with its corporate members. Through facilitated meetings with faculty, scheduled events covering many technologies, and customized workshops involving teams of principal investigators (PIs), MITEI discovers topics of interest to its members and identifies opportunities for substantive faculty research collaborations. Research takes the form of both sponsored research projects by individual companies and jointly sponsored research activities in areas of common interest among members. Leveraging MITEI's existing administrative infrastructure, we are able to quickly initiate new research projects with faculty where we find a match between capabilities and member interest. Where we identify new strategic areas of focus, we are building the collaborative foundation for future work in critical areas such as data center power, low-carbon fuels, and long-duration energy storage.

Priority update: Address the data center problem

In 2023, data centers consumed about 4.4% of the total electricity supply in the United States. With the meteoric expansion of the use of artificial intelligence and burgeoning number of data centers being built, the demand for energy is projected to far exceed the power supply. The growing energy demand from data centers was one challenge MITEL recognized when we identified the theme for our 2024 Annual Research Conference as, “[A durable energy transition](#): How to stay on track in the face of increasing demand and unpredictable obstacles.” A panel discussion with key stakeholders examined this topic more deeply at the fall conference. The 2025 Spring Symposium, “[AI and energy: Peril and promise](#),” continued that exploration by looking at the key challenges and opportunities at the nexus of AI and energy. For broader audiences and to help inform the public on this urgent issue, we also published an [article](#) highlighting the data center/energy challenge and a [brief video](#) featuring MITEL Director William H. Green explaining the issues we currently face.

MITEL began exploring the launch of a members’ interest group focused on the urgent energy needs arising from the rapidly growing demand for electricity for data centers. The Data Center Power Forum, launched in early FY26, will leverage MITEL’s established expertise and leadership in convening multiple energy sectors to consider a timely and complex issue facing many companies.

Priority update: Organize better assessments of new energy technologies

In collaboration with the MIT Climate Project, MITEL is committed to creating clear guidance and standards to assess the climate benefits and projected costs of new energy technology. This is critical to empowering research funders and investors to make clear, data-backed decisions on which new technologies merit support. We have recruited several renowned researchers in techno-economic and emissions assessment to serve on a steering committee. The first meeting was held in early June 2025. Under the leadership of MITEL Director William H. Green, and Elsa Olivetti, the Jerry McAfee Professor in Engineering, the goal of the Consistent Lifecycle and Economic Assessment Recommendations (CLEAR) effort is to develop state-of-the-art assessment approaches that can produce reliable, robust results grounded in trusted principles and data.

Funding for early-stage research

In FY25, [seven early-stage research projects](#) submitted during the annual MITEL Seed Fund call were funded for a total of more than \$1.2 million. Over the last four cycles, just over 30% of the projects receiving MITEL seed funding have been related to batteries or storage, demonstrating the importance of innovation in energy storage if renewable energy is to reach its full potential in helping to decarbonize the energy system. Through FY25, MITEL has supported more than 226 energy-focused seed projects with grants totaling \$29.8 million.

The Future Energy Systems Center

In August 2024, Morgan Andreae (PhD '06) was named executive director of MITEL's [Future Energy Systems Center](#), MITEL's member-funded research consortium and a vital component of MITEL's research program. The Center funded 20 new projects this year, with topics ranging from the hurdles facing small modular nuclear reactors in industrial settings to the interplay between hydrogen production and renewable fuel synthesis. The Center's research portfolio aims to foster and inform interdisciplinary energy research across MIT, accelerating progress toward a net-zero carbon future. Using techno-economic and lifecycle analysis to examine energy pathways in different sectors, the Center enables its corporate members to explore and develop strategic energy plans, taking into consideration technology, economics, and policy.

- **Future Energy Systems Center projects:** The 20 new Future Energy Systems Center projects funded in FY25 bring the number of system modeling and analysis projects being carried out within the Center to 53. MITEL kicked off meetings for the 10 newest projects at the Center's September 2025 Workshop. Our next call for project proposals was sent to MIT's 1,300 PIs in July 2025, and a new cohort of projects will be selected in the fall.
- **Future Energy Systems Center meetings and workshops:** In May, the Future Energy Systems Center held its spring workshop to address timely energy topics of interest to our members. Topics included deep geothermal, an improved business case for new fission power plants, and how policy reversals shape the U.S. and international energy landscape. The Center also held its advisory committee meeting and hosted student presentations and a poster session.
- **Future Energy Systems Center webinars:** The Center hosted 17 webinars in FY25, as well as four lightning talk sessions. The webinar series is a platform for MIT faculty from across departments to share insights on emerging technologies, policy developments, and sustainability challenges by highlighting the latest updates from their Center-supported projects.

There are 36 Future Energy Systems Center members. The member companies span four continents and are involved in many industries, including energy, utilities, automotive, semiconductors, mining/metals, chemicals, telecommunications, infrastructure, insurance, and engineering/construction. We are in discussions with a number of prospective members.



Studies and reports

[*The role of fusion energy in a decarbonized electricity system*](#), published in September 2024, showed that [*fusion energy could be a major contributor*](#) in future electric power systems and identified what is required to achieve that potential. The report was based on a one-and-a-half-year study examining the factors likely to shape the deployment and utilization of fusion energy. This study applied a multi-disciplinary approach using techno-economic analysis and modeling to investigate the factors, such as cost and climate policy, that will impact the deployment of fusion power plants. Several key findings emerged from this study:

- Fusion has potential societal value in the trillions of dollars in a decarbonized world.
- The scale of fusion deployment in the electricity system will depend on fusion power plant costs.
- The scale and timing of fusion deployment in different regions of the world will be driven by economic growth, population density, electrification needs, regional costs, decarbonization targets, relative prices of electricity, limitations of fission-based nuclear generation, and resource availability for other low-carbon technologies (wind, solar, and biomass).
- The scale of fusion deployment in the electricity system will highly depend on the availability and cost of other low-carbon technologies and on how tightly carbon emissions are constrained in the future.
- Key cost drivers for fusion power plants include reactor equipment cost, regulatory considerations, and operations and maintenance costs.

MIT researcher highlights

- [*The changing geography of “energy poverty”*](#)
This study of the United States shows homes in the South and Southwest could use more aid for energy costs due to a growing need for air conditioning in a warming climate. This work was supported by MITEI’s Future Energy Systems Center.
- [*Decarbonizing steel is as tough as steel*](#)
A new study shows how advanced steelmaking technologies could substantially reduce carbon emissions. This study was supported by MIT Center for Sustainability Science and Strategy and ExxonMobil through the MIT Energy Initiative.
- [*The multifaceted challenge of powering AI*](#)
Providing electricity to power-hungry data centers is stressing grids, raising prices for consumers, and slowing the transition to clean energy. MITEI’s research scientists are collaborating with faculty members to explore multiple facets of this problem—from sourcing power to grid improvement to analytical tools that increase efficiency, and more.
- [*MIT engineers make converting CO₂ into useful products more practical*](#)
A new electrode design boosts the efficiency of electrochemical reactions that turn carbon dioxide into ethylene and other products. The work was supported by Shell through the MIT Energy Initiative.



MIT PhD candidate Shaylin A. Cetegen (left) and her colleagues, Professor Emeritus Truls Gundersen of the Norwegian University of Science and Technology and Professor Emeritus Paul I. Barton of MIT, have developed a comprehensive [assessment](#) of the potential role of liquid air energy storage for large-scale, long-duration storage on electric power grids of the future.

Photo: Gretchen Ertl

- [New filter captures and recycles aluminum from manufacturing waste](#)
MIT engineers designed a nanofiltration process that could make aluminum production more efficient while reducing hazardous waste. This work was supported in part by MITEI's Energy UROP fund.
- [Rooftop panels, EV chargers, and smart thermostats could chip in to boost power grid resilience](#)
MIT engineers propose a new "local electricity market" to tap into the power potential of homeowners' grid-edge devices. This work was supported in part by the MIT Energy Initiative.
- [Will neutrons compromise the operation of superconducting magnets in a fusion plant?](#)
New experiments show that the immediate effect of atomic displacements, known as the "beam on effect," should not be an issue during fusion power plant operations. This research was supported by Eni S.p.A. through the MIT Energy Initiative.
- [How to solve a bottleneck for CO₂ capture and conversion](#)
Today's carbon capture systems suffer a trade-off between efficient capture and release, but a new approach developed at MIT using nanoscale filtering membranes can boost overall efficiency. The research was supported in part by Shell International Exploration and Production Inc. through the MIT Energy Initiative.
- [More durable metals for fusion power reactors](#)
MIT researchers have found a way to make structural materials last longer under the harsh conditions inside a fusion reactor. This research was supported by Eni S.p.A. through the MIT Energy Initiative.
- [Reality check on technologies to remove carbon dioxide from the air](#)
This MITEI study finds many climate-stabilization plans are based on questionable assumptions about the future cost and deployment of "direct air capture" and therefore may not bring about promised reductions.

- [Study helps pinpoint areas where microplastics will accumulate](#)
New research shows that one key factor in determining where microparticles are likely to build up has to do with the presence of biofilms. Biofilms deposited by living organisms reduce the accumulation of small particles, while areas of bare sand can be microplastics hotspots. The work was supported by Shell International Exploration and Production Inc. through the MIT Energy Initiative.
- [New climate chemistry model finds “non-negligible” impacts of potential hydrogen fuel leakage](#)
An MIT study confirms the climate impacts of hydrogen and recommends that leak prevention be a priority as infrastructure for handling this clean-burning fuel is built. This work was funded by the MIT Energy Initiative.
- [Reducing carbon emissions from residential heating: A pathway forward](#)
A new MIT study identifies steps that can lower not only emissions, but also costs, across the combined electric power and natural gas industries that currently supply heating fuels. This work was supported by MITEL’s Future Energy Systems Center.
- [Using liquid air for grid-scale energy storage](#)
New research finds liquid air energy storage could be the lowest-cost option for ensuring a continuous power supply on a future grid dominated by carbon-free, but intermittent, sources of electricity. This work was supported in part by MITEL’s Future Energy Systems Center.
- [How can India decarbonize its coal-dependent electric power system?](#)
MITEL researchers have explored and clarified India’s decarbonization options and have posted their methods and results for use by other countries in the midst of similar energy transitions. The analysis identifies some promising options but also raises unexpected concerns. This work received funding from IHI Corp. through the MIT Energy Initiative.

Reports and Studies

A selection of MITEL-supported reports and studies published in FY25.

Alec Agee, et al. “Mixed conducting polymers alter electron transfer thermodynamics to boost current generation from electroactive microbes.” *Journal of the American Chemical Society*. July 2024.

bit.ly/3JGHnAF

Electroactive microbes that can release or take up electrons are essential components of nearly every ecological niche and are powerful tools for the development of alternative energy technologies. This paper reports that electrode modification with ion- and electron-conductive polymers yields biosimilar, concerted two-electron transfer from *Shewanella oneidensis* via flavin mediators. These important findings pave the way for a complete understanding of the ecological role of electroactive microbes and their broad application in sustainable technologies.

Grace I. Anderson, et al. "Imidazolium-based ionic liquids support biosimilar flavin electron transfer." *Materials Advances*. September 2024.

bit.ly/47cC85B

Understanding electron transport with electroactive microbes is key to engineering effective and scalable bio-electrochemical technologies. This work demonstrates the power of ionic liquids to enable the mechanistic study of biological electron transfer, providing critical guidelines for improving electrochemical technologies based on these biological properties.

Kārlis Baltputnis, et al. "Independent aggregation in the Nordic day-ahead market: What is the welfare impact of socializing supplier compensation payments?" *Heliyon*. January 2025.

bit.ly/3UMUdQo

This paper addresses the participation of independent aggregators for demand response (DR) in European electricity markets. This paper argues that the socialization of the supplier compensation should be at least conditional upon the level of the hourly wholesale price (i.e., a "threshold price") and on DR cost estimates.

Nicholas S. Caros, et al. "The need for an interdisciplinary approach to remote work and urban policy." *Nature Cities*. August 2024.

bit.ly/4n4Kfpv

The unexpectedly rapid rise of remote work in recent years has presented a major challenge for cities across the globe. This paper proposes a new conceptual approach to remote work research that promotes deeper collaboration across disciplines to inform robust and comprehensive remote work policy.

Xin Chen, et al. "Carbon-aware Optimal Power Flow." *IEEE Transactions on Power Systems*. December 2024.

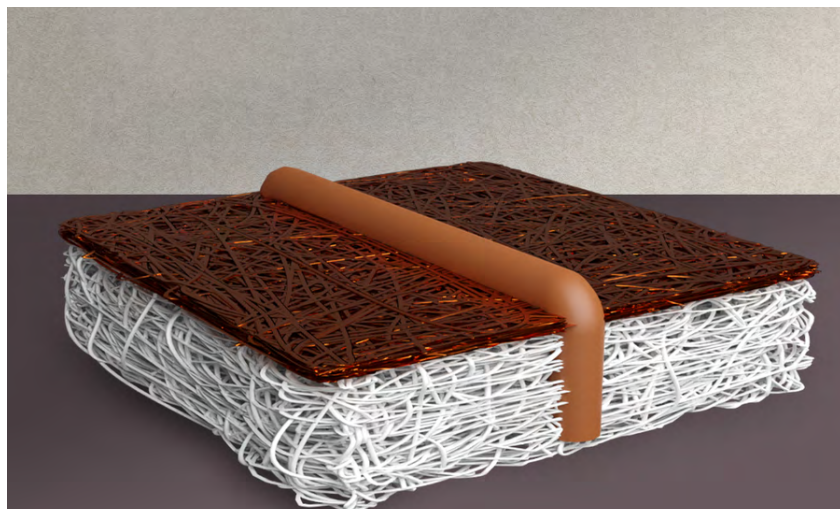
bit.ly/42RpoOD

To facilitate effective decarbonization of the electric energy sector, this paper introduces a generic Carbon-aware Optimal Power Flow (C-OPF) methodology for power system decision-making that considers the active management of the grid's carbon footprints. This paper rigorously establishes the conditions that guarantee the feasibility and solution uniqueness of the carbon emission flow equations, and it proposes a reformulation technique to address the critical issue of undetermined power flow directions in the C-OPF model.

Xinjiang Chen, et al. "A planning model for flexibility retrofitting of coal-fired power plants." *2024 3rd International Conference on Power Systems and Electrical Technology (PSET)*. August 2024.

bit.ly/47cT4Ja

This paper develops an optimal planning technology for retrofitting coal plants for flexibility. The proposed technology employs a capacity expansion and dispatch model that informs a plan for retrofitting coal-fired power plants for flexibility and a configuration scheme for battery energy storage.



New [research](#) by engineers at MIT could lead to rapid improvements in a variety of electrochemical systems that are under development to convert carbon dioxide into a valuable commodity. The team developed a new design for the electrodes used in these systems, which increases the efficiency of the conversion process. As shown in the conceptual schematic (left) of the woven electrode design, researchers wove a series of conductive copper wires (the brown-orange pipe) through a very thin membrane to reach the catalyst.

Image: Courtesy of the researchers, edited by MIT News

Candice Chen, et al. "On the chemistry of the global warming potential of hydrogen." *Frontiers in Energy Research*. October 2024.

bit.ly/3VjFL2j

Hydrogen is considered a promising fuel to contribute to net-zero carbon emission goals. While hydrogen itself is not a greenhouse gas, leakage of hydrogen fuels causes indirect warming due to hydrogen's influence on methane, tropospheric ozone, and stratospheric water vapor, with the methane term dominating the impact. This paper finds that relative to an equivalent mass of emission of fossil CH_4 , hydrogen emission has a climate impact about three times smaller. These global warming potentials underscore that hydrogen leakage does contribute to climate change, emphasizing the importance of limiting both hydrogen and methane leakage if global net-zero greenhouse gas emissions are to be achieved by 2050.

Weiyin Chen, et al. "Hybrid solvating electrolytes for practical sodium-metal batteries." *Joule*. March 2025.

bit.ly/41SeE24

Sodium-metal batteries could be competitive against lithium-metal batteries, but their applications depend on the stability of electrolytes against sodium-metal anodes and cathodes simultaneously. This paper proposes hybrid solvating electrolytes, composed of both strongly and weakly solvating solvents of sodium salts, to tune the solubility, solvation structure, and electrochemical decomposition properties.

Anna Cybulska, et al. "Challenges of decarbonizing aviation via hydrogen propulsion: Technology performance targets and energy system trade-offs." *ACS Sustainable Chemistry & Engineering*. September 2024.

bit.ly/4p3asXp

The aviation sector is challenging to decarbonize since aircraft require high power and energy per unit of weight. Liquid hydrogen is an interesting solution due to its high gravimetric energy density, minimal end-use emissions impact, and low-carbon production potential. This paper quantifies the performance targets for fuel-cell systems and onboard storage to enable hydrogen-powered regional aviation. This article explores the energy infrastructure impacts of meeting this additional hydrogen demand in the European context under deep decarbonization scenarios.

Glen Andrew D. de Vera, et al. "Mitigating matrix effects in oil and gas wastewater analysis: LC-MS/MS method for ethanolamines." *Environmental Science Processes & Impacts*. February 2025.

bit.ly/4oZARW6

The high salinity and organic content in oil and gas wastewaters can cause ion suppression during liquid chromatography mass spectrometry (LC/MS) analysis, diminishing the sensitivity and accuracy of measurements in available methods. This work develops an analytical method that enables further investigation of the fate of low molecular weight organic additives in oil and gas development and provides an enhanced ability to evaluate risks associated with chemical release to the environment.

Pablo A. Dean, et al. "Tertiary-amine-functional poly(arylene ether)s for acid-gas separations." *JACS Au*. October 2024.

bit.ly/4IJOTlj

Competitive sorption enables the emergent phenomenon of enhanced CO₂-based selectivities for gas separation membranes when using microporous polymers with primary amines. However, strong secondary forces in these polymers through hydrogen bonding results in low solvent solubility, precluding standard solution processing approaches to form these polymers into membrane films. This study circumvents these manufacturing constraints while maintaining competitive-sorption enhancements and helps to elucidate the role of tertiary amines for acid gas separations in solution-processable microporous PAEs.

Lingyan Deng, et al. "Decarbonizing of power plants by ammonia co-firing: Design, techno-economic, and life cycle analyses." *International Journal of Green Energy*. August 2024.

bit.ly/47ViWcG

This research investigates the decarbonization of India's electricity grid using ammonia in power plants. It focuses on ammonia produced in Western Australia and transported to India, co-fired with high rank coal, and compared with power plants utilizing carbon capture and sequestration (CCS). Under scenarios with low capacity factors or reduced ammonia production costs, coal-ammonia co-firing could become more economical and greener than the CCS. This study provides quantitative insights for policy makers and project developers.

Fabian J. Dickhardt, et al. "Enhanced electrostatic dust removal from solar panels using transparent conductive nano-textured surfaces." *Small*. December 2024.

bit.ly/4mwJoxR

Dust accumulation on solar panels is a major operational challenge faced by the photovoltaic industry. Removing dust using water-based cleaning is expensive and unsustainable. Dust repulsion via charge induction is an efficient way to clean solar panels and recover power output without consuming any water. The study proposes nano-textured, transparent, electrically conductive glass surfaces to significantly enhance electrostatic dust removal for particles smaller than $\approx 30 \mu\text{m}$. The study shows that reduced adhesion on nano-textured surfaces results in significantly better dust removal of small particles compared to non-textured or micro-textured surfaces.

Fabian J. Dickhardt, et al. "Thermodynamics of electrochemical marine inorganic carbon removal." *Environmental Science and Technology*. December 2024.

bit.ly/3HToABz

In recent years, marine carbon removal technologies have gained attention as a means of reducing greenhouse gas concentrations. One family of these technologies is electrochemical systems, which employ Faradaic reactions to drive alkalinity-swings and enable dissolved inorganic carbon (DIC) removal as gaseous CO₂ or as solid minerals. This work develops a thermodynamic framework to estimate upper bounds on performance for Faradaic DIC removal systems. Overall, this thermodynamic framework aims to guide system and process design and to drive material discovery and engineering for future electrochemical marine DIC removal systems.

Yifu Ding, et al. "Repurposing coal power plants into thermal energy storage for supporting zero-carbon data centers." *2024 IEEE Power & Energy Society General Meeting (PESGM)*. July 2024.

bit.ly/47LQYjG

Coal power plants will need to be phased out and face stranded asset risks under the net-zero energy system transition. Repurposing coal power plants could recoup profits and reduce carbon emissions using the existing infrastructure and grid connections. This paper investigates a retrofitting strategy that turns coal power plants into thermal energy storage and zero-carbon data centers.

Amanda Farnsworth, et al. "In what regions can fusion help decarbonize the U.S. power sector." *Cell Reports Sustainability*. October 2024.

bit.ly/424yBTk

This paper evaluates the potential role of fusion in decarbonizing the U.S. power sector in the year 2050. This is done by breaking the U.S. electricity system into regions to understand factors that favor or disadvantage fusion.

Zi Hao Foo, et al. "Toward a circular lithium economy with electrodialysis: Upcycling spent battery leachates with selective and bipolar ion-exchange membranes." *Environmental Science and Technology*. October 2024.

bit.ly/45XuQjI

Recycling spent lithium-ion batteries offers a sustainable solution to reduce ecological degradation from mining and mitigate raw material shortages and price volatility. This study investigates using electrodialysis with selective and bipolar ion-exchange membranes to establish a circular economy for lithium-ion batteries.

Sijia Geng, et al. "An integer clustering approach for modeling large-scale EV fleets with guaranteed performance." *Electric Power Systems Research*. November 2024.

bit.ly/4n49Uyv

Large-scale integration of electric vehicles (EVs) leads to a tighter integration between transportation and electric energy systems. This paper develops a novel integer-clustering approach to model a large number of EVs by managing vehicle charging and energy at the fleet level yet maintaining individual trip dispatch. The model is then used to develop a spatially and temporally-resolved decision-making tool for optimally planning and operating EV fleets and charging infrastructure.

Michela Geri, et al. "Interplay between wall slip and shear banding in a thixotropic yield stress fluid." *Soft Matter*. August 2024.

bit.ly/424F7tg

This work studies the local dynamics of a thixotropic yield stress fluid that shows a pronounced non-monotonic flow curve. This mechanically unstable behavior is generally not observable from standard rheometry tests, resulting in a stress plateau that stems from the coexistence of a flowing band with an unyielded region below a critical shear rate γ_c . The researchers' approach provides a framework where constraints imposed in the classical shear-banding scenario can be relaxed, with wall slip acting as an additional degree of freedom.

Cameron Hickert, et al. "A data-informed analysis of scalable supervision for safety in autonomous vehicle fleets." *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. October 2024.

bit.ly/4oMCYw6

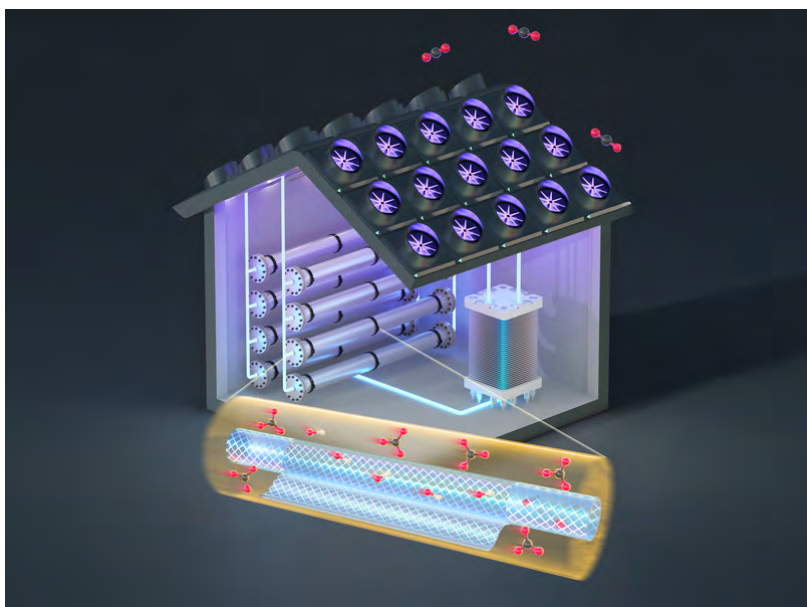
Autonomous driving is a highly anticipated approach toward eliminating roadway fatalities. At the same time, the bar for safety is both high and costly to verify. This work considers the role of remotely-located human operators supervising a fleet of autonomous vehicles for safety.

Richard T. Ibekwe, et al. "A platform to study defect-induced behavior in high-temperature superconductor cables." *Superconductor Science and Technology*. July 2024.

bit.ly/4mw3E2J

High-temperature superconductor (HTS) cables and magnets are enabling a range of high-current and high-field applications, including compact fusion devices aiming to achieve net energy. Defects in HTS pose manufacturing, cost, and operational challenges. A rigorous understanding and predictive capability for defect-induced behavior at relevant scale has not been established. To address this shortcoming, this work has developed a cable-level defect characterization experimental platform coupled to high-fidelity computational modeling.

Using nanoscale filtering membranes, researchers at MIT have added a simple [intermediate step](#) that makes the process of removing carbon dioxide from the air more efficient. *Image: Courtesy of the researchers*



Gasim Ibrahim, et al. "A novel framework for the economic and sustainability assessment of carbon capture and utilization technologies." *Gas Science and Engineering*. November 2024.

bit.ly/4g6JOIX

This study presents a novel framework for assessing early-stage carbon capture and utilization (CCU) reactions. The introduced greenhouse gas abatement, sustainability, and economics framework assesses commercial viability by simultaneously analyzing a CCU technology's CO₂ fixation potential with its economic potential.

Taigyu Joo, et al. "Enhancing acid-gas separations using free volume manipulation for microporous poly(arylene ether)s." *Journal of Materials Chemistry A*. February 2025.

bit.ly/47LXc2T

To address global energy needs, traditional and renewable natural gas will likely be key energy sources for years to come. However, raw feeds require removal of impurities like hydrogen sulfide (H₂S) and carbon dioxide (CO₂) before use. This study illustrates the key challenges of using traditional post-synthetic modification approaches to simultaneously enhance H₂S/CH₄ and CO₂/CH₄ selectivities in microporous polymer membranes, while also demonstrating how free volume manipulation can overcome some of these challenges.

Kyung-Shik Kim, et al. "Remove hydrogen and store it too: an acid-in-clay based electro-chemical solution." *Materials Horizons*. February 2025.

bit.ly/4pdDVxZ

Extracting hydrogen from metallic components can open up a new pathway for preventing hydrogen embrittlement. To this end, this work proposes an electrochemically driven, all-solid method for hydrogen control, capable of both extracting and storing hydrogen simultaneously. In this approach, the researchers employ acid-in-clay as a proton-conducting electrolyte at room temperature.

Marcello Laurenti, et al. "Time mesh independent framework for learning materials constitutive relationships." *Engineering Applications of Artificial Intelligence*. November 2024.

bit.ly/4oRAP2p

Real-world datasets are rarely populated by evenly distributed entries; unevenness may be caused by sensor malfunctions or randomized sampling due to the process nature. Modeling the constitutive relationship of materials in scenarios where the temporal data available are uneven is a serious challenge for black box approaches such as artificial neural networks. This work presents a general framework capable of modeling uneven sampled data.

Serin Lee, et al. "Temperature dependent growth kinetics of Pd nanocrystals: Insights from liquid cell transmission electron microscopy." *Small*. August 2024.

bit.ly/4oXrPZp

Quantifying the role of experimental parameters on the growth of metal nanocrystals is crucial when designing synthesis protocols that yield specific structures. Here, the effect of temperature on the growth kinetics of radiolytically-formed branched palladium (Pd) nanocrystals is investigated by tracking their evolution using liquid cell transmission electron microscopy and applying a temperature-dependent radiolysis model.

Tae Hoon Lee, et al. "Dual-phase microporous polymer nanofilms by interfacial polymerization for ultrafast molecular separation." *Science Advances*. August 2024.

bit.ly/4fUnoui

Fine-tuning microporosity in polymers with a scalable method has great potential for energy-efficient molecular separations. This work reports a dual-phase molecular engineering approach to prepare microporous polymer nanofilms through interfacial polymerization.

Trent R. Lee, et al. "Enhancing resource circularity in aluminum production through nanofiltration of waste cryolite." *ACS Sustainable Chemistry & Engineering*. January 2025.

bit.ly/45T3sn5

This study presents a novel approach to the selective separation of aluminum from waste cryolite electrolyte with two nanofiltration membranes: a conventional polyamide membrane and a membrane coated with a polyelectrolyte layer.

Yunpo Li, et al. "Prediction of oil and gas well integrity using well construction physical parameters and geospatial metrics." *Energy & Fuels*. December 2024.

bit.ly/3VqQ8Bn

Oil and gas (O&G) well integrity issues could cause significant environmental and climatic risks by releasing methane-containing fluids into the environment. The large number of O&G wells makes routine inspection or spatiotemporally adequate screening of well integrity issues expensive and sometimes intractable. Machine learning algorithms with the ability to predict O&G well integrity issues could help prioritize such inspections. This research identifies important predictive features that would help prioritize well integrity inspection and have the potential to guide well design and well location selection for mitigating integrity issues that lead to methane emissions.

Samantha A. McBride, et al. "Crystal patterning from aqueous solutions via solutal instabilities." *ACS Applied Materials & Interfaces*. October 2024.

bit.ly/4fTVa2N

Fluid instabilities can be harnessed for facile self-assembly of patterned structures on the nano- and microscale. Evaporative self-assembly from drops is one simple technique that enables a range of patterning behaviors due to the multitude of fluid instabilities that arise due to the simultaneous existence of temperature and solutal gradients. However, the method suffers from limited controllability over patterns that can arise and their morphology. This work demonstrates that a range of distinct crystalline patterns including hexagonal arrays, branches, and sawtooth structures emerge from evaporation of water drops containing calcium sulfate on hydrophilic and superhydrophilic substrates.

M. Moscheni, et al. "Cross-code comparison of the edge codes SOLPS-ITER, SOLEDGE2D, and UEDGE in modeling a high-power neon-seeded scenario in the DTT." *Nuclear Fusion*. January 2025.

bit.ly/4oVi4Lq

This work cross-compares the state-of-the-art edge plasma codes SOLPS-ITER, SOLEDGE2D, and UEDGE in a reactor-relevant neon-seeded Divertor Tokamak Test scenario at nominal power, extending the simplified test-bed of Moscheni et al (2022 Nucl. Fusion 62 056009).

Mohammad Ostadi, et al. "Flexible and synergistic methanol production via biomass gasification and natural gas reforming." *Cleaner Chemical Engineering*. December 2024.

bit.ly/47Olnhf

Sustainable liquid fuels are essential for decarbonization of various means of transportation that are challenging to address through electrification or hydrogen use. A possible method for producing low-carbon liquid fuel is through the thermochemical biomass to liquid process. This study conducts a technoeconomic-environmental analysis of two processes that take advantage of integration of natural gas reforming and biomass gasification, with the objective of improving the economics.

Mohammad Ostadi, et al. "CH₄ and CO₂ reductions from methanol production using municipal solid waste gasification with hydrogen enhancement." *Sustainability*. October 2024.

bit.ly/45D93iA

This study evaluates the greenhouse gas (GHG) impacts of converting municipal solid waste (MSW) into methanol, focusing on both landfill methane (CH₄) emission avoidance and the provision of cleaner liquid fuels with lower carbon intensity. This study conducts a lifecycle assessment (LCA) to assess potential GHG reductions from MSW gasification to methanol, enhanced with hydrogen produced via natural gas pyrolysis or water electrolysis. Additionally, this study analyzes the sensitivity of net-GHG emissions to varying levels of fugitive methane emissions.

James Owens, et al. "Commercial electric vehicle fleets in U.S. ancillary services markets: A stochastic analysis to inform utility rate design." *Utilities Policy*. October 2024.

bit.ly/4oZ1IGV

For commercial fleets in the United States, traditional electricity tariffs can disincentivize vehicle-to-grid participation and render electrification less attractive. First, this work shows that absent a rate redesign, opportunities for both fleets and the grid are missed. This work proposes a rate design modification: demand charge relaxation during off-peak (overnight) hours. This approach would enable fleets to shift additional load share to overnight hours and increase ancillary service revenues without the expectation of impacting local grid cost drivers (i.e., coincident peak load).



Will neutrons compromise the operation of superconducting magnets in a fusion plant? New [experiments](#) show that the immediate effect of atomic displacements, known as the "beam on effect," should not be an issue during fusion power plant operations.

James Owens, et al. "Risk-informed evaluation of delivery fleet electrification and vehicle-to-grid economics." *Energy Reports*. June 2025.

bit.ly/47fMTEb

Commercial fleet electrification offers various cost optimization options, from smart charging to vehicle-to-grid (V2G) services. The optimal configuration is a function of a particular fleet's attributes and travel obligations. Comprehensive cost-benefit analyses are crucial, considering all costs and uncertainties in the changing electricity market. However, prior fleet electrification studies do not sufficiently capture market-based cause-and-effect relationships in estimating fleets' V2G capabilities and revenues. This study addresses gaps in prior research by using a risk-informed Monte Carlo modeling framework to evaluate electrification costs and benefits under operational uncertainty and changing market conditions.

Simon Rufer, et al. "Hierarchically conductive electrodes unlock stable and scalable CO₂ electrolysis." *Nature Communications*. November 2024.

bit.ly/4IPAlqL

Electrochemical CO₂ reduction has emerged as a promising CO₂ utilization technology, with gas diffusion electrodes becoming the predominant architecture to maximize performance. Such electrodes must maintain robust hydrophobicity to prevent flooding, while also ensuring high conductivity to minimize ohmic losses. Intrinsic material trade-offs have led to two main architectures: Carbon paper is highly conductive but floods easily; while expanded polytetrafluoroethylene is flooding resistant but non-conductive, limiting electrode sizes to just 5 cm². This work demonstrates a hierarchically conductive electrode architecture that overcomes these scaling limitations by employing inter-woven microscale conductors within a hydrophobic expanded Polytetrafluoroethylene membrane.

Sara Catherine Sand, et al. "A critical review on Li-ion transport, chemistry and structure of ceramic-polymer composite electrolytes for solid-state batteries." *Chemical Society Reviews*. January 2025.

bit.ly/4IL5bk6

In the transition to safer, more energy-dense solid-state batteries, polymer-ceramic composite electrolytes may offer a potential route to achieve simultaneously high lithium-ion (Li-ion) conductivity and enhanced mechanical stability. Despite numerous studies on the polymer-ceramic composite electrolytes, disagreements persist on whether the polymer or the ceramic is positively impacted in their constituent ionic conductivity for such composite electrolytes, and even whether the interface is a blocking layer or a highly conductive Li-ion path. This lack of understanding limits the design of effective composite solid electrolytes. By thorough and critical analysis of the data collected in the field over the last three decades, this work presents arguments for lithium conduction through the bulk of the polymer, ceramic, or their interface.

Rachel Schaefer, et al. "Proximity to inlet channel drives spatial variation in sediment carbon across a lagoonal seagrass meadow." *The Science of The Total Environment*. December 2024.

bit.ly/45RUgzb

Seagrass meadows can be sinks for organic carbon, but estimates of global organic carbon stocks are complicated by substantial spatial variability in organic carbon burial observed within meadows. To improve estimates of organic carbon burial in seagrass meadows, it is necessary to understand the causes of the spatial heterogeneity. This study investigated relationships between spatial patterns in sediment organic carbon storage and accretion rates, hydrodynamics, and proximity to sources of organic carbon in a current-dominated *Zostera marina* Linnaeus meadow in Menemsha Pond, Massachusetts, USA.

Landon Schofield, et al. "Dynamic optimization of proton exchange membrane water electrolyzers considering usage-based degradation." *AIChE Journal*. November 2024.

bit.ly/41LYurd

This work presents a techno-economic optimization model for the design and dynamic operation of proton exchange membrane electrolyzers, for enabling cost-effective hydrogen production. The proposed modeling framework is adaptable to study other electrochemical systems relevant for decarbonization.

Alexander E. Siemenn, et al. "Archerfish: A retrofitted 3D printer for high-throughput combinatorial experimentation via continuous printing." *Digital Discovery*. April 2025.

bit.ly/42HjHTo

The maturation of 3D printing technology has enabled low-cost, rapid prototyping capabilities for mainstreaming accelerated product design. The materials research community has recognized this need, but no universally accepted rapid prototyping technique currently exists for material design. Toward this end, the researchers develop Archerfish, a 3D printer retrofitted to dispense liquid with in situ mixing capabilities for performing high-throughput combinatorial printing of material compositions. The continuous printing and low-cost design of Archerfish demonstrate promising accelerated materials screening results across a range of materials systems from nanoparticles to perovskites.

Paul Sizaire, et al. "A novel hydrogen supply chain optimization model — Case study of Texas and Louisiana." *International Journal of Hydrogen Energy*. August 2024.

bit.ly/3HLY9CM

Hydrogen is viewed as a potential enabler of deep decarbonization, notably in hard-to-abate sectors such as industry. A multi-modal, hourly resolved, linear programming model was developed to assess the infrastructure requirements of a low-carbon supply chain over a large region.

Emre Tekoglu, et al. "Superior high-temperature mechanical properties and microstructural features of LPBF-printed In625-based metal matrix composites." *Materials Today*. November 2024.

bit.ly/41WudWs

The growing demands for high-temperature materials, especially in aerospace and energy production, compel thorough explorations of innovative materials. This work demonstrates significantly enhanced high-temperature mechanical properties of Inconel 625 (In625) based metal matrix composites fabricated by laser powder bed fusion (LPBF) additive manufacturing.

Yu Weng, et al. "Co-optimizing power-transportation networks with circulating loads and particle-like stochastic motion." *IEEE Transactions on Smart Grid*. September 2024.

bit.ly/41tjPFD

Coupling power-transportation systems may enhance the resilience of power grids by engaging energy-carrying mobile entities such as electric vehicles (EVs), truck-mounted energy storage systems, and data centers, which can shift the computing loads among their network. This work aims to facilitate power-transportation co-optimization by proposing and formalizing the concept of circulating loads to generalize these spatial-temporal dispatchable entities. Based on this aggregated model, a co-optimization framework is proposed to coordinate the bulk of EVs while respecting data privacy between transportation and power systems. Simulation results demonstrate the effectiveness of the proposed framework.

Hongbin Xu, et al. "A cobalt-platinum-ruthenium system for acidic methanol oxidation." *Chemistry of Materials*. July 2024.

bit.ly/4fTkQjo

The electrochemical oxidation of methanol is a crucial catalytic reaction in direct methanol fuel cells. Platinum (Pt) or Pt-alloy electrocatalysts have dominated the space, especially in acidic conditions, and different design strategies are needed to achieve both high specific and mass activities. This work comprehensively develops a system of cobalt-platinum-ruthenium nanoparticles within three-dimensional nitrogen-doped porous carbon (Co-Pt-Ru/NC) as an efficient methanol oxidation reaction catalyst and investigates different factors such as Pt loading and acid treatment.

Daniel J. Zheng, et al. "Uniting activity design principles of anode catalysts for direct liquid fuel cells." *EES Catalysis*. November 2024.

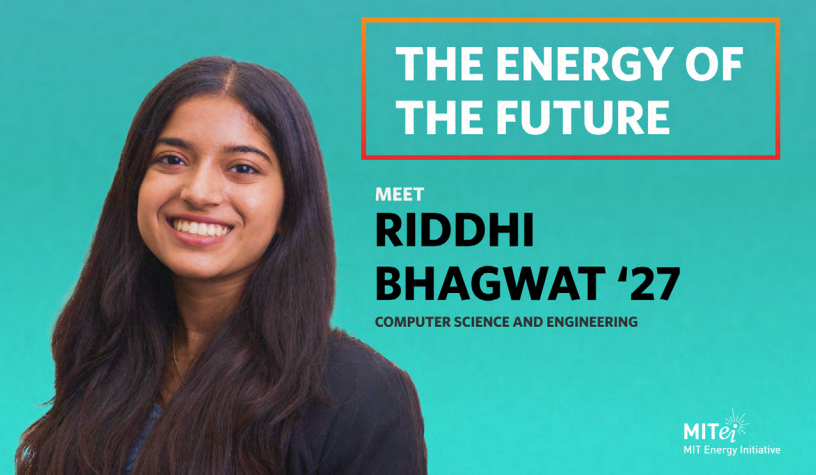
bit.ly/3UPCIVO

This review provides a comprehensive overview of liquid fuel oxidation electrocatalysts, from fundamental principles to state-of-the-art materials in an effort to unify design principles for future materials.



During summer 2024, 24 students conducted energy research through MITEI's Energy Undergraduate Research Opportunities Program.

Photo: A. Laiman - MIT Technique



"The Energy of the Future" is a new video series showcasing the work of our energy students and their efforts to advance the energy transition and expand energy access.

Education

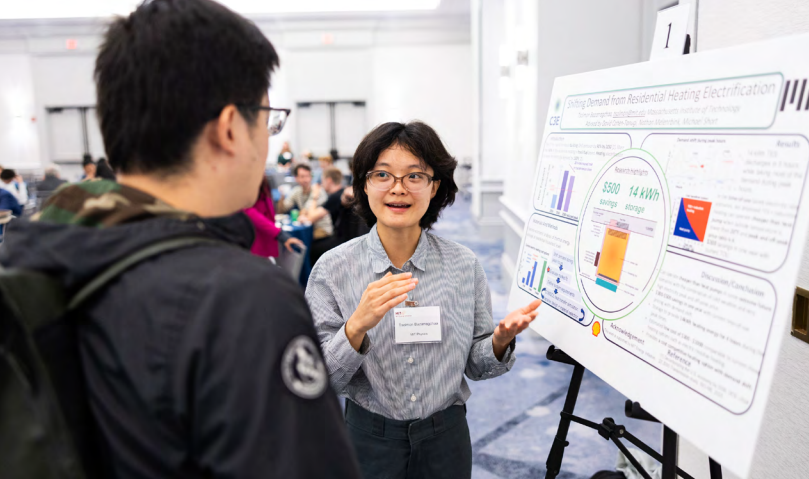
Priority update: Make a plan to revitalize energy education at MIT

In preparing the Energy Studies Minor's five-year report to the Committee on Curricula, MITEI Education broadly evaluated opportunities to evolve its energy education program and engage more students over the next five years. The MIT Committee on Curricula responded with a letter that commended MITEI's effort and dedication, and said the "Energy Studies Minor is clearly a cohesive and valuable program."

MITEI leads MIT's [energy education](#) efforts and has engaged with thousands of students through sponsored research opportunities and other programs—preparing the next generation of innovators, entrepreneurs, and policy makers 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, an energy-focused first-year pre-orientation program, the postgraduate Society of Energy Scholars, and [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 Education Program Highlights

- **Energy Studies Minor:** MITEI supports and regularly updates the Energy Studies Minor curriculum, relying on an endowed fund provided by a generous donor. The Energy Studies Minor enables undergraduate MIT students to gain an integrative understanding of energy and develop the skills required of tomorrow's energy professionals, leaders, and innovators in research, industry, policy, management, and governance. 216 students have graduated with the Energy



At MITEI's 2024 Annual Research Conference, Energy UROP students presented their research to MITEI's corporate members and conference attendees during poster sessions. *Photo: Jake Belcher*



Six MIT students got a first-hand view of the energy industry in Denmark as part of a field trip in August 2024. With support from the MIT Energy Initiative, they visited startups working on safer nuclear energy production; local utility companies integrating offshore wind, biowaste, and district heating; a green-energy-based business park; and more.

Studies Minor, including four that graduated in 2025. Eight are on track to graduate with the minor in 2026. The new Chair of the Energy Minor Oversight Committee, Professor Daniel Frey (Mechanical Engineering), worked with the committee to evaluate course development proposals that MITEI then funded to refresh the Energy Minor Curriculum. A particular goal is to enhance connections between the energy minor and computer science, including promising applications of AI/machine learning for analyzing and solving energy challenges. Increasingly, we are also coordinating with other energy/climate/sustainability offerings at MIT to enhance efficiency and to be complementary in the curriculum, to engage students, and to link with Climate Project initiatives as those take shape.

- **Teaching Assistant support:** MITEI provided support for graduate teaching assistants in the following subjects: 1.067[J]: Energy Systems for Climate Change Mitigation, 5.812[J]: Principles of Innovation, EC.711: Introduction to Energy in Global Development, and EC.712[J]: Applications of Energy in Global Development. MITEI also provided course development funds for 8.01x: Information and Entropy: Energy and Exergy.
- **Postgraduate Scholars:** In 2024–2025, MITEI welcomed 14 new graduate students and postdocs to the Society of Energy Scholars (formerly known as the Society of Energy Fellows). The Energy Scholars network at the end of FY25 totaled more than 540 current and former graduate students and postdoctoral fellows, spanning 20 departments and divisions at MIT's five schools and one college. In FY25, support was provided by MITEI member companies Shell, Chevron, Eni S.p.A., and ExxonMobil, and by Friends of MITEI.
- **Undergraduate energy research:** During FY25, MITEI supported 85 Undergraduate Research Opportunities Program (UROP) student projects, bringing the total UROPs supported by MITEI since inception to 1,060.

- **Online energy courses:** To train global professionals, policy makers, and students in energy topics and tools to support and accelerate the energy transition, the MITEL education team has developed a series of open online courses (MOOCs) based on interdisciplinary residential MIT subjects. These courses are free and available in almost every country, and have attracted more than 145,000 online learners. The courses cover critical aspects of future energy systems: load and demand-side management; economics and regulation; production, distribution, and transmission; mobility; and integrating climate topics across disciplines. The courses include [Sustainable Building Design](#); [Sustainable Energy](#); [Energy Economics and Policy](#); [Transformative Living Labs in Mobility](#); and [Climate in Classrooms: Tools for All Teachers and Disciplines](#).
- **IAP courses:** MITEL supported several IAP courses in January 2025. “Information and Entropy: Energy and Exergy” focused on the concept of entropy and its connection to information theory, as well as ideas about exergy and the usefulness of energy, energy efficiency, and CO₂ capture. “AI for Energy Solutions” (47-210 attendees, depending on the lecture), which explored the applications of AI/machine learning to climate and energy challenges, and was offered to MIT and participants out of MIT via Zoom. “Computational Modeling for Clean, Reliable, and Affordable Electricity” offered a hands-on learning experience introducing analysis techniques to model and understand the role of electric power systems within a carbon-constrained economy, for which 49 students enrolled.
- **First-Year Pre-Orientation Program (FPOP):** MITEL’s summer 2024 energy pre-orientation program welcomed 18 new first-year students to the MIT community. Activities included a visit to a sustainable farm, tours of MIT’s Nuclear Reactor Lab and the Plasma Science and Fusion Center, and talks with faculty and student group leaders.
- **Field trip to Europe:** In August 2024, MITEL Education Director Antje Danielson took six undergraduate and graduate students to Denmark to explore renewable energy startups and visit the Danish Tech University in Copenhagen.

MIT Student Energy Groups

MITEL provides financial and staff support for a number of student groups throughout the year.

The **MIT Energy and Climate Club** connects students, alumni, and community members who are passionate about energy and climate change. Since 2004, MITEC has been a central platform for discussions about energy at MIT, the world’s leading technical institute.

The **MIT Energy and Climate Hack** brings opportunities for learning, problem solving, and networking to the forefront as teams develop rapid, innovative solutions to the problems in energy and climate that our society faces today.

MIT Motorsports is a student-run team that fully designs, manufactures, and races a new electric Formula One style race car every year. They compete in Formula SAE Electric, the largest intercollegiate engineering design competition in the world with over 600 participating universities, as well as Formula Hybrid + Electric.

The **MIT Policy Hackathon** allows participants from a wide range of academic backgrounds to work in teams to develop creative policy solutions to problems posed by governmental and industry partners.

The hackathon is convened by MIT's Institute for Data, Systems, and Society and MIT's Technology and Policy Program

The **MIT Solar Electric Vehicle Team** is a student group under the MIT Edgerton Center. Every two years they design and manufacture a solar-powered vehicle that competes in prestigious national and international competitions.

The **MIT Sustainable Engine Group** is a dedicated group of students at MIT passionate about the potential of hydrogen gas turbine engines. Through their designs, fabrication, and testing, they aim to elevate the efficiency of these engines.

MIT Wind focuses on the technical, logistical, ecological, and societal implications of adding renewable wind energy to the electricity generation mix. Undergraduates in MIT Wind compete in the Collegiate Wind Competition (CWC), an annual design competition hosted by the U.S. Department of Energy.

Energy Education Task Force

MITEI's Energy Education Task Force guides the development of energy education at MIT. The task force meets regularly throughout the academic year and includes MIT faculty from all five schools and one college, as well as graduate and undergraduate student representatives. MITEI's education team members support the task force by implementing energy education programs.

ENERGY EDUCATION TASK FORCE FACULTY MEMBERS FY25

Chair: Oliver Jagoutz, Professor of Geology

Martin Bazant, Professor of Chemical Engineering and Mathematics

Matthew Evans, MathWorks Professor of Physics

Daniel Frey, Professor of Mechanical Engineering

Michael Howland, Esther and Harold E. Edgerton Assistant Professor

David Hsu, Associate Professor of Urban Studies and Planning

Juejun Hu, John F. Elliott Professor of Materials Science and Engineering

Robert Jaffe, Jane and Otto Morningstar Professor of Physics

Christopher Knittel, Associate Dean for Climate and Sustainability; George P. Shultz Professor of Energy Economics; Director, Center for Energy and Environmental Policy Research

Janelle Knox-Hayes, Professor of Economic Geography and Planning

Steven Leeb, Professor of Electrical Engineering and Computer Science

Michael Short, Associate Professor of Nuclear Science and Engineering

Kate Trimble, Senior Associate Dean and Director, Office of Experiential Learning

Amos Winter, Associate Professor of Mechanical Engineering



MITEI Director William H. Green provides the opening address at MITEI's 2024 Annual Research Conference, which explored the topic of a durable energy transition. Credit: Jake Belcher

At the MITEI Presents: Advancing the Energy Transition speaker series, U.S. Representative Sean Casten outlined government policy's role in the energy transition before talking through specific strategies and roadblocks in an audience Q&A. Photo: Kelley Travers

Outreach

Priority update: Engage more broadly with MIT campus

A major priority for MITEI in FY25 was to strengthen MITEI's connection across campus and ensure a better understanding of MITEI's mission. MITEI did this by launching a new podcast, *What if it works?*, and speaker series, MITEI Presents: Advancing the Energy Transition, in fall 2024. MITEI also increased its collaborations with other departments, labs, and centers (DLCs) and campus groups. On campus and beyond, MITEI's [outreach efforts](#) foster dialogue within the research community and across the academic, industry, and government sectors and provide the public with context on current energy issues. In FY25, the MITEI communications team published 25 original [news articles](#), including event coverage, research reports, and explainers, to highlight MIT energy researchers and students, and their work across print and digital platforms. MITEI articles are frequently republished by MIT News, providing broader reach through MIT News' channels. Additionally, MITEI worked with other DLCs to bring important industry and policy leaders to campus to engage with the MIT community. This included a partnership with MIT Ukraine, MIT Security Studies Program, and the Belfer Center at Harvard University to bring Volodymyr Kudrytskyi, the former CEO of Ukraine's electric grid operator Ukrenergo, to discuss the challenges of securing Ukraine's energy system throughout the war.

Outreach Program Highlights

- MITEI Presents: Advancing the Energy Transition speaker series:** Launched in September 2024, this speaker series connects the MIT community with energy experts and leaders who are actively working on the scientific, technological, and policy solutions we urgently need to transform our energy systems. Six speakers were brought to campus this FY, including [Alicia Barton](#), CEO of Vineyard Offshore; U.S. [Representative Sean Casten](#) of Illinois; [Joseph F. DeCarolis](#), administrator of the U.S. Energy Information Administration; [Emily Knight](#), president



Lucia Tian (center), the head of clean energy and decarbonization technologies at Google, discusses the challenges and opportunities that AI and rapid electrification bring to electricity demand during a panel at the 2025 MIT Energy Conference. *Photo: Rory Fisher*

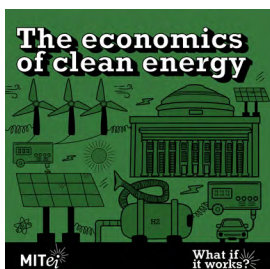
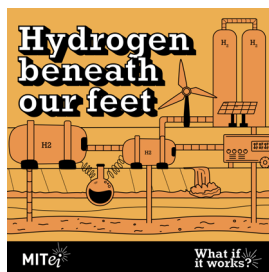
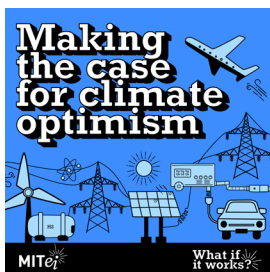


Manish Bapna, president and CEO of the Natural Resources Defense Council, advocated for reinstating climate action as a national priority at the MIT Energy Initiative's 2025 Earth Day Colloquium. *Photo: Kelley Travers*

and CEO of The Engine; Manish Bapna, president and CEO of the Natural Resources Defense Council (more below); and [Emily A. Carter](#), the Gerhard R. Andlinger Professor in Energy and the Environment at Princeton University.

- **Podcast: *What if it works?*:** In October 2024, MITEI launched its podcast series, [What if it works?](#) Season one gained more than 1,000 subscribers with 18 published episodes by the end of FY25. Every two weeks, MITEI hosts Rob Stoner and Kara Miller spoke with energy experts about the science, technology, and policies that can transform our energy systems and give us a more sustainable future. Guests included [Ernest Moniz](#), former U.S. Secretary of Energy; [Susan Solomon](#) (Earth, Atmospheric and Planetary Sciences); Climate Project Mission Directors [Elsa Olivetti](#) (Material Science and Engineering) and [Christopher Knittel](#) (MIT Sloan); [Howard Herzog](#) (MITEI); and [Namrata Kala](#) (MIT Sloan).
- **The *Energy of the Future* video series:** In March 2025, MITEI launched a [video series](#) on social media showcasing the work of MITEI's energy students and their efforts to advance the energy transition and expand energy access. This series supports MITEI's priority of engaging more broadly with campus and growing its social media audiences. In FY25, MITEI published five videos in the series, featuring Energy UROP participants, on Instagram and LinkedIn. MITEI promoted the videos across campus with both print and digital advertisements and a special display in the infinite corridor.
- **Spring Symposium:** In May 2025, MITEI advanced its focus on data centers at MITEI's [Spring Symposium](#), which brought together researchers, industry leaders, and academic experts to explore artificial intelligence as both a problem and solution for the clean energy transition. Speakers included Vijay Gadepally, a senior scientist at MIT's Lincoln Lab; Evelyn Wang, MIT vice president for energy and climate; Antonia Gawel, global director of sustainability and partnerships at Google; and Dustin Demetriou, senior technical staff member in sustainability and data center innovation at IBM.

- **Earth Day Colloquium:** As part of MIT's celebration of Earth Week, MITEL hosted [Manish Bapna](#), the president and CEO of the Natural Resources Defense Council, one of the United States' largest environmental organizations, who advocated for reinstating climate action as a national priority.
- **Congressional Staff Seminar 2025:** MITEL, the MIT Washington Office, and the Climate Policy Center jointly hosted a bipartisan group of 27 U.S. House, Senate, and Congressional committee staffers for three days of panels, tours, and presentations from faculty, research scientists, and students about energy and climate research. Topics included climate & AI, the role of nuclear energy in U.S. power generation, and electricity transmission, among others.
- **Annual Research Conference 2024:** Energy researchers, policy makers, and industry members came together this year to explore the topic of "[A durable energy transition: How to stay on track in the face of increasing demand and unpredictable obstacles.](#)" The conference included eight panels that featured MIT moderators, 13 MIT panelists, and 19 panelists from other academic institutions, government, or industry. MIT President Sally Kornbluth opened the conference, and the keynote speaker was Praveer Singh, CEO and Managing Director of the Tata Power Co, Ltd. In collaboration with MIT's Industrial Liaison Program, the conference also highlighted seven companies with a Startup Showcase session. MITEL's summer UROP students participated in a slam, presenting their research to MITEL's corporate members and conference attendees.
- **C3E 2024 Women in Clean Energy Symposium:** In November 2024, the 13th annual Clean Energy, Education, and Empowerment (C3E) Women in Clean Energy Symposium and Awards was hosted by Stanford Energy in collaboration with MITEL, the U.S. Department of Energy (DOE), and Julie Ann Wrigley Global Futures Laboratory at Arizona State University. The conference featured award presentations, as well as diverse speakers and rich conversations on pursuing sustainable clean energy goals. The U.S. C3E Initiative advances clean energy by closing the gender gap and increasing the participation, leadership, and success of women in clean energy fields.



[What if it works?](#) is a new podcast produced by MITEL that looks at the energy solutions to climate change. Our hosts speak with energy experts about the science, technology, and policies that can transform our energy systems and give us a more sustainable future.

Art: Zeitler Design

Events

MITEI SEMINARS AND COLLOQUIA, AND MITEI-SPONSORED EVENTS, 2024-2025 ACADEMIC YEAR

- September 12, 2024: MITEI Special Webinar: “The role of fusion energy in a decarbonized electricity system”
- September 18, 2024: MITEI Presents: Advancing the Energy Transition
“Offshore wind and a new era of success”
Alicia Barton, CEO, Vineyard Offshore
- September 23, 2024: MITEI Special Seminar: “The transformation of rural India’s power supply through microgrids”
Praveer Sinha, CEO and Managing Director, The Tata Power Company Limited co-hosted with MIT Sangam
- September 25-26, 2024: MITEI Annual Research Conference: “A durable energy transition: How to stay on track in the face of increasing demand and unpredictable obstacles”
- September 27, 2024: MITEI Special Seminar: “Energy transition: Global and Indian perspectives on renewable energy and supply chain challenges”
Praveer Sinha, CEO and Managing Director, The Tata Power Company Limited co-hosted with MIT Energy and Climate Club
- October 16, 2024: MITEI Presents: Advancing the Energy Transition
“Powering the future: Clean energy and federal policy”
U.S. Representative Sean Casten
- October 17, 2024: MITEI Special Seminar: “The role of fusion energy in a decarbonized electricity system”
- October 17, 2024: U.S. C3E Women in Clean Energy webinar: “Evolving financing structures in the energy transition”
- November 13, 2024: U.S. C3E Women in Clean Energy Symposium & Awards
co-hosted with U.S. Department of Energy, Stanford University’s Precourt Institute for Energy, and Arizona State University.
- November 13, 2024: MITEI Presents: Advancing the Energy Transition Fall Colloquium:
“Stay humble and prepare for surprises: Lessons for the energy transition”
Joseph F. DeCarolis, Administrator, U.S. Energy Information Administration

- March 5, 2025: MITEI Presents: Advancing the Energy Transition
"Blueprint for Tough Tech entrepreneurship"
Emily Knight, President and CEO, The Engine
- March 11, 2025: MITEI Special seminar: "Vulnerabilities and Resilience of Electrical Grids in
Wartime: Lessons from Ukraine"
Volodymyr Kudrytskyi, Former CEO and Chairman, Ukrenergo
co-hosted with MIT Ukraine and MIT Security Studies Program
- April 30, 2025: MITEI Presents: Advancing the Energy Transition Earth Day Colloquium:
"Where do we go from here? Pathways to a clean energy transition"
Manish Bapna, President and CEO, Natural Resources Defense Council
- May 7, 2025: MITEI Presents: Advancing the Energy Transition
"The energy transition is no longer enough: Transformation, intervention,
and adaptation"
Emily A. Carter, Gerhard R. Andlinger Professor in Energy and the
Environment, Princeton University co-hosted with MIT Department
of Chemistry
- May 13, 2025: MITEI Spring Symposium: "AI and energy: Peril and promise"

Governance



MITEI Leadership Team

In April 2024, William H. Green, the Hoyt C. Hottel Professor at MIT, began his tenure as MITEI Director, leading MITEI's leadership team to build on the Initiative's strong foundation and multidisciplinary approach to deliver global energy solutions, broadening MITEI's membership base, bringing in new member companies, increasing opportunities for faculty research, strengthening operations, and playing a lead role in energy education and outreach at MIT.

William H. Green, Director

Carolyn Ruppel, Deputy Director of Science and Technology

Martha Broad, Executive Director

Leia Amarra, Manager of Financial Operations

Morgan Andreae, Executive Director, Future Energy Systems Center and Eni-MIT Alliance

Randall Field, Director, Research

J.J. Laukaitis, Director, Member Services

Tom Witkowski, Director, Communications

Antje Danielson, Director, Education

Sarah MacLeod, Human Resources Administrator

Heather Leet, Development Officer

External Advisory Board

The MITEI External Advisory Board, composed of esteemed industry, academic, nonprofit, and public sector leaders, meets each autumn and provides feedback on MITEI's ongoing work and priorities. The Board, chaired by Ellen Williams, Distinguished University Professor Emerita, University of Maryland, offers perspectives and guidance that assist MITEI in maximizing its impact in helping to meet the world's energy needs, reduce the environmental impacts of energy production and consumption, and inform public discourse on energy and the environment. The FY25 meeting was held in November 2024.

Governing Board

The Governing Board represents Founding and Sustaining Members' strategic interests for engaging with MITEI, and their research, analyses and education priorities. The Board serves to provide feedback on the effectiveness and coherence of MITEI's offerings and provides input and direction on new MITEI products, services and deliverables. The Board is also a forum for sharing and vetting new ideas and industry challenges between MITEI and the members.

MITEI Energy Council

The Energy Council helps shape MITEI's research, education, and outreach directions. The Council in FY25 included faculty from MIT's five schools and one college, in addition to MITEI executive leadership.

John Deutch, emeritus Institute Professor

Bradford Hager, Associate Director, Earth Resources Laboratory; Professor Post-Tenure of Geophysics

Christopher Knittel, Associate Dean for Climate and Sustainability; George P. Shultz Professor of Energy Economics; Director, MIT Center for Energy and Environmental Policy Research

Caitlin Mueller, Associate Director, MIT Climate & Sustainability Consortium; Associate Professor of Architecture; Associate Professor of Civil and Environmental Engineering

Elsa A. Olivetti, Jerry McAfee (1940) Professor in Engineering, MacVicar Faculty Fellow

Christoph Reinhart, Terri and Alan Spoon Professor of Architecture and Climate; Director, Building Technology Program

Bettina Stoetzer, Associate Professor of Anthropology

Yogesh Surendranath, Donner Professor of Science; Professor of Chemistry

Catherine Wolfram, William Barton Rogers Professor in Energy

Jinhua Zhao, Professor of City and Transportation Planning; Director, JTL Urban Mobility Lab; Director, MIT Transit Lab

Energy Education Task Force

In FY25, Oliver Jagoutz, the Cecil and Ida Green Professor of Geology, was named chair of The Energy Education Task Force. This task force, composed of faculty members and students from all five of MIT's schools and one college, oversees the Initiative's Education program.

MITEI Members

MITEI's corporate member program facilitates collaborations between industry and MIT to research, develop, and accelerate low- and zero-carbon solutions for the energy transition. MITEI's member roster is reflective of MITEI's mission to work across the broad industrial spectrum of energy production, conversion, delivery, and usage.

MEMBER HIGHLIGHTS

- Overall, in FY25, MITEI maintained a steady net membership roster of 38 members. Reflecting ongoing efforts to diversify across the energy spectrum, MITEI welcomed several notable new members, including Copenhagen Infrastructure Partners, Siemens Energy, and RWE (a German multinational energy company). MITEI is also welcoming GE Vernova, as part of their role in the new MIT research alliance. GE Vernova's membership in MITEI is expected to be finalized in early FY26.
- A key focus in FY25 was renewals of our Founding and Sustaining members, which remain on target, along with several other member renewals within MITEI's Future Energy Systems Center.
- As members' research organizations rebounded from Covid-19 disruptions, their research priorities evolved from single-PI, relatively straightforward projects to complex, multi-disciplinary initiatives involving multiple PIs. To support this shift, MITEI organized workshops that connected members and PI teams, enabling them to pitch project ideas to Founding members ExxonMobil and Shell. As a result, MITEI has launched—or is on the verge of launching—six complex, multi-PI, multi-year projects aimed at addressing critical challenges across all aspects of the energy transition.
- As part of MITEI's efforts to help industry and governments facing critical energy transition decisions, MITEI executed a workshop in Taiwan under the TIGER Consortium. This was a collaboration with the EPOCH Foundation meant to help Taiwan develop a robust roadmap for its own green energy transition.

Along with financial support for research, analyses, and education, industry members contribute valuable perspectives and detailed knowledge of real-world conditions for practical scaling-up, deployment, and integration of decarbonization solutions.

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 multi-tiered 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 graduate students working on the energy transition; support innovative energy concepts from proposals solicited across the campus; and participate in MITEI's seminars, lectures, and colloquia. A list of members is available on the [MITEI website](#).

Affiliated Groups



MITEL collaborates on research and education activities with faculty members from many MIT centers, departments, and laboratories pursuing interdisciplinary energy and environmental activities. In particular, researchers from both the Center for Energy and Environmental Policy Research (CEEPR) and the Center for Sustainability Science and Strategy (CS3) are working with MITEL researchers to support the work of the Future Energy Systems Center.

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

CEEPR carries out rigorous and objective research for improved decision-making in government and the private sector, and closely cooperates with government and industry partners from around the globe. Affiliated faculty and research staff as well as external research affiliates contribute to the empirical study of a wide range of policy issues related to energy supply and demand and the environment. CEEPR produces working papers, policy briefs, and research input to larger, interdisciplinary studies, and hosts two annual research workshops at MIT. CEEPR has extensive previous and current international collaborations and has co-organized a series of international energy policy conferences.

CEEPR houses the Roosevelt Project, a research initiative that takes a multidisciplinary approach to examining the transitional challenges associated with deep decarbonization of the U.S. economy. The project was initiated by former U.S. Secretary of Energy and Cecil and Ida Green Professor of Physics and Engineering Systems emeritus 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.

Center for Sustainability Science and Strategy

In August 2024, the MIT School of Science launched a center to advance knowledge and computational capabilities in the field of sustainability science, and support decision-makers in government, industry, and civil society to achieve sustainability goals. Aligned with the Climate Project at MIT, researchers at the MIT Center for Sustainability Science and Strategy (CS3) develop and apply expertise from across the Institute to improve understanding of sustainability challenges, and thereby provide actionable knowledge and insight to inform strategies for improving human well-being for current and future generations. Noelle Selin, professor at MIT's Institute for Data, Systems and Society and the Department of Earth, Atmospheric and Planetary Sciences, serves as the center's inaugural faculty director. C. Adam Schlosser and Sergey Paltsev, a senior research scientist at MITEI, serve as deputy directors, with Anne Slinn as executive director. CS3 incorporates and succeeds both the Joint Program on the Science and Policy of Global Change and the Center for Global Change Science.

STAY CONNECTED

Keep up with MITEI's latest research, news, and events:

To sign up for MITEI's weekly newsletter, visit: energy.mit.edu/subscribe

Events calendar: energy.mit.edu/events

"Future of" studies: energy.mit.edu/futureof

Latest MITEI publications: energy.mit.edu/publications

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