MIT Energy Initiative

The year 2006–2007 was one of transition for the Laboratory for Energy and the Environment (LFEE). In response to President Hockfield's inaugural call for an Institute-wide initiative in energy, an Energy Research Council (ERC) formed to determine MIT's resources, strengths, and potential contributions to an advanced, transformative, multidisciplinary energy program; this effort was led by Professor Ernest J. Moniz (Physics and Engineering Systems Division [ESD]). Following a year of inputs, analysis, consultations, and reviews across campus, ERC recommended that the Institute establish the MIT Energy Initiative (MITEI) to integrate and further develop MIT's resources in this multifaceted field. The ERC report also included recommendations on the structure, governance, and focus areas for the initiative, formally launched in fall 2006.

MITEI is designed to mobilize the research capabilities of the Institute to help meet the world's most pressing energy challenges. The MITEI interdisciplinary research program and related education and campus-wide activities (discussed in detail below) focus on:

- Innovative technologies and underlying policy analysis that will improve how we produce, distribute, and consume conventional energy
- Transformational technologies to develop alternative energy sources that can supplement and displace fossil fuels, including the economic, management, social science, and policy dimensions needed for this transformation
- Global systems to meet energy and environmental challenges through a multidisciplinary systems-approach that integrates policy design and technology development
- Tools to enable innovation, transformation, and simulation of global energy systems through strategic basic research

To achieve its objectives in these energy focus areas, MITEI has established four initiative components: industry research partnerships; education; campus energy management; and outreach.

Industry Research Partnerships

Consistent with MIT's historical engagement with industry, the MITEI reflects the understanding that robust research partnerships between academia and industry are highly effective vehicles for transforming the global energy marketplace.

Achieving these outcomes through specific research programs involves multiple academic disciplines and personnel, supported by an infrastructure that maximizes opportunities for MITEI's industry partners. MITEI aggregates MIT's research capability, innovation, expertise, and experience in successful industry collaborations to help meet key strategic objectives. A four-tier membership structure enables private sector partners to sponsor multidisciplinary, multiple faculty "flagship" research programs, contribute to a range of energy-focused MIT labs, programs, and centers, support innovative energy concepts from proposals solicited across the campus, participate in MITEI organized seminars, lectures, and colloquia, and fund critical energy fellowships. An

external advisory board comprised of industry and public sector leaders was organized to provide strategic direction for MITEI and MIT's energy research.

Education

Catalyzing student knowledge and enthusiasm to solve technologically, socially, and politically challenging problems is a central component of MITEI. Education is closely integrated with MIT's energy research and "walk the talk" activities discussed below.

Energy education at MIT is thoroughly cross-disciplinary, addresses both fundamental and applied knowledge, and includes offerings from the undergraduate first year through advanced graduate study. More than 70 subjects offered across all five schools have a substantive connection to energy issues. A wide range of topics are covered, from subjects with a deep science and technology focus, to those emphasizing economics and policy, to those with hands-on, lab-based, and project-based components. In many cases, environmental concerns and impacts associated with energy supply and consumption are discussed as well. New energy subjects are being developed each semester, and the MITEI database will provide an up-to-date view of these.

The Education Task Force meets on a regular basis to provide MITEI with direction on student, faculty and curriculum needs relative to energy.

Campus Energy Management

The Energy Initiative has established an innovative campus energy program that opens MIT's campus as a learning laboratory to develop and showcase leading approaches for significantly reducing energy use and greenhouse gas emissions. This program offers a unique platform to engage the entire campus community to identify, develop, and implement hands-on sustainable energy practices that leverage the expertise of our students, staff, and faculty. MITEI has solicited and funded innovative student research proposals that will help meet program objectives.

A campus Energy Task Force was established to develop an integrated strategy and program of action enabling MIT to "walk the talk" on energy and the environment. Drawing on faculty, staff, and students, the task force is well positioned to engage MIT energy experts, draw on new technologies and approaches developed in their research, and build on the grounded expertise of MIT's administrative and operational resources.

Outreach

MITEI's outreach efforts are primarily designed to enhance MIT's role as an as an "honest broker" in framing and analyzing important energy-related societal issues with significant scientific and technological content. Large, multidisciplinary energy studies conducted by the Institute have had major impacts on public policy debates and are viewed by energy policy makers as highly credible, unbiased analyses of key energy topics. Additional studies of this type are contemplated by MITEI in the coming year.

Professor Moniz continues to codirect LFEE and is also the director of MITEI. In the spring of 2007, Professor Robert Armstrong (Chemical Engineering) came on board as deputy director of MITEI. Other new MITEI personnel include Melanie Kenderdine,

associate director, and Robin Elices, executive director. The MITEI website http://web.mit.edu/mitei/ went live in spring of 2007; it describes and links to research, education, and applied energy activities throughout MIT.

LFEE is the administrative home of MITEI; lab staff members are reorganizing their missions under the MITEI banner.

Structure and Mission of LFEE

Since 2000, LFEE has brought together collaborating faculty and staff from 14 departments to address the complex, long-term, multifaceted problems of energy supply and use and of sustainable development. LFEE multidisciplinary teams work not only on technological solutions but also on the economic, political, and social aspects associated with their realization. LFEE fosters constructive relationships between industry, governments, academia, and the public to understand and seek solutions to long-range energy and environment issues. A central theme running through all of LFEE's initiatives is the role of science and technology in shaping better energy and environmental policy at all levels in both the public and private sectors. The education program of LFEE is committed to educating the next generation of energy and environmental leaders worldwide via joint projects locally and nationally, and through participation in international education programs with partners around the world.

In 2006–2007, LFEE was codirected by Professor David H. Marks of ESD and the Department of Civil and Environmental Engineering and Professor Moniz. They were supported by Professor Jeffrey Steinfeld (Chemistry), director of the LFEE Education Program; Stephen Connors, coordinator of multidisciplinary research; Dr. Teresa Hill, assistant director for communications and programs; and administrative officer John O'Brien. LFEE research volume for FY2006 was $5.8 million.

LFEE includes both core component and affiliated programs; the 2006–2007 work of each is detailed below. The Summer Air Quality Symposium Series held annually at Endicott House is also affiliated with LFEE. Proceedings of the 2006 symposium are posted on the LFEE website: http://lfee.mit.edu/. LFEE also administers the jointly listed graduate subject Sustainable Energy (22.811J/10.391J/ESD66/11/371J/1.818J/3.564J), offered for the ninth time this year during the January 2007 Independent Activities Period.

Component Programs

Alliance for Global Sustainability

Research and educational activities supported by AGS connect scholars from four partner universities—MIT, the Swiss Federal Institute of Technology (ETH), the University of Tokyo (UT), and Chalmers University of Technology, Sweden—with stakeholders from industry, NGOs, government, and other leading academic institutions addressing complex environmental problems transcending geographical and disciplinary boundaries.

AGS projects have traditionally fallen within three major focus areas: water, energy, and mobility. In addition, many projects addressed multidisciplinary topics such as urban systems, cleaner technologies, policies and institutions, and communications and

outreach supporting sustainable development. AGS project leaders raised over $20M to supplement these projects and related sustainability research at partner universities.

Building on past integrated, collaborative research activities, AGS has inaugurated a large-scale research program focused on near- and medium-term energy scenarios. The first Flagship Program, Near-Term Pathways to a Sustainable Energy Future, is comprised of a set of regional projects that focus on key energy sectors. These projects are looking in detail at how alternative portfolios of technologies and policies can affect the development of a region's energy infrastructure. AGS has already invested in sustainability-focused energy research and can present a credible worldwide analysis while at the same time providing a neutral forum for the development of integrated scenarios that will require political and regulatory action. To increase the profile of AGS and promote synergy among Near-Term Pathways research activities, the program will also include crosscutting communication, outreach, and learning initiatives. At the 2007 Annual Meeting held in Barcelona, AGS discussed plans for a second Flagship Program on food and water: Secure Ecosystem Services for a Nourished World. The program will identify development paths for social and technical systems in addressing critical issues of food and water for a burgeoning world population over the next five to fifteen years.

In addition to its research programs the AGS supports education and outreach initiatives to raise awareness of the important role of science and technology in meeting the sustainability challenge to future development and to equip the next generation of leaders with the knowledge and skills they need to address sustainability issues throughout their careers. The major AGS educational activity this year was the development of "Teaching Energy and Climate in the Short Course Format." In this joint project, MIT, Chalmers, UT, and ETH will each offer a one-week short course on energy and climate, with each university targeting a distinct audience. LFEE planned and offered its short course "Energy and Climate: Toward Sustainable Systems," for advanced undergraduate students from ten US universities on the MIT campus in June 2006. LFEE coordinated MIT student and faculty participation in the ETH/AGS-supported international Youth Encounter on Sustainability and the UT-sponsored Intensive Program on Sustainability. Professors David Marks and Jeffrey Steinfeld are the MIT coordinators for the AGS.

MIT/AGS Consortium on Environmental Challenges

This year, MIT/AGS worked with the international AGS program primarily in the area of energy futures and transport with substantial support from the Ford Motor Company:

- AGS Flagship program participation at MIT places particular emphasis on sustainable mobility. Stephen Connors (Analysis Group for Regiona Energy Alternatives [AGREA]) is coordinating that effort.
- Professor John Heywood, head of the Sloan Automotive Lab (SAL), has been working on analyzing the conditions that must be met to field a robust fleet of hydrogen-powered vehicles and on other types of alternatives, including the continuing refinement of internal combustion engines. The environmental impacts and efficiency of such engines has been rising steadily.

- Professor Kenneth Oye (Political Science) has been working on what incentive structure would be most likely to encourage a major "first mover" to devote serious resources to developing diesel transport technologies.
- Howard Herzog's program on carbon sequestration technologies continues to draw increasing amounts of attention from industry and government as a solution to controlling CO_2 emissions into the atmosphere at various stages of petroleum extraction and use.
- Visiting scholar Simon Pitts of Ford and Paul Killgoar, also of Ford, have been working with the Joint Program on the Science and Policy of Global Change on greenhouse-gas markets.

The Cambridge/MIT Alliance project on energy security and competitiveness in the UK has also received Ford support.

Carbon Capture and Sequestration Technologies Program

The field of carbon capture and sequestration is attracting much interest due to increasing concerns about global climate change. LFEE's continuing work on carbon sequestration technologies focuses on three areas: assessment, education/outreach, and basic research. Howard Herzog leads this effort. Some key research thrusts include:

- An integrative assessment of carbon sequestration technologies in collaboration with Professor Jacoby and the Joint Program. The focus of the current project in this area is investigating potential penetration rates of sequestration technologies.
- The Carbon Sequestration Initiative, an industrial consortium on carbon management. The seventeen members are: Alstom Power, American Electric Power, American Petroleum Institute, Aramco Services, Chevron, ConocoPhillips, Electricité de France (EDF), EPRI, ExxonMobil, Ford Motor Company, General Motors, Marathon Oil, Peabody Energy, Schlumberger, Shell, Southern Company, and Vattenfall.
- An investigation of social and political factors that will affect the future of carbon capture and sequestration technologies. These factors involve siting, permitting, regulatory, environmental justice, etc. The investigation includes:
- An effort to develop a carbon sequestration information system (using a Geographic Information System [GIS] as a platform)
- A survey to determine the attitudes toward global warming and climate change mitigation technologies, the level of public understanding of global warming and the carbon cycle, and public awareness of carbon dioxide capture and storage (or carbon sequestration). Over 1,200 people, representing a general population sample of the US, responded.
- An economic analysis of the concept of "capture-ready" power plants

In addition, the program has been involved in many national and international efforts related to carbon capture and sequestration. For example, Howard Herzog has been designated as one of the two US Technical Group members for the Carbon Sequestration

Leadership Forum (a ministerial-level agreement between about 20 countries to promote research into carbon sequestration technologies).

Funding for the program comes from a diverse number of sources including the US Department of Energy (DOE), private industry, and NGOs.

Additional information can be found on the program web site at http://sequestration.mit.edu/.

Analysis Group for Regional Energy Alternatives

LFEE research in the area of strategic planning for energy infrastructures and environmental performance is centered in the AGREA, led by Stephen Connors. The scenario-based multi-attribute tradeoff-analysis approach, developed in the 1980s by the DOE's National Renewal Energy Laboratory researchers, is the primary tool used by AGREA. Recent and ongoing projects include the AGS China Energy Technology Program, the Mexico City Air Quality Integrated Assessment, Avoided Emissions from Solar and Wind power in the US, and Combined Emissions Reduction and Energy Security Strategies for Scandinavia, England (CMI Energy Security Initiative), and Portugal (MIT-Portugal Program). Through the LFEE and AGREA, Mr. Connors also coordinates the sustainable energy activities of the AGS, and the MIT-Portugal Program Sustainable Energy Systems Focus Area.

In addition to the projects and programs listed above, Mr. Connors cosupervises numerous independent graduate and undergraduate students looking at the fuel consumption and emissions impacts that are worsening traffic congestion; the widespread deployment of distributed generation technologies; challenges to electrification in Africa and other developing regions; and real options applications to energy investments involving climate change, economic growth, and energy security. Details are available at http://web.mit.edu/agrea/.

Political Economy and Technology Policy Group

The Political Economy and Technology Policy Group led by Professor Kenneth Oye is a joint program of the LFEE and the Center for International Studies. Its purpose is to identify means to improve the quality of public and private responses to critical environmental problems by combining expertise on problems of political economy with fundamental understanding of scientific and technical issues. The group's research focuses on two key areas for improving environmental decision making.

The first area is the use of scientific information in public policy making. The intent is to identify methods for more robust and integrated assessments of policy options and for credible assessments of risks in areas of environmental policy controversy, and to improve the capacity of political institutions to adapt to new information. Research has included the improvement of responses to uncertainty associated with the environmental, security, and economic effects of rapid technological change; the private effects of public environmental policies, with specific attention to the competitive position of firms, sectors, and nations; and links among regulation, the utilization of technologies, and industrial structure.

In addition, the group worked with scientists and engineers to ensure that assessments of technical options include analyses of political and economic constraints and opportunities. Members of the group worked with the LFEE Carbon Capture and Sequestration Program and with the Joint Program on Science and the Policy of Global Change assessment of developing country CO_2 options.

Affiliated Groups

Faculty in several MIT centers, programs, and laboratories pursuing interdisciplinary energy and environmental activities are affiliated with LFEE through the financial administration of some projects and through research and educational activities shared through the LFEE component programs listed above.

Building Technology Program

Research in the Building Technology Program (BTP) has its principal focus on energy efficiency and sustainable design for buildings. In the US, buildings consume almost 40% of the total energy and more than two thirds of the electricity. The long life and the difficulty of renovation mean that mistakes in today's buildings will create energy and environmental problems for much of this century. In many instances, investment in new energy efficiency technologies for buildings is more cost effective than investment in new energy production facilities. If done properly, energy-efficient and sustainable design will also lead to better indoor health, comfort, and productivity. It has been frustrating to deal with the lack of focus of the federal government in this area. MIT facilities also need attention. There is a growing consensus to develop leading edge economic, energy-efficient buildings on the MIT campus. Building Technology faculty are actively involved in the campus Energy Task Force, helping to develop metrics for new lab buildings and prepare proposals for advanced technology activities on campus.

Four of the five faculty members in the BTP have had strong input to LFEE's energy research and teaching: Professors Marilyne Andersen, John Fernandez, Leon Glicksman, and Les Norford, all of the Department of Architecture. Professor Andrew Scott of the Architecture faculty is also a member of our group and is active in many of our projects. Many of the activities involve substantial joint efforts with faculty members and students in Civil and Environmental Engineering, Electrical Engineering and Computer Science (EECS), and Mechanical Engineering as well as Harvard School of Public Health, Cambridge (UK), Chalmers, ETH, and Tsinghua University (China). Typically we have 15 to 20 graduate students carrying out building technology research. Some students receive degrees in the Department of Architecture, others in the School of Engineering.

Several major projects underway or recently completed:

Natural Ventilation of Commercial Buildings

When natural ventilation is properly designed and operated, indoor air quality is improved and a substantial portion of the energy used for cooling can be saved (typically 33–50% in Boston and up to 100% in the UK). A joint project with Cambridge University under the CMI program includes the development of basic models to predict the airflow and thermal conditions in complex open plan buildings under buoyancy

and wind forces. In addition, BTP faculty members have done one of the first detailed monitorings of a large commercial, naturally ventilated building during occupancy, and are developing proper similitude rules to allow small-scale experiments to closely simulate large buildings. They have also developed methods for in-situ measurement, modeling, and control of building performance, with the goal of optimally cooling buildings when outdoor temperatures permit, as is often the case at night. A new design tool has been developed that predicts the natural ventilation air flow due to wind and buoyancy in multizone open-plan buildings.

Design Tools

Currently, energy studies are lengthy and costly and typically are not undertaken until a building design is near final form. Simple web-based tools are under development that will allow designers to get real-time feedback of design scenarios during the conceptual design phase. Advanced technologies such as double skin facades and natural ventilation are simulated in the tool. Recent additions include a real-time (one to two minute running time) optimizer that considers the optimum choice of up to 30 different design parameters to yield the lowest yearly energy consumption for heating, cooling, and lighting. In a parallel effort, a design tool is being developed for material selection that allows a designer to screen conventional and newly developed materials and tradeoff characteristics such as embodied energy and nonrenewable content.

Fault Detection, Monitoring and Control

Studies in Texas showed that better commissioning of HVAC equipment and ongoing detection of major problems reduced energy consumption by over 20% in over 100 buildings. BTP researchers are working with EECS professor Steven Leeb on techniques to detect faults in and monitor the performance of a wide range of HVAC equipment in buildings and ships, using high-speed electrical measurements and signal processing.

Sustainable Buildings for Developing Countries

The largest increase in energy use and CO_2 production is occurring in the developing world. Each year China is building upwards of 10 million housing units. In a recently completed project we worked with Chinese developers, architects, and academics at Tsinghua University to develop technical solutions and building designs appropriate to Chinese buildings. This was supplemented by design workshops in China, and will culminate in a book to be published by the end of this year.

In earlier projects in the developing world, BTP scholars developed low-cost retrofit insulation for the mountainous regions of Pakistan and analyzed village houses in India, where lack of kitchen ventilation poses a serious problem to women and children.

Daylighting

Energy for lighting is the larger segment of energy use in a commercial building. The level of daylight outdoors is one to two orders of magnitude higher than that required within a building. A new faculty member is leading efforts to develop innovative materials and systems to bring daylighting deeper into commercial buildings. In most cases this would be more efficient than using photovoltaics to generate electricity for conventional lighting systems.

Real Options

Option theory has been applied to determine the value of flexibility in the initial building design. This flexibility allows the option of less costly future renovations such as the installation of chillers to supplement natural ventilation if global warming causes more severe summer conditions.

MIT Facilities

Design projects were carried out to evaluate advanced techniques substantially improving energy efficiency and performance of MIT buildings. These include control optimization, exterior wind conditions around the Stata Center, and using displacement ventilation (based on US design guidelines for this technology developed by the BTP group).

Education

A number of subjects with an energy focus are offered by our group to both graduates and undergraduates. These include lectures, laboratory subjects, and design workshops.

Center for Advanced Nuclear Energy Systems

LFEE administered two research projects in the Center for Advanced Nuclear Energy Systems (CANES). Dr. Pavel Hejzlar finished a three-year project investigating fundamental thermal-hydraulic phenomena for advanced gas-cooled reactor applications. Professor Jacopo Buongiorno is studying water-based nanofluids for nuclear systems applications. Both projects are sponsored by Battelle Energy Alliance, LLC. In addition, Professor Mujid Kazimi is engaged in a comparison of quantification methods of proliferation resistance of the nuclear fuel cycles.

CANES develops research concepts for nuclear energy systems promising more favorable economics, safety, proliferation resistance, and environmental impact. The Center's programs involve development and application of methods for the design, operation, and regulation of current and advanced nuclear reactors and fuel cycles. Professor Mujid S. Kazimi is the founding and present director of CANES. Information on CANES extensive research and outreach activities is at http://web.mit.edu/canes/.

Two two-day symposia were held: Innovative Nuclear Technology, in November 2005; and R&D Needs of Advanced Nuclear Energy Systems, in March 2005. Electronic proceedings can be ordered at http://web.mit.edu/canes/symposia/symposia.html. CANES faculty also offered four short summer courses on Nuclear Plant Safety, Reactor Technology for Utility Executives, and Reliability in Operational Decision Making on Degradation of Materials in Radiation Environments.

Sloan Automotive Laboratory

A significant amount of LFEE's and MITEE's research volume supports work at the SAL. Many of the lab's projects involve quantitative and cross-disciplinary study of complex energy and environmental systems. SAL is directed by Professor John Heywood, with participation from Professor Wai Cheng, Professor James Keck, Dr. Tian Tian, Dr.Victor Wong, and Professor William Green. It continues to pursue promising research to

improve engine performance, efficiency, and fuel utilization in internal combustion engines and reduce adverse emissions.

Focusing on new engine and fuel technologies, the Engine and Fuels Research Consortium explores critical fuel/air mixture preparation and emission formation mechanisms in gasoline and diesel engines and in developing engine/fuels concepts. It is funded by automotive and petroleum companies and DOE. Complementing the engine and fuels studies, the Consortium on Lubrication in Internal Combustion Engines involves major engine component and lubricant manufacturers in addressing issues in oil consumption and engine friction reduction. Members in these consortia also sponsor separate research projects on topics of specific interest to the individual sponsors related to engines and fuels. A new consortium with 10 members, focused on developing low ash-producing lubricants to enable significantly improved diesel emission control, is now underway with strong support from the diesel engine industry.

SAL researchers are also involved in multidisciplinary studies assessing new vehicle and propulsion system technologies for future road transportation use. A major study, "Before a Transition to Hydrogen Transportation," is examining the potential for more efficient engines, transmissions, vehicle weight reduction, and new fuel streams such as ethanol to reduce US and European fuel consumption and greenhouse gas emissions.

An example of the group's efforts to develop new technology is a downsized gasoline engine concept with fuel economy levels close to today's hybrid engines at much lower cost, which uses ethanol to enable knock-free boosted engine operation. This concept is being developed by Dr. Leslie Bromberg, Dr. Daniel Cohn, and Professor John Heywood.

Center for 21st Century Energy

Codirected by professors Ahmed Ghoniem and John Heywood, the Center for 21st Century Energy, part of the Department of Mechanical Engineering, is affiliated with LFEE and MITEI. The center is encouraging scholars to undertake research in new and mainstream energy technologies and contribute to the broad-based, multidisciplinary assessments and analyses undertaken at LFEE. According to Professor Heywood, "There needs to be a steady stream of people who get involved, especially new people who bring different engineering expertise to these multidisciplinary activities."

Center for Energy and Environmental Policy Research

The Center for Energy and Environmental Policy Research (CEEPR) is an activity jointly sponsored at MIT by LFEE, the Department of Economics, and the Sloan School of Management. CEEPR funds policy-related research in energy and environmental economics. The center receives financial support from corporate sponsors and government agencies such as the US Environmental Protection Agency and the US National Oceanic and Atmospheric Administration.

CEEPR research, administered through LFEE, is focused on evaluating the functioning and performance of markets created for environmental services and for electricity and associated network services. Past environmental research has been concerned with emissions trading with particular attention to the US SO_2 Allowance Trading Program

and the Northeastern NO_x Budget Program. Recent work includes analysis of the market for carbon created under the European Emissions Trading System. The electricity research is concerned with restructuring decisions with respect to asset ownership, transmission access, and customer choice. CEEPR is also involved in evaluating the future of nuclear and coal energy and in the development of markets for oil and natural gas and renewables. Research includes analysis of financing large scale investments as well as the price dynamics and risk in these markets.

Joint Program on the Science and Policy of Global Change

This program, codirected by Professor Jacoby of the Sloan School of Management and Professor Ronald Prinn of the Department of Earth, Atmospheric, and Planetary Sciences, draws on MIT's traditional strengths in science and economics to conduct the serious interdisciplinary work needed to provide a basis for global climate policy. Currently administered through LFEE, the now 15-year-old joint program is one of the world's leading centers for the integrated assessment of climate change. An MIT Integrated Global Systems Model developed by program researchers provides a facility for research on the climate issue and assessment of policy proposals. An interdisciplinary team of faculty, professional staff, and graduate students carries out the work, and it produces a continuing flow of reports, articles, student theses, and professional and public presentations on the science and policy of global warming. Five US government agencies, 23 corporate sponsors in North America, Europe, and Japan, and one foundation support the work.

Education and Curriculum Initiatives

The mission of the LFEE Education Program is to enhance energy and environmental literacy and to deepen multidisciplinary knowledge on energy and the environment, particularly among the leaders of tomorrow's science and technology communities. The program is dedicated to increasing awareness of the complexity of energy, environmental, and sustainability challenges, and to increasing society's capacity to respond effectively to these challenges. A special challenge of the mission of the LFEE Education Program is to foster the inclusion of energy and environmental issues in the education of every MIT student. Professor Jeffrey Steinfeld (Chemistry) directs the LFEE Education Program; Dr. Amanda Graham is program manager.

Major campus initiatives during the past year include:

- Coordinating the planning, instruction, and evaluation of 5.92 Energy, Environment, and Society, a pilot project-based subject for first-year students supported by the d'Arbeloff Fund for Educational Excellence.
- Providing support to the Energy Education Task Force (led by professors Angela Belcher and Jefferson Tester) and the Environmental Assessment Task Force (led by Professor Maria Zuber)
- Supporting more than a dozen Undergraduate Research Opportunities Programs (UROPs) through the Martin Family Society of Fellows for Sustainability and Campus Sustainability UROP Programs

- Convening leaders once per semester from more than 20 MIT student groups related to energy, environment, and sustainability to network and plan for future collaboration. The program also supported a new campus-wide student event, the "EcoExpo," as well as the development of a new student effort, the MIT Generator, which has evolved into a significant hub of student activity related to campus sustainability. Program staff codelivered a presentation on this topic at the Second Annual Smart and Sustainable Campuses Conference sponsored by the National Association of College and University Business Officers in April.

In addition, the program continues to:

- Manage fellowship programs for scholars in sustainability, including the Martin Family Society of Fellows for Sustainability, for outstanding upper-level MIT graduate students. MITEI director Moniz addressed the Martin Fellows at their annual induction dinner in September. The program coordinates an Environmental Fellows Group to engage all environmental fellows at MIT. Activities this year included a retreat on aquaculture at the Woods Hole Oceanographic Institute and a fellow-to-fellow research exchange.
- Support efforts by the MIT Council on the Environment to improve coordination and coherence among academic, research, and activity offerings for undergraduates, including coordinating with Admissions, Careers, and Orientation to better serve prospective students and future alumni. The Program cohosted MIT's third Environmental Careers Panel in January with the MIT Career Office.
- Upgrade and maintain EnergyClasses and enviroClasses, two web-based indices of MIT subjects, viewable at http://energyclasses.mit.edu/ and http://enviroclasses.mit.edu/.
- Support and participate in the development of subjects and programs for environmental majors and graduate students
- Participate in campus-wide events such as the International Development Forum, Campus Preview Weekend, Freshman Orientation, and Earth Day, and serve as MIT host for community events such as the Junior Solar Sprint.

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More information about the Laboratory for Energy and the Environment can be found at http://lfee.mit.edu/metadot/index.pl