

MITEI Campus Energy Task Force Summary Report - August, 2007

MIT Energy Initiative: Walking the Talk on Energy and the Environment

Executive Summary

The Campus Energy Task Force (aka “Walk the Talk” Task Force) was established spring semester 2007 to develop and coordinate the campus energy program as outlined in the Energy Research Council report to the President and Provost. The Task Force has met monthly since January to identify priorities and develop a program of action. The Task Force is co-chaired by Leon R. Glicksman, Professor of Building Technology and Mechanical Engineering and Theresa M. Stone, MIT Executive Vice President and Treasurer. Task Force members include faculty from the 5 academic schools, representatives from key administrative offices and support staff, and both under-graduate and graduate students. The Task Force membership is included at the end of this report.

The Task Force's aim is to bring forward solutions from the research laboratories and classrooms as well as from practice-based management innovations that minimize the energy footprint of energy-intensive institutions such as MIT. The Task Force is working to develop 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 through campus-focused research, student learning opportunities and the implementation of best practices. This program is seeking to develop a unique platform to engage the entire campus community to identify, develop and implement sustainable energy practices and policies. Through the establishment of a broad, intense and economically viable sustainable energy program, MIT will serve as a model for other large organizations.

The Campus Energy Task Force has concluded its first semester of work with progress being made in several areas that are detailed later in the report. Key accomplishments that involve many academic and administrative units include:

1. Developing a methodology in collaboration with a Sloan School class to evaluate campus project investment opportunities using both financial and carbon emission reduction metrics. This has led to the initiation of a new process for internally funding attractive near-term energy conservation investments;
2. Help to focus the emerging design of the new cancer research facility to incorporate several new approaches and technologies to substantially reduce lab energy use while reducing life cycle costs;
3. Establishing a small grant fund to support innovative student campus energy projects; in response to a call for proposals, seven student projects have been awarded seed funds;
4. Encouraging student learning opportunities that use our campus as an energy learning laboratory through UROP, student theses and special projects. Recent projects include

fume hood energy savings, analyzing official air travel records to determine CO2 impacts, and energy intensity mapping of the campus;

5. Cooperated with IS&T to begin an energy audit and research program focused on building N42 and facilitated MIT joining the Google and Intel-led Climate Savers Computing Initiative;
6. Building awareness on campus of the task Force and its work through presentations, a new website and tech talk articles; these measures are beginning to increase community involvement
7. Developing a multi-disciplinary, long-range research agenda that examines campus energy opportunities. Two new research efforts are already being developed:
 - a. A long range integrated study of future campus energy efficiency (Sloan, Architecture and Planning, and Engineering Schools);
 - b. Intelligent Infrastructure for Energy Efficiency (I2E), a program to use new monitoring and control techniques to achieve building energy efficiency (Media Lab, Building Technology, and Engineering);
8. Established a dialogue with the new Cambridge Energy Alliance; MIT and Harvard will co-host a design workshop in the fall to identify energy efficiency opportunities for the city of Cambridge

Looking forward, the Task Force will focus on developing several key areas to ensure an effective, sustained and leading campus energy initiative. These include:

1. Develop joint academic research and education programs in coordination with the MITEI Education Task Force that support the “walk the talk” mission;
2. Develop and institutionalize new building and major renovation performance metrics to ensure highly efficient, cost effective sustainable designs;
3. Discuss specific campus energy goals and targets to motivate & drive innovation;
4. Develop a campus energy program identity to enhance outreach & participation;
5. Increase support for student campus energy projects;
6. Develop a process for fostering and applying emerging technologies from the research lab to our campus built environment; and
7. Plan a new energy research facility - a “building 20 for the 21st century” - where advanced building technology prototypes can be developed and tested and innovative undergraduate educational projects can be hosted.

Currently, it has become clear that there is a need to consider and establish certain strategic, high-level institutional mechanisms to ensure long-term success and program penetration. These mechanisms may include: articulation of an institute vision for a campus that “walks the talk” on energy and the environment; top-level commitment to the objectives of the Task Force;

and establishment of goals, milestones and evaluation metrics for campus energy use, conservation, and greenhouse gas emissions. The Campus Energy Task Force looks forward to helping to define these mechanisms and vision.

Detailed Working Group Summaries

The Campus Energy Task Force has been organized into a number of working groups to focus on key tasks within our overall goal. The work encompasses the following scope:

- Opening our campus as a learning laboratory for students, faculty and staff;
- Investing in energy conservation;
- Increasing energy efficiency in campus energy production and use;
- Applying advanced energy technologies and management approaches;
- Embracing sustainable design in building and campus development;
- Creating campus-focused energy research and education agendas & opportunities;
- Applying new financial strategies to enhance campus energy performance;
- Identifying the critical enabling policies needed to sustain a campus energy program; and
- Providing institutional leadership among colleges and universities on campus sustainable energy practices.

The detailed summary of the working groups are given in the following sections.

I. Near-Term Measures Working Group Summary

The Near-Term Measures Working Group is identifying and advancing measures that can be taken on campus in the next few years to reduce energy use and greenhouse gas emissions while also exploring new funding approaches and mechanisms. This working group has made strong progress to both plan for and implement a large-scale campus energy conservation and efficiency program that is designed to substantially reduce energy use, while making financially attractive returns on investments.

Highlights and Accomplishments

- Developed a methodology in collaboration with a Sloan School class to evaluate campus project investment opportunities using both financial and carbon emission reduction metrics. This methodology has proven effective for prioritizing selection of near-term measures.
- Developed a comprehensive portfolio of potential near-term mitigation measures including projects in: facility efficiency, behavioral change, procurement, off-site green power purchasing, and on-site renewable power. This portfolio includes over 100 projects, over \$100 million dollars of possible investments, \$16 million in potential annual cost savings, and a 50% reduction in campus greenhouse gas emissions from 2003 levels.

- Established a new funding evaluation and capitalization process with the Executive Vice President and Finance Offices to support long-term investments in facilities infrastructure energy conservation measures.
- Created and submitted a portfolio of select near-term facilities conservation and efficiency investment opportunities with attractive ROI for immediate consideration by the EVP, totaling \$9 million.
- Department of Facilities has initiated a select number of conservation projects including steam system renewals, lighting upgrades, and behavioral change initiatives.

Future Areas of Focus and Opportunities

- Establish a process for ***non-building infrastructure*** initiatives such as behavior change, procurement standards, computer energy, lab equipment efficiency, transportation, renewable power, solid waste, etc.
- Establish a process to fund efficiency enhancements to ***renovation and new building*** projects, as well as projects that support innovation and education objectives.
- Articulate near-term MIT community campus energy goals and action plan to drive sustained implementation and build programmatic recognition and awareness.
- Develop a marketing & communication plan to support energy conservation initiatives.
- Evaluate and consider essential departmental organizational and staffing needs to ensure adequate capacity to implement emerging campus energy program.

Working group members: Walt Henry, Peter Cooper, Eric Beaton, Jason Jay, Larry Benedict, Debbie Sorocco, Bob Jaffe, Steve Lanou, and Nick Hofmeister.

II. New Building Design and Construction Working Group Summary

Highlights and Accomplishments

This working group has been focused on examining the mechanical system designs of planned new construction on campus for opportunities of improving the energy performance. The cancer research facility has been the initial focus, examining several higher performance heating, ventilation and air conditioning (HVAC) options. Working collaboratively with the Department of Facilities, the EHS Office and others, the working group has supported life-cycle cost analyses that highlights the long-term cost benefits of more efficient technology choices while meeting the strict health and safety needs of occupants. Currently, the cancer research facility is including heat recovery and high-performance duct designs that might otherwise have been omitted due to higher first costs.

The working group has also collaborated with Facilities and EHS to assess the ventilation requirements of fume hoods, a major energy consumer in campus laboratory buildings. For the cancer research facility, this investigation has included a review of how laboratory airflow is controlled and whether airflow can be reduced during unoccupied periods. Improved control strategies that can be adapted for retrofit use in existing campus laboratory buildings are another area of investigation.

Future Areas of Focus and Opportunities

- Assess retrofit opportunities for campus fume hoods, based on control strategies developed for the new cancer research facility.
- Develop new-building energy-consumption metrics, for different building types (e.g. labs, offices, dormitories). The metrics will be based on data from MIT campus buildings, exemplary buildings on other campuses, and existing data sets from the U.S. Department of Energy, Environmental Protection Agency and state organizations.
- Develop guidelines for incorporation of energy-efficiency measures into campus construction projects, whereby the estimated life-cycle energy savings are evaluated in conjunction with the capital cost.

Working group members: Peter Cooper, Laxmi Rao and Les Norford.

III. Education/Campus Learning Lab Working Group Summary

Engaging our students to help jointly find solutions to MIT's own campus energy challenges is a fundamental mission of the Education/Campus Learning Lab Working Group. Students have demonstrated a rapidly growing and very strong interest and commitment to make contributions to improve MIT's own energy performance, institutional leadership position, and learning opportunities. Students are eager to shape and help how MIT "walks the talk" to reduce its energy and environmental footprint. Using MIT's campus operations as a learning laboratory to test their emerging technical and leadership skills to help define and solve our own energy challenges offers an exciting component of the campus energy initiative. This campus learning laboratory concept offers true opportunity for meaningful collaborations among our faculty, staff and students that are cross-disciplinary and engage the entire campus.

A working group composed of students and staff has been assessing existing and developing new mechanisms to provide rich project-based educational opportunities on campus. These opportunities are found in both the formal and informal educational settings.

Highlights and Accomplishments

- There is currently a rich set of proven mechanisms and opportunities to engage both graduate and undergraduate students in campus project-based learning that examine real world energy challenges while providing potential solutions to campus energy problems. Some of those underway include:
 - UROPs jointly developed and supervised by operations staff and academic faculty departments, e.g. Campus Sustainability UROPs;
 - class curriculum-based projects that address community energy issues, e.g. Sloan School Sustainability Lab;
 - Special classes assessing community climate protection approaches, e.g. IAPs, Freshman Advising Seminars, etc.;
 - Theses that examine opportunities for improved campus energy management;
 - Informal volunteer projects through student groups, e.g. through the Energy Club, MIT Generator, SAVE, etc.

- A competitive mini grant-making program has been established and seeded with pilot funds to support innovative student campus energy projects that advance “walk the talk” objectives. Seven grants have been awarded this summer and fall through the Student Campus Energy Project Grant Program to support projects ranging from mapping energy use on campus to supporting an IAP wind turbine design competition. Grant proposals are reviewed by a team of faculty, students, and staff.
- A mechanism has been established to ensure a robust liaison with the MITEI Education Task Force to best leverage the collaborative educational and “walk the talk” opportunities. A staff member from the MITEI Education Task Force serves jointly on this working group.
- A unique post-doc position proposal has been developed to solidify and fully realize campus learning laboratory objectives, collaborations, and synergies across the MITEI and beyond.

Future Areas of Focus and Opportunities

- MITEI should support continued development of both formal and informal campus energy learning opportunities.
- Formal cases studies should be undertaken to learn from and document past experiences.
- A formal mechanism needs to be developed to develop, match and coordinate campus energy project needs with appropriate student learning mechanisms and students.
- Sustained, modest funding will be needed to support student projects and learning opportunities, and coordination.
- Larger scale funding will be needed to support graduate study and implementation of innovative student-identified opportunities, such as renewable power installations or energy efficiency upgrades.
- Deeper recruitment and engagement of faculty on this working group is needed to identify additional campus project-based learning opportunities.
- A post-doc level staff member should be hired to identify, develop, coordinate, and sustain an integrated “learning laboratory” education program.
- Establishment of an “Ideas”-type competition for the best student campus energy project is an excellent driver of sustained student engagement

Working group members: Steve Lanou, Jason Jay, Ariel Esposito, Amanda Graham, and Elsa Olivetti.

IV. Outreach and Community Engagement Working Group Summary

The Outreach and Community Engagement Working Group is identifying and enabling needs and methods to communicate the goals, plans and progress of the Campus Energy Task Force and its programs to inform, educate, engage, and inspire the wider MIT community on campus energy issues. In addition, the working group has been helping articulate the purpose, mission, and identity of the Task Force and its work. To achieve the Task Force’s objectives and to build a wide community of engaged and participating faculty, staff, and students, a consistent and compelling identity needs to be developed and communicated. The emphasis of the work this past semester has been to build awareness of the Campus Energy Task Force, its work, and early progress to date through development of written materials and development of a web presence.

Principal activities included coordinating and developing written outreach material on Task Force news; serving as liaison with the MITEI Web Team for the Campus Energy Activities site; collaborating with News Office for story development; developing outreach for the Student Campus Energy Project Grants; and brainstorming branding ideas and strategies for campus energy activities.

Highlights and Accomplishments

- Developed, launched and updated preliminary Campus Energy Activities website section of the MITEI website at <http://web.mit.edu/mitei/campus> .
- Developed, coordinated, and placed prominent Tech Talk article and MIT homepage spotlight about the Campus Energy Task Force on May 9th.
- Developed and/or supported numerous additional Tech Talk articles and web spotlights on campus energy-related activities including:
 - MITEI Website launch (<http://web.mit.edu/mitei>)
 - Fume hood behavioral change program
 - Student campus wind power assessment class project
 - Energy efficient Great Dome re-lighting project
 - Sloan S-Lab class
 - 5.92 Energy, Environment and Society Energy d'Arbeloff class
 - Student biodiesel project
 - Student Generator events
 - Student Campus Energy Project Fund Request for Proposals
- Developed proposal for expanded and comprehensive Campus Energy Activities website.
- Established a dialogue with the new Cambridge Energy Alliance; MIT and Harvard will co-host a design workshop in the fall to identify energy efficiency opportunities for the city of Cambridge

Future Areas of Focus and Opportunities

- Develop Campus Energy Activities website beyond a news site to be a key destination and resource for stakeholders to both learn about campus energy issues and provide tools to enable them to participate and/or take action.
- Undertake a more focused dialogue among Task Force members and key stakeholder representatives to more clearly articulate an identity for the Task Force and the initiatives it supports to build a visible and coordinated “brand” for campus energy activities. This should include development of a graphic identity/logo for printed and web material.
- After Task Force establishes programmatic priorities, develop brief printed and electronic material to distribute to MIT community to build awareness.
- Sponsor several “Town Hall” type meetings to build support and engagement on specific topic areas, e.g. energy conservation on campus, building educational opportunities, sustainable design, etc.

Working group members: Steve Lanou, Ariel Esposito, Diana Daigle, with Ruth Davis (Dept. of Facilities) collaborating.

V. Personal Behavior Working Group Summary

The Personal Behavior Working Group of the Campus Energy Task Force has just recently been formed. This is in response to the realization that there are significant short-term opportunities for energy conservation by changing the behaviors of individuals. But we found that projects addressing behavioral change are embedded in longer-term programs that are scattered across the emerging campus energy program. By forming this working group, we can focus and coordinate these activities to foster the early and meaningful engagement of large numbers of members of the MIT community.

The working group had its first meeting in mid-July and mapped out a four-pronged effort to define their assignment:

- Define the audiences that we will address for the behavioral effort.
- Identify and engage other key players (faculty, administration, etc.) that can play a role in the task force efforts.
- Gather together in one place (e.g. a web site) all of the projects involving behavioral changes that are underway or proposed. Define the analysis required to put all efforts into a common framework.
- Create a marketing plan to define how we will reach, educate and engage individuals.

Assignments were made and strategy laid out with the goal of having clear direction for the group by the beginning of the academic year in September.

Working group members: Sherwin Greenblatt, Jason Jay, Steven Lanou, Elsa Olivetti, Jianlan Wang, Diana Diagle, Laxmi Rao, Alana Levine, Dan Wesolowski, and Peter Cooper.

VI. Information Services and Technology (IS&T) Energy-Related Activities

A new role of information technology (IT) energy coordinator, reporting to the VP for Information Services and Technology (IS&T) was created in March 2007, to lead, plan and coordinate activities in the area of IT energy use across campus, to work closely with the Campus Energy Task Force, the MIT community and vendors to find solutions to reduce the IT energy footprint at MIT and to support innovative uses of energy for computing.

Preliminary work has commenced on a one-year energy audit of Building N42 that will involve faculty, graduate students and a UROP working with IS&T and Facilities as community partners. The project will serve as a testbed for application of innovative monitoring and communications technology under development at the Media Lab's Center for Bits and Atoms in cooperation with the Building Technology Group in Architecture. This will include research on the use of next generation intelligent devices to monitor and control selected building zones. The goal is to produce comfortable local conditions for occupants while simultaneously achieving the most

energy efficient operations. The research program has been developed from the collaboration of Media Lab and Building Technology faculty and students as part of the Intelligent Infrastructure proposal.

IS&T staff partnered with and supported students and faculty of subject 1.102 “Introduction to Civil and Environmental Engineering Design” in spring 2007 to develop a pedal-powered Athena laptop project with resources from vendors and IS&T.

In June 2007, MIT joined the Climate Savers Computing Initiative, a worldwide effort led by Intel and Google aimed at energy-efficient computing through procurement of computers with higher efficiency power supplies and promoting the adoption of power management practices.

Staff conducted special educational and outreach sessions at Earth Day and IT Partner’s Conference events on campus. Information is communicated to the MIT community through a newly launched IT-Energy web page and a monthly Computer Currents column in the IS&T newsletter. Ideas for energy saving suggestions are also solicited via the IT-Energy e-mail list.

Working group members: Laxmi Rao, Les Norford, and Leon Glicksman.

VII. Innovative Research in Energy Efficiency

One of MIT’s strengths is the expertise inherent in many ongoing research groups throughout the campus. An important effort for the Campus Energy Task Force is to bring together these researchers to define and develop a multi-disciplinary, long-range research agenda that examines campus energy opportunities. Two new research efforts are already being developed:

- A long-range, integrated study of future campus growth and energy efficiency entitled, “Exploring the Barriers to Increasing Energy Efficiency in the Built Environment: A Proposal for an Integrated Study at MIT and Beyond”. This proposal has been jointly developed by faculty in Sloan, Architecture and Planning, and the Engineering Schools, Leon Glicksman, Rebecca Henderson and John Sterman
- Intelligent Infrastructure for Energy Efficiency (I2E), which uses new internet protocol and devices to develop monitor and control techniques to achieve building energy efficiency. This research is being put together by faculty at the Media Lab, Building Technology, and Engineering, Neil Gerschenfeld, Leon Glicksman, and Les Norford

VIII. Campus Energy Task Force Members

Co-chairs

- Leon R. Glicksman, professor of building technology and mechanical engineering
- Theresa M. Stone, MIT executive vice president and treasurer

Faculty

- Vladimir Bulovic, associate professor of electrical engineering and computer science
- Robert L. Jaffe, professor of physics

- Leslie K. Norford, professor of architecture
- John Sterman, Jay Forrester Professor of Management
- Christopher P. Zengras, assistant professor of urban studies and planning

Administration

- Larry G. Benedict, dean for Student Life
- Peter L. Cooper, manager of sustainability engineering and utility planning, Department of Facilities
- Diana J. Daigle, public service support associate, MIT Libraries
- Robin Elices, Executive Director, MITEI
- Richard R. Fenner, director of undergraduate teaching labs, Dept. of Mechanical Engineering
- Lorna Gibson, associate provost
- Sherwin Greenblatt, director, Venture Mentoring Services, Office of the Provost
- Walter E. Henry, director, systems engineering group, Department of Facilities
- Steven M. Lanou, deputy director, Sustainability Program, Environmental Programs Office
- Laxmi J. Rao, IT energy coordinator, Information Services & Technology
- William Van Schalkwyk, managing director, Environmental Health and Safety Programs

Students

- Ariel M. Esposito, Department of Civil and Environmental Engineering
- Jason J. Jay, Sloan School of Management