

international sustainable campus network



April 24, 2008 – Zurich

North-American Best Practices

MIT Engaging Students in Campus Greening: Local Action, Leadership, Global Change

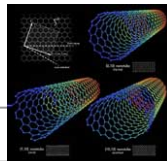
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MIT Campus: A Microcosm of Our Global Challenge

- MIT targeting energy and climate issues
- Aligning research, education, walking the talk
- A learning laboratory for local & global change
- Students play key role in all aspects
 - Pushing the envelop on all frontiers

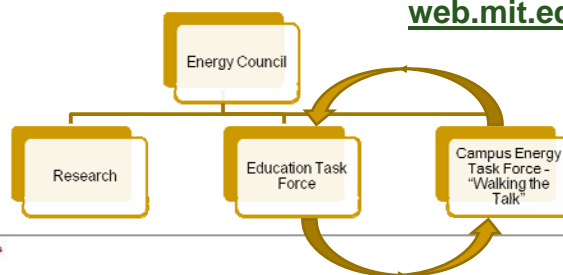


MIT Energy Initiative



- **Energy Initiative:** President Hockfield's signature research initiative
 - A call to action for MIT to tackle the global "energy crisis":
 - *"The need for workable energy options is perhaps the greatest single challenge facing our nation and the world in the 21st century"*
 - The gist: how to meet growing energy demand without destroying our world's resources = sustainable energy

web.mit.edu/mitei



MIT Energy Initiative: Walking the Talk on Campus

- Extending research impact by demonstrating sustainable energy practices on campus and integrating education opportunities
- Leading and educating by example: MIT taking action to reduce its own campus energy foot print through:
 - Making a commitment
 - Investing in energy conservation
 - Increasing energy efficiency
 - Applying advanced energy technologies
 - Embracing sustainable design
 - Applying innovative financial strategies
 - Opening our campus as a learning laboratory
 - Creating campus-focused energy research and education opportunities
- Using greenhouse gas emissions & student engagement as some metrics of our progress



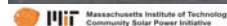
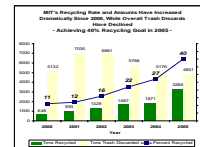
Setting the Stage at MIT

- 130 academic buildings
- 11.5 million sq feet academic space
- 153 urban acres in Cambridge
- 20,000 person campus population
- Over 2,000 research labs
- District steam, chilled water & electricity
- Utilities purchased for FY06 \$49M (FY07 \$60M)
 - \$31.7M natural gas (2.9 million mmbtu)
 - \$9.4M electric (80 GWh of 200 GWh total)
 - \$3.8M oil (0.4 million mmbtu)
 - \$4.2M water and sewer
- Building energy intensity
 - Campus average 373 kbtu/sf/year
 - Typical wet lab 1200 kbtu/sf/yr
 - Bldg 39 2600 kbtu/sf/yr
 - Typical dorm (unairconditioned) 150 kbtu/sf/yr
- Historical 1M sq ft of new space/decade



MIT's Sustainability Challenge

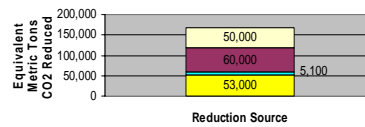
- MIT uses 350 million gallons of water annually
- Generates nearly 16,000,000 lbs of trash per year
- ...and over 270,000 lbs of lab chemical waste per year
- Produces thousands of cu/ft of other regulated lab waste waste annually
- 25% of MIT community drives to campus alone
- But 75% take the T, carpool, bike, walk, etc. versus 45% nationally
- Of over 100 campus vehicles, only 3 use alternative fuel
- Energy, energy, energy...



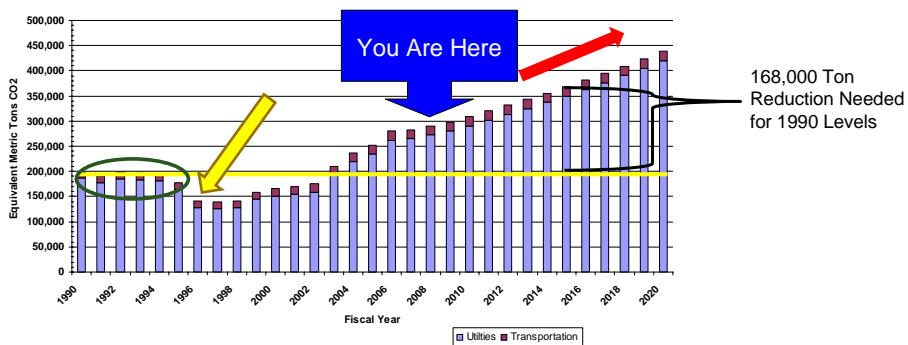
Our GHG Challenge

- Building consumption 90%
- Transportation (including commuting) 9.5%
- Solid waste 0.5%

GHG Reduction Scenario
(1990 levels by 2015)

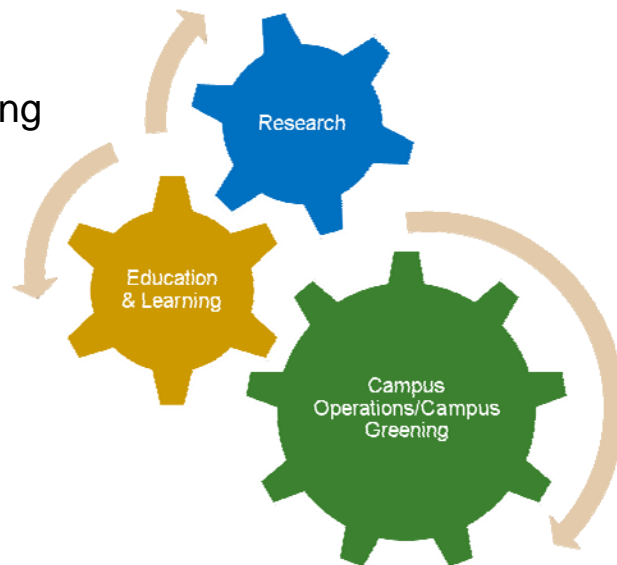


CO₂ EMISSIONS FROM MIT CAMBRIDGE CAMPUS
(Calculated 1990-2005; Estimated 2006-2020)



Avenues for Student “Education” in Sustainability

- Researching
- Learning
- Doing
- Leading
- Driving





Students Embrace the Campus as a Learning Laboratory



- ✓ Student interest in on-campus energy and environmental performance has skyrocketed
- ✓ Driven by desire to:
 - Walk the Talk on campus and affect change in their community
 - Create a unique space to apply MIT-honed creative problem-solving skills
 - Develop and test emerging leadership abilities
 - Build collaborative bridges across academy and administration
- ✓ Lead the way on campus for win-win solutions:
 - ✓ Reduce energy use and costs
 - ✓ Educate the community (and themselves)
 - ✓ Minimize MIT's climate footprint
 - ✓ Create smarter, more efficient campus

How We Engage Students On Campus (and Get Engaged by Them)

■ “Formal” education channels

- Course curricula
- Class projects (5.92, S-Lab)
- Special modules (FPOP DEEP)
- Faculty-sponsored research (CS-UROPS)



■ “Informal” education channels

- Explosion of volunteer activities & internships
 - Student clubs: SAVE, SfGS, Sloan EE, Energy Club
 - MIT Generator
 - MIT Pledge

■ Campus as a learning laboratory

Classwork – Undergraduates

Energy, Environment & Society (5.92)

- First Year Students
- Project-Based Learning
- Interdisciplinary



Key Lessons

- Freshman exceed expectations
- Meaningful results for partners
- Sufficient guidance is key
- Bring new students into network

Projects

- MIT Wind Capacity
- Waste Heat from MIT Nuclear Research Reactor
- Renewables Capacity at Cambridge High School



Classwork – Sustainability Lab (S-Lab)

MIT Carbon Mitigation Matrix



Carbon Mitigation Projects Matrix

Key columns:		132,164		52.27%		\$103,721,140		\$16,284,745	
Project category	Project description	ROI	Reduction MTCO ₂ e/yr	NPV per MTCO ₂ e	MIT CO ₂ e 2003	# of Units	Installed Cost	Energy Saving \$	
Fac Eff	Cogen Plant Expansion 16MW, 300,000 pph	8%	53,086.13		21.00%		\$78,000,000	\$6,500,000	
Fac Eff	Window Film Application	40%	110.98	\$148,647	0.04%	2,400,000	\$10,000,000	\$4,000,000	
Fac Eff	Retrocommission Six Buildings	233%	16,776.82	\$503	6.64%	6	\$600,000	\$1,400,000	
Fac Eff	Lighting Occupancy Sensors	63%	5,026.04	\$992	1.99%	9,867	\$1,609,820	\$1,006,933	
Fac Eff	Laboratory Fume Hoods Upgrade & VAV Controls	19%	4,274.88	\$267	1.69%	500	\$4,000,000	\$750,000	
Fac Eff	Continuous Commissioning of Buildings W35 & 18	302%	12,522.20	\$244	4.95%	2	\$165,000	\$499,102	
Fac Eff	Continuous Commissioning of Four More Academic	133%	10,017.76	\$229	3.96%	4	\$300,000	\$400,000	
Fac Eff	Re-Lamp / Re-Ballast Campus-Wide	16%	1,570.64	\$133	0.62%	50,000	\$2,500,000	\$390,000	
Fac Eff	Steam Trap Retrofits	119%	8,184.59	\$248	3.24%	3,000	\$302,000	\$360,000	
Fac Eff	Add Heat Recovery to Building 13	11%	9,093.98	-\$43	3.60%	1	\$2,000,000	\$225,000	
Fac Eff	Air Handler Low Drop Filters and Coil Cleaning	100%	604.09	\$1,366	0.24%		\$150,000	\$150,000	
Fac Eff	Underground Steam Pipe Insulation	35%	4,546.99	\$117	1.80%	1,800	\$400,000	\$140,000	
Fac Eff	Add Heat Recovery from Lab Exhaust Systems	13%	4,092.29	-\$11	1.62%	5	\$750,000	\$100,000	
Fac Eff	Incandescent Light Bulbs to CFL Retrofits (Task Lighting)	70%	212.04	\$1,269	0.08%	5,000	\$75,000	\$52,650	



FPOP DEEP@MIT

Pre-freshmen get DEEP into energy and environment

- Freshmen Pre-Orientation Program = Discover Energy & Environmental Programs
 - ❑ Leading faculty presentations on global climate issues, research, classes
 - ❑ Calculation of own "carbon footprint"
 - ❑ Learning about MIT's own energy use & CO2 emissions
 - ❑ Dorm building audit: heating loss, water & electricity use, trash and recycling
 - ❑ Leads to sets of recommendations for improvements
- New addition to programs on literature, engineering and outdoor adventures

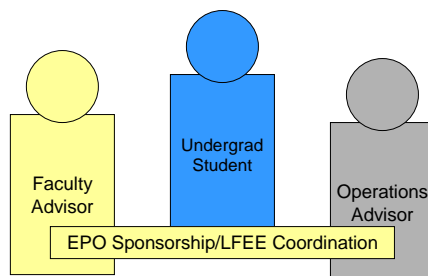


Campus Sustainability UROPs



UROP = Undergraduate Research Opportunity Program

- ❑ >80% of MIT undergraduates do at least one



Project Examples

- Green Building Feasibility Analysis
- Benchmarking Analysis of Green Funding Mechanisms
- Recycling Systems & Communications Analysis



Campus Sustainability UROP Guidelines

- Both student and campus learning essential
- Integrated supervisory team: faculty, facilities/operations, UROP coordinator, sometimes graduate students
- Timeline for deliverables including presentation and report



Architectural Model of New MIT Graduate Dorm, NW-35

Graduate Thesis or Independent Research

A Methodology for Assessing MIT's Energy Use and Greenhouse Gas Emissions

by

Tiffany Amber Groode

B.S., Mechanical Engineering
University of California, Los Angeles, 2002

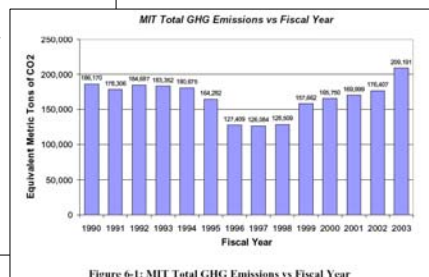
Submitted to the Department of Mechanical Engineering
in Partial Fulfillment of the Requirements of the Degree of
Master of Science in Mechanical Engineering

at the

Massachusetts Institute of Technology

May 2004

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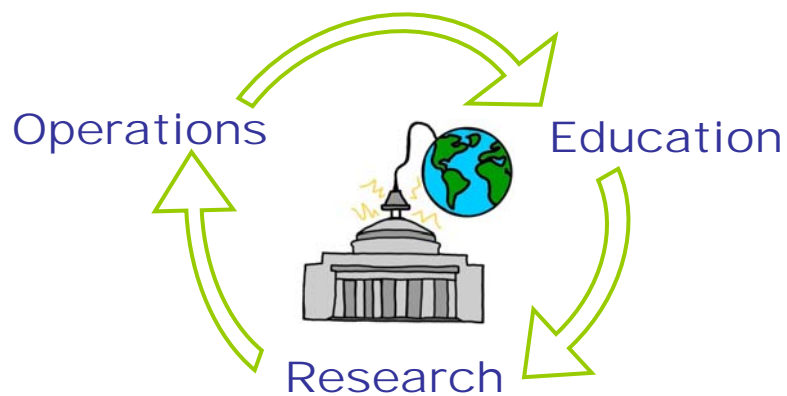
MIT Generator



Students walking
the talk on
energy and the
environment



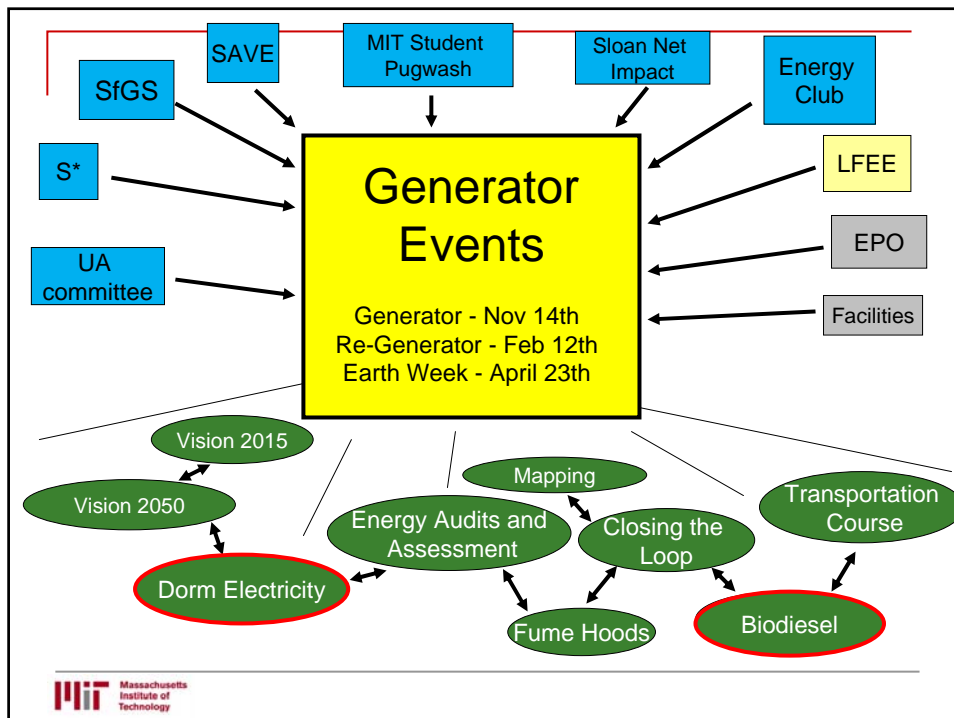
The MIT Generator exists to **unite and catalyze** student groups working on local energy, environment, and sustainability **projects** with a **campus focus**



Our vision is for MIT to be a **living laboratory**, where the campus itself is a development site and proving ground for **student leadership** and **innovative policies, practices, and technologies**

MIT Generator: Students Walking the Talk on Energy and Environment

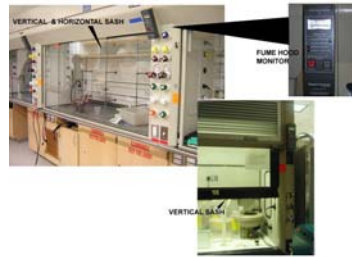
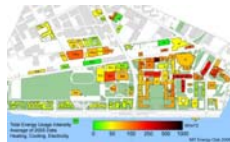
- A coalition, an event series, a community, working groups
- Alliance through joint action
- Distributed innovation... under one roof



Behavior Change Measures

- Behavior change measures essential
- Require different set of skills and programs
- Students well suited to advance these

Dorm Electricity

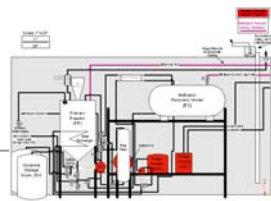


- ✓ This student team really wanted to get their hands dirty and make a difference
- ✓ Setting the gold standard for student leadership, commitment and organization
- ✓ Created whole new campus community
- ✓ Established new model for bringing change
- ✓ Leading faculty member: "Don't let these proposals gather dust!"

The Boston Globe

MIT group strikes oil, wins "eco-grant"

A plan to turn used cooking oil into biodiesel fuel has won a group led by MIT students a \$25,000 "eco-grant" and a concert to be headlined by [Angels & Airwaves](#).



Student Campus Energy Project Grants



Wind Turbine Competition



Campus Climate Awareness Project



Energy Mapping Project



Revolving Door Behavioral Change Campaign



MIT Generator



UA Campus Energy and Environment Pamphlet



Appliance Use Energy Audits and Case Studies

<http://mit.edu/mitei/news/opportunities/index.html>



Benefits of Student Engagement

- Enthusiasm
- Brainpower
- Creative problem solving
- Change agents – presses us further
- Better outcomes
- Community building
- Leadership creation
- Multiplier effect – local to global



Lessons to Share

- Student learning is optimized through a mix of informal and formal opportunities for learning and leadership
- For academics and educators, knowing the rhythms of operations is critical
- Aligning operational goals with core academic and educational mission increases its power
- Persistence, vigilance, and constant connecting are key to keeping the threads together in an “emergent” process
- Building awareness, community, empowerment, lasting change

We're doing lots, but need to do more

- Environmental policy
- Environmental goals
- EHS management system
- Sustainability staff
- Co-Generation & heat recovery
- Solar power systems
- Green building standards
- Diesel pollution control retrofits & alternative vehicles
- Transportation demand programs
- Recycling, waste minimization & pollution prevention
- Energy and water conservation programs