Toward a Greener Campus: Experiments With Sustainable Resource Management at One Mexican University and Two United States Universities

By

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Submitted to the Department of Urban Studies and Planning in Partial Fulfillment of the Requirements of the Degree of

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ABSTRACT

Modern society faces a range of difficult resource management problem like climate change, acid rain and soil depletion. To confront problems like these successfully, educational institutions, along with all other public and private entities, must do their part. Universities, in particular, need to reflect on whether they are managing their campus environments in a sustainable fashion, since the professionals they seek to train will be influenced as much by the everyday practice of campus management as by what they are taught in the classroom.

The main objective of this study is to generate proposals for the implementation of a sustainable resource management program at the Guadalajara campus of the “Instituto Tecnologico de Estudios Superiores de Monterrey” system (ITESM) in Mexico. ITESM is well known as an innovative institution. Its thirty-two-campus system made a commitment to greater sustainability in 2004. Subsequently, while efforts have been made to transform resource management practices at ITESM, there is still a lot to be learned before a truly sustainable resource management program can be put in place.

To help generate ideas for ITESM, an analysis of efforts to promote sustainability at two prestigious American universities -- MIT and Harvard -- has been generated. Both campuses have had to confront, and are still confronting, obstacles of various kinds including confusion about what is and is not sustainable, resistance to change, and concern that investments in sustainability are not recoverably. Harvard has designed an integrated approach to all the “green initiatives” on its campus (i.e. the Harvard Green Campus Initiative). MIT has pursued a series of independent and opportunistic projects. Practical ideas that would complement efforts already underway on the Guadalajara campus can be drawn from both American campuses.

What is essential to effective sustainable resource management at any university, regardless of its size, financial power or prestige, is the commitment of its core staff and administration to continuous quality improvement. This must be undertaken in collaboration with all stakeholders on the campus and involve extensive outreach that facilitates widespread involvement and public learning. Other important preconditions for
sustainable resource management are a comprehensive audit that can help to benchmark existing conditions and careful consistent monitoring.

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INTRODUCTION

Societies everywhere face serious natural resource management problems. All major institutions in every country will have to play a role in addressing these problems for progress to be made. Major educational institutions, like universities, have a crucial leadership role to play in this regard.

This thesis presents a preliminary analysis of preliminary experience with sustainable resource management of two prestigious leading American universities in Cambridge Massachusetts: MIT and Harvard.

My intention is to see what can be learned from the American experience that could be used by the “Instituto Tecnologico de Estudios Superiores de Monterrey” (ITESM) Guadalajara campus to promote sustainable resource management on its campus. ITESM University system in Mexico has announced its intentions to operate its campuses in a more sustainable fashion. Actions have been undertaken by several campuses in the ITESM system to start the necessary transformation, but there are still a lot of questions regarding how to promote the right process of change.

On campus Guadalajara I formed part of the Sustainable Campus Base Group, which in 2003–2004 designed and started implementation of an Internal Sustainable Audit. Using the opportunity to spend one year in a masters program at MIT and Harvard in Cambridge, I decided to benchmark these two universities regarding their initiatives toward a sustainable resource management program on campus.

Descriptive case studies of each institution were assembled through an analysis of relevant documents like, internal newspapers, annual reports, publications and web sites. In addition, interviews and field visits were also carried out in each institution. This thesis offers the outcome of this research, divided into six chapters. The first deals with the benchmarking of sustainability, which includes the main propositions and obstacles regarding the typical sustainable resource management programs on a campus. Chapters 2 and 3 offer descriptive cases of the three international institutions followed by a discussion on the different approaches taken by the two American universities regarding the greening of their campuses. Chapter 4 presents my findings in the form of lessons learned. A more precise proposal for the Guadalajara campus, building on the American experience, is then presented in chapter 5. This proposal is split into two parts focusing on strategic planning and operational actions. Chapter 6 ends with my conclusions.

The Guadalajara campus has already encountered a range of not surprising obstacles to implementing more sustainable practices. A look at MIT and Harvard suggests two different approaches to overcoming these obstacles in the US. It turns out that time constraints, resistance to change and general disbelief regarding the merits of sustainable operation with respect to cost effectiveness and efficiency; represent three key obstacles to sustainable resource management at all three institutions. It is not an easy task, anywhere, to operate a campus in a more sustainable fashion.
Chapter 1. Benchmarking Sustainability: the importance of an efficient use of resources for a sustainable campus

1.1 Introduction

Worldwide concerns for environmental deterioration has rendered it necessary for governments, organizations, and society alike to participate and become more ethically and responsibly involved in the conservation of resources, as well as the improvement of overall environmental quality in their surroundings.

Education is henceforth of critical importance in promoting sustainable development, and therefore, increasing the abilities of populations to deal with environmental and development issues holistically.

Education in general is the answer to change the way we solve real world problems. I strongly believe that the earlier we start to educate our future professionals about the importance that their actions and decisions have on the impact to the environment the better.

Starting from primary schools all the way to the highest educational levels there should be an important focus on sustainability aspects and the skills required to solve the problems that society is facing today.

Educational institutions rather than any other types of institutions should play the main role in shaping the way of thinking and behaving of the future society. To be successful, these institutions must accept their genuine role of “educators” in an ever-changing society, with new challenges that require citizens with the ability to solve interdisciplinary problems.

Universities as the highest educational level institutions can no longer consider themselves separate entities form the outside world. Universities can and should no longer deny that what is happening outside has a direct impact on the inside.

In other words out of practical reasons for their own effectiveness in delivering competent professionals, they need to rethink the way they are preparing their students. They need to be very creative in finding innovative and effective ways to deliver the best professionals.

The nature of current problems facing our societies is complex and wide reaching. Climate change, acid rain, deforestation, species extinction, fisheries depletion, soil erosion, toxic buildup in ecosystems, water, land and air pollution and ozone depletion are some of the most important environmental problems that are forming a web of destruction around the world. The solution of these problems requires professionals with multi level problem solving skills, professionals that can work collaboratively in interdisciplinary teams to solve problems form a holistic point view. Hence, the role of universities becomes imperative.

In the US, prestigious universities such as MIT and Harvard have been doing important changes toward becoming greener campuses. Harvard has a zero interest loan fund of six million US dollars assigned for activities related to the “Harvard green campus initiative” plan.

In Mexico, the “Instituto Tecnologico de Estudios Superiores de Monterrey” (ITESM university) is well known for its mission of innovation. In order to keep up with innovation the thirty-two-campus system decided to include sustainability in its 2005-
2015 mission. Efforts have been made here starting the transformation of these campuses into greener ones, but there is still a lot to be learned and done in order to design a integrative and effective resource management proposal. Important questions must be addressed, such as how to create a community commitment for involvement in sustainable actions? What exactly should a sustainable resource management on college campuses involve? How do we measure success? 

In an effort to find answers to some of these questions this thesis will explore how these two U.S Universities are doing with their efforts towards an efficient management of resources and see if there are any important lessons to be learned out of their experience. In other words this study aims to design of a proposal for ITESM Guadalajara regarding the effective use of resources on campus, through a comparative study of the experience of 2 international campuses with sustainable resource management. These two universities are chosen, for their leading role in education and research, their importance as models and partners for a Mexican Institution like the ITESM, and the accessibility to relevant information on the subject matter.

1.2 Agenda 21 and leadership of Universities regarding sustainability.

The 1992 UN Summit for Environment and Development held at Rio de Janeiro produced Agenda 21, the global sustainable development agenda. Aside from the word government, education appears more often than any other term in Agenda 21. (Rogers, 1999) Education underlies and has the potential to reinforce every other priority in this extensive blueprint for a sustainable world. Agenda 21 calls for integrated decision making based on integrated information to enable individuals, organizations, institutions, businesses and governments to incorporate environmental considerations and goals into social, economic decisions.

Since higher education to date largely fails to expose students to issues and considerations outside of the narrow confines of their disciplines, it consequently fails to produce integrated decision makers (David Orr 1992) In order for higher educational institutions to successfully discharge their obligation to prepare their graduates to participate responsibly as citizens in the twenty first century, they must become models for sustainability.(Cortese 1999). Thus higher education for sustainable development (HESD) primarily involves teaching students to understand ecological, social and economic problems through the many lenses of an interdisciplinary framework. It assumes that integrated decision-making is not possible without integrated thinking.

Chapter 36 of Agenda 21 focuses on three programme areas: Education; Training and Public Awareness. This chapter states "education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues". Chapter 36 makes brief but specific reference to universities and their role in building a sustainable future. Directly pertinent to sustainability in higher education are the following statements:

- Countries must "broaden the means and scope of education" to support sustainable development.
- Governments should strive to prepare strategies aimed at integrating environment and
development as a cross-cutting issue into education at all levels.

- Countries must support "cross-disciplinary courses" for all students, "regional networks and activities and national university actions which promote research and common teaching approaches on sustainable development," and "new partnerships with business and other independent sectors."

- Countries should encourage universities "to contribute more to awareness building for all audiences."

These sections of Chapter 36 touch on most of the major priorities of HESD today, mainly: cross-disciplinary curriculum development on sustainable development; scientific and other sustainability related research; outreach and multi-stakeholder network formation promoting environmental awareness and sustainability 1

Since 1996, the United Nations (UN) Commission on Sustainable Development (CSD) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), the task manager for Chapter 36, has promoted HESD in various official documents and conferences. An International Work Programme on Education, Public Awareness and Training for Sustainability was initiated at the fourth session of the CSD in 1996, in order to give added impetus and visibility to the themes of Chapter 36. The Work Programme was further elaborated at the sixth session of the CSD in 1998, which stressed for higher education the reorientation of formal educational systems and interdisciplinary approaches to teaching and research.

Outside of the UN process, major efforts to influence and articulate what Chapter 36 of Agenda 21 implied for higher education occurred through the development of a set of declarations and conferences throughout the 1990s.

Starting in 1990, university representatives convened several conferences around the world and produced a series of internationally recognized declarations focused on HESD and calling their institutions to action. One of the most important of the six major declarations is the Talloires declaration. (See appendix 1.1 for a summary of the declarations) The Talloires Declaration is the only one signed by a significant number of U.S. College and university presidents. As of September 2001, over 280 university presidents and chancellors at institutions in over 40 countries had signed the declaration. U.S. signatories numbered 73

The Talloires Declaration was created in October 1990. This was the first attempt by university leaders to define and promote sustainability in higher education.

Jean Mayer, the President of Tufts University (Medford, Massachusetts), hosted twenty-two presidents, vice-chancellors, and rectors from universities around the world at a conference in Talloires, France to discuss the role of universities in shaping a sustainable future and to provide input for the Earth Summit. Recognizing the shortage of specialists in environmental management and related fields, as well as the lack of comprehension by professionals in all fields of their effect on the environment and public health, the participants defined the role of the university in the following way: "Universities educate most of the people who develop and manage society's institutions. For this reason, universities bear profound responsibilities to increase the awareness, knowledge, technologies, and tools to create an environmentally sustainable future."

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1Notably, there is no reference in chapter 36 to sustainable campus operations (i.e., energy and water conservation, recycling, etc.), where most progress has been made in the U.S. this is a major component in the U.S and Europe.
The Declaration is a 10-point voluntary action plan for building a sustainable university.

Other official declarations from university leaders and organizations around the world followed the Talloires Declaration and contributed to an international consensus on HESD. The themes, which nearly all international declarations share, include promoting sustainability in all relevant disciplines; research on sustainable development issues; the 'greening' of university operations; engaging in inter-university cooperation; forming partnerships with government, NGOs and industry; and most consistently, the moral obligation of higher education to work for a sustainable future. All of the priorities in Chapter 36 of Agenda 21 are reaffirmed in these declarations.

In the U.S., the camp summit hosted by Yale University in February 1994 resulted in the document titled: Blueprint for a Green Campus. This document set a standard for how to think about greening the campus in America. Blueprint for a Green Campus recommends incorporating environmental learning into all relevant disciplines; making the campus a model of environmental behavior through waste reduction, energy efficiency and sustainable design; instituting environmentally responsible purchasing policies; and supporting students seeking environmentally responsible careers. The emphases on purchasing and careers, in particular, recognized the importance of working with external stakeholders, whether as suppliers of sustainable products for the institution or as environmental leaders and alumni from business, government, media and other sectors.

1.3 Strategic resources to build a green campus

According to Calder and Clugston 1999, Agenda 21, the various international and national conferences, and the numerous reports and declarations they produced reflect the analysis and concerns of many constituencies in different regions of the world over the last twelve years. The understandings of the agenda for higher education to support sustainable development are remarkably similar, and point toward a basic framework for seeing sustainability in practice. Furthermore, they agree, with only few exceptions, upon a very similar ideal type of college or university, which transforms its research, teaching, outreach and operations to support sustainable development.

The manner in which academic institutions define and approach sustainability could be very divergent, reflecting cultural, bioregional, economic and political ‘diversity. But 7 critical dimensions of the institutional life that need to be addressed in order to create a real commitment towards sustainability is presented by these authors as a result of the Association of University Leaders for Sustainable Future’s (ULSF) Sustainable Indicators project:

1. The written statements of the mission and purpose of the institution and its various units express their philosophies and commitments. The descriptions of learning objectives and public relations materials of the various schools, departments, programs or offices thus would express prominent and explicit concern for sustainability.

2. The college or university appropriately incorporates the concepts of sustainability into all academic disciplines and in liberal arts and professional education requirements, as well as into faculty and student research. Likewise, a firm grounding in basic disciplines
and critical thinking skills is essential to pursuing a sustainable future. Institutions committed to sustainability prominently feature certain topics in their course offerings, e.g. Globalization and Sustainable Development; Environmental Philosophy; Nature Writing; Land Ethics and Sustainable Agriculture; Urban Ecology and Social Justice; Population, Women and Development; Sustainable Production and Consumption; and many others.

3. A major shift from the current academic paradigm lies in a conscious reflection of the role of the institution in its social and ecological systems. Students learn about the institutional values and practices in this context. For example, all students would understand:
   a. How the campus functions in the ecosystem (e.g. its sources of food, water, energy, endpoint of waste and garbage) and its contribution to a sustainable economy.
   b. How the institution views and treats its employees (such as student, staff, faculty involvement in decision-making, their status and benefits, etc.).
   c. The basic values and core assumptions present in the content and methods of the academic disciplines.

4. Since research and teaching are the fundamental purposes of academic institutions, knowledge of sustainability is a critical concern in the hiring, tenure and promotion systems. We would expect the institution to:
   a. Reward faculty members' contributions to sustainability in scholarship, teaching, or campus and community activities.
   b. Provide significant staff and faculty development opportunities to enhance understanding, teaching and research in sustainability.

5. The institution has an "ecological footprint." In its production and consumption the institution follows sustainable policies and practices: for example, CO₂ reduction practices and the use of emission control devices; sustainable building construction and renovation; energy conservation practices; local food purchasing program; purchasing and investment in environmentally and socially responsible products; and many others. Furthermore, these operational practices are integrated into the educational and scholarly activities of the school.

6. Institutional support and campus student life services that emphasize certain practices, such as:
   a. New student orientation, scholarships, internships and job placement counseling related to community service, sustainability and/or justice issues;
   b. An Environmental or Sustainability Council or Task Force, an Environmental Coordinator or Curriculum Greening Officer;
   c. Regularly conducted environmental audits;
   d. Prominent public, student and staff celebrations of sustainability on campus (for example, lectures, conferences, Earth Day celebrations, etc).

7. The institution is engaged in outreach and forming partnerships both locally and globally to enhance sustainability. The college or university supports sustainable
communities in the surrounding region and relationships with local businesses that foster sustainable practices. The institution seeks international cooperation in solving global environmental justice and sustainability problems through conferences, and student/faculty exchanges, among others. This list is an abbreviated version of the questions found in ULSF’s Sustainability Assessment Questionnaire, 1999.

Activities in these seven dimensions are largely supported by the reports and declarations discussed in 1.1.1. Transformation in faculty development and campus operations, though not explicitly noted in Agenda 21, is supported in virtually every other report and declaration. Only student engagement is left out of the international documents and recommendations, while given special attention in Blueprint for a Green Campus in The U.S.

But besides these 7 dimensions it is also important to mention the critical conditions for the level of success. The same analysis of ULSF delivered 7 critical conditions:

1. How are the "champions" of sustainability initiatives perceived by others in the institution? Do they have the credibility and the personality needed to promote the initiative or are they marginal institutional actors complaining and promoting their narrow self-interest? Do they persist in the face of resistance, with adaptability and grace, or do they give up or become frustrated?

2. Do the initiatives have the endorsement of key administrative leaders at the institution? Is a commitment to sustainability supported by the President or Chancellor (e.g. by signing the Talloires Declaration), or by other high level and influential figures (e.g. senior managers)?

3. Who benefits from the initiative? Which departments and programs will the faculty and administration perceive the initiative to be strengthening, and which will it threaten? If it is perceived to be the imposition of a special interest group demanding that all faculty understand "Earth Sciences" or embrace a new counter culture or "politically correct" movement, then it is doomed. However, if it promises to empower and strengthen many programs, it will be supported.

4. Does the initiative fit with the institution’s ethics, its saga, and its organizational culture? Each college and university has a particular story that it tells about itself and a particular "niche" that it fills in the ecology of higher education. How well does the initiative conform to this institutional identity?

5. Does the initiative elicit the engagement of the college or university community? Is there sufficient publicity (through awareness events, press releases, articles, etc.) for new policies and initiatives? Is there regular disclosure of progress, successes and failures? Is information made available to ensure accountability on the part of those managing and carrying out the initiative? Finally, is the process for critique of current sustainability programs and determining next steps broadly participatory across the school community?
6. Is the initiative academically legitimate? Is it perceived to be grounded in a recognized body of knowledge: of sound theory and scholarly backing? Can it claim an academic rigor and validity? If it lacks this basic sine qua non of academic credibility, it will be rejected.

7. How successful is the initiative in bringing in critical resources (e.g. grants and contracts, state funding, student demand, recognition and support from key stakeholders such as the media or trustees, and state, national and international leaders)? Does the initiative produce cost savings over time (e.g., energy conservation)?

While trying to capture an overall view of the activities of the Universities of MIT, Harvard and ITESM Guadalajara regarding greening of their campuses the main focus will be on dimension number 5. This latter with a special pick on: electricity, water, paper and solid waste. This early decision is based on the fact that the conservation, reduction, reuse and/or recycling of these resources will have a direct economic effect on any campus budget and this in itself can serve as an initial incentive toward a broader greener resource management.

A 1998 report by National Wildlife Federation’s (NWF) Campus Ecology Program documented annual savings of over $15 million from 20 selected U.S. campus conservation projects. (Eagan and Keniry, 1998). In part for this reason, more progress has been achieved in this dimension than in any other.

Overall, there seems to be a quite clear consensus on the comprehensive actions higher education must take if it is to embrace sustainable development.

After having worked on several intentions, including the most recent one starting in the summer of 2003, to implement an integrated efficient resource management program in Tecnologico de Monterrey campus Guadalajara (Guadalajara campus from now on) and going through the above analysis, I consider the following propositions regarding important considerations Universities should take into account while seeking to implement a program like this:

- A real commitment from the highest direction board. This could be done through several means such as:
  - A public statement with specific sustainability or environmental goals and/or principles.
  - A sustainability policy for the institution.
  - A signed partnership to any national or international organization concerned with Higher Educations for Sustainable Development. (HESD)
  - A clear statement in the institutions mission referring to a commitment with sustainable development

This in itself may not guarantee the success of a program in sustainable resource management, but it will at least encourage initiatives toward that end.

- The university should provide a curriculum that has a significant impact on their students’ comprehension of sustainability issues and sufficient skills to target
these issues. Rather than designing a sole core course in sustainable development and/or environmental education, universities should strive to connect this knowledge throughout the curriculum of any academic program offered. Complementary to this, a fair amount of electives on sustainability and/or environmental issues should also be provided.

- Congruency: Universities exist to prepare future professionals in a wide range of fields to be good citizens committed to the overall development of their direct surroundings and beyond. In doing so most universities, if not all, teach and/or do research on sustainable development issues. However, it is incongruent to teach something that is not applied in the institution itself, Universities must “practice what they preach” and make sustainability an integral part of operations, purchasing and investment.

- There should be a gradual implementation of a sustainability program to assure an increasing participation and involvement of representatives of all stakeholders to the institution. Any sustainability program should start focusing on the efficient management of specific resources such as, water, electricity, paper and solid waste. The main focus should be on what is called “low hanging fruit” projects in order to start informing, educating and later on convincing the community of the savings aspect of the projects. By doing this, the campus does not have to incur in possible high risk investment projects from the start. An integrative management of these small scales, but effective actions could lead to a growing participation and involvement. Hence, this will lead to long-term life cycle projects with large scale investment in the future.

- An extensive and effective internal communication network. A sustainable resource management program on campus should be more than separate actions carried out by a portion of the stakeholders through technological changes. These types of programs require a gradual attitudinal and cultural change in all stakeholders to the institution. Institutions should strive to develop an extensive communication network that can provide enough opportunities for the information, education, participation and involvement of all representatives of their stakeholders groups.

But the question remains how do you do this effectively? It would be unwise for anyone to ignore that there are some general obstacles that hinder Universities in acting on these propositions above. The willingness and/or ability to take actions regarding these obstacles in order to overcome them, is what could determine the success of the sustainable resource management program. Here follows a summarized list of those possible obstacles:

- Time. These institutions are sometimes so involved in their day-to-day activities that finding time to sit back and design and implement and evaluate these types of projects seems impossible.
• Universities may find it risky to invest significant amount of resources (Human and financial) in areas like these that may not have a direct impact on their academic performance evaluation systems. They evaluate performance solely related to a narrow view of quality of education and/or research.

• Universities may falsely believe that their initial financial investments may not be recovered.

• Resistance to change. Every change in traditional ways of doing things automatically encounters resistance. People don’t like the feeling of doubt because it is uncomfortable. Nevertheless this is required in order to truly go through the process of change.

• Instead of adapting already existing programs from other institutions they adopt programs that do not necessarily fit their particular institutional cultures or specific needs. This creates false barriers to implement programs like this in the future.

• There is general skepticism about the real scientific bases for sustainability as a concept and as practice that could really make a difference for the better. This is observed mainly because of a possible lack of awareness or interest.

1.4 Innovation for sustainable leadership

Why is it important for higher education in the United States to pursue sustainability in these dimensions? First, as nearly every international HESD declaration claims, it is important from a moral perspective. Since colleges and universities educate and train our future community and business leaders, teachers and policy makers, these institutions bear a moral responsibility to provide the expertise and vision needed to foster a sustainable future. Second, universities should pursue this course from a practical perspective: they are uniquely equipped to help solve the challenge of sustainability through innovation in teaching and learning. Sustainable development is not just another category of environmental, social and economic problems we face; it is also a way of thinking about these issues. If we do not learn to think about global environmental degradation in a more effective way, we will continue to make little progress in reducing them. Part of the intellectual challenge of sustainable development, therefore, is that we must learn how to solve several problems at once. Universities can give students and future leaders the intellectual tools for doing that. Third, a U.S. commitment to HESD matters because U.S. colleges and universities influence the standards for higher education throughout the world. They also serve a larger international student body than in any other country. It is incumbent upon American higher education to contribute to solving the global challenge of sustainable development. (Clugston and Calder 2002)

In particular, Universities with an excellent global reputation like MIT and Harvard attract a significant amount of international students and in that sense they could make an impact not only nationally but internationally too.

According to Anthony Cortese there is a growing demand at colleges and universities in the United States and internationally for environmental education and for institutions to reduce the environmental impact of their own operations. This effort must be encouraged.(Cortese 1999)
Throughout the evolution of HESD in the U.S we can see that Institutions in Massachusetts played and are still playing an important role in the scaffolding of “how” to become a greener campus and through that process educate on sustainability. Universities like Tufts, University of Massachusetts, Harvard, MIT, Boston University, just to mention a few, have all been to some degree active in this process. Anthony Cortese mentions in his paper “Education for sustainability (the university as a model of sustainability)” that without strong outside influence higher education is not likely to change its direction far enough or fast enough.

Here we have a good example in Massachusetts where the commonwealth is adopting a GHG emissions reduction plan. The Plan represents Massachusetts’ commitment to implementing the regional climate change plan adopted by the New England Governors and Eastern Canadian Premiers (NEG/ECP) in August 2001. It is a joint effort of more than 15 agencies, spearheaded by the Office for Commonwealth Development. The Plan was made possible by the technical support of the Northeast States for Coordinated Air Use Management (NESCAUM), an interstate organization that promotes air quality, and the support of the Center for Clean Air Policy, the Massachusetts Technology Collaborative’s Renewable Energy Trust, and the U.S. Environmental Protection Agency (EPA). The City of Cambridge Climate Protection Plan is calling for a 20% decrease in greenhouse gas emissions from 1990 levels by the year 2010.

In recognition of state government’s significant potential impact on reductions in GHG emissions, and to demonstrate state leadership on this issue, Executive Order 438, signed in July 2002, established the Massachusetts State Sustainability Program. The primary goal of the Program is to help agencies to incorporate environmentally sustainable practices into their operations, focusing on three top priorities: waste reduction, mercury elimination, and reduction of greenhouse gas emissions. A Coordinating Council, made up of representatives from 15 key state agencies and offices, is responsible for guiding the Program, setting long-range targets, and developing and implementing effective strategies to help agencies meet Program goals.

The above makes it even more worthwhile to analyze some cases in Massachusetts. What are they doing regarding the management of resources on campus in order to be able to cope with these external pressures? Besides this external pressure, do they have other reasons to work on efficient resource management on campus? Basically, what exactly is going on these campuses?

The main question in this study as stated above will concentrate on MIT and Harvard.

1.5 Managing for sustainability: Some general actions towards a strategy for the efficient use of resources in a campus.

As concerns about energy scarcity and prices have increased in recent years, and cost-benefit analyses look promising, efforts to conserve energy (and water) have steadily increased on campuses in the U.S. since 1992. NWF's 2001 study, for example, indicates that 81% of campuses surveyed have enacted lighting efficiency upgrades. More than half of respondents said they've developed efficiency design codes for new
and old buildings, and 72% reported they have installed efficient toilets, showerheads and faucets in all or some campus units. (Clugston and Calder 2002)

1.5.1 Energy and water conservation

Energy Conservation
Energy conservation is the practice of using energy resources in a sustainable way by considering which processes are wasteful and addressing those inefficiencies. The dictionary definition is the reduction or avoidance of energy loss or wastage by various means. The fact is that it is generally employed principally for economic reasons. As the clearly finite quantities of non-renewable resources, such as coal, crude oil and natural gas, are reduced further, the question of conserving remaining stocks until alternatives are found is becoming more pressing. This can be addressed through conservation of energy, or increased production by other means. The latter process does not consider other environmental consequences of increasing production of energy.

In general there are two mayor areas in energy conservation projects, mainly the behavioral and the technological one.

- There is a need for behavioral change in order to get the consumer to reduce the energy used. The process for affecting behavioral change has to be multifaceted and must involve many stakeholders. From EarthCare “an environmental education partnership” here follows a summary of factors that this process of change must include.

  - Develop a call to action which is compelling, inspiring and engaging.
  - Work closely with the early adopters to support their efforts, celebrate their achievements and involve them as coaches to the cohort who are later adopters.
  - Provide every opportunity for student involvement in all aspects of the program from training, to promotion, to monitoring and evaluation to partnership development.
  - Develop a partnership model that looks beyond school walls to involve school councils and leading stakeholders from the community.
  - Develop a communications campaign that celebrates action, achievement and engagement.
  - Develop an incentive system in partnership with key stakeholders that is customized to their needs.

- New technology use is the other mayor area of conservation of energy. These technologies provide higher energy efficiency. In the webpage of US department of energy the energy efficiency and renewable energy program (EERE) has a complete list of equipments that will provide better electricity efficiency to consumers. Basically there is the appliances category and the lighting and day lightning category, which are more relevant to the main focus of this study, electricity. They strongly recommend looking for the yellow EnergyGuide labels that indicate the energy efficiency of the electrical appliance.
Another label to help you identify energy-efficient appliances is the ENERGY STAR® label. Promoted by DOE and the U.S. Environmental Protection Agency, the ENERGY STAR is only awarded to appliances that significantly exceed the minimum national efficiency standards.

**Water Conservation**

Water conservation activities are a key aspect of sustainable development because they help to protect water as a natural resource, minimize the use of chemicals needed to treat water and wastewater, and reduce energy use and related pollution associated with pumping and transporting water. Water conservation can be accomplished through design and planning changes, changes in maintenance and infrastructure activities, and, as mentioned above, changes in behavior. According to the Department of Energy, estimates indicate that Federal-sector expenditures for water and sewer run between $0.5 billion and $1 billion annually, and that the Federal Government could save as much as $240 million per year by implementing water conservation measures. Expenditures and potential savings will increase as the cost of water continues to rise; rates have already increased 100% to 400% in major cities during the past 10 years, and this trend is expected to continue. Building design and planning may incorporate both indoor and outdoor water conservation strategies. Inside, the installation of water-efficient plumbing fixtures, such as ultra low-flow toilets and urinals, waterless urinals, low-flow and sensored sinks, low-flow showerheads, and water-efficient dishwashers and washing machines, will reduce overall water use. Outdoors, designers can plan landscaping features, vegetation, and irrigation to reduce the need for water. Consider water-efficient irrigation systems, irrigation control systems, low-flow sprinkler heads, and xeriscaping, which involve planting native vegetation that needs little or no additional water. Daily maintenance and facility operations offer several additional opportunities to conserve water. First, a water audit can help to identify leaks and wasteful practices. Develop a regular schedule for checking for and repairing leaks. Separating and reusing gray water generated by indoor activities such as laundries, showers, and sinks, and capturing rainwater to use in irrigation and other on-site uses also can help conserve water. Checking and repairing heating, cooling, and ventilation equipment to ensure that water is being used efficiently will also lead to effective water conservation. Replacing outdated equipment that uses excessive quantities of water with more efficient systems also can help conserve.

**1.5.2 Reduce, Reuse and Recycle (the 3 r’s)**

Many man-made products are not readily biodegradable and take up space in landfills or must be incinerated. Recycling is an alternative to this. In theory, recycling would allow a continuing reuse of materials for the same purpose. In practice, recycling most often extends the useful life of a material, but in a less-versatile form. For example, when paper
is recycled, the fibers shorten, making it less useful for high grade papers. Other materials can suffer from contamination, making them unsuitable for food packaging. Consumer recycling has succeeded mostly in reducing industrial consumption of energy and water. Production of materials such as aluminum or glass requires large amounts of electricity or fossil fuels. The recycling of such materials is profitable and prevents a substantial amount of greenhouse gas emissions.

Skeptics believe, with the exception of aluminum cans, that recycling is wasteful. In particular, the market for recycled materials is limited, and using recycled materials may be more expensive for manufacturers than new raw materials. As a result, state support for recycling may be more expensive than alternatives such as landfill; recycling efforts in New York City cost $57 million per year. However, recycling becomes relatively cheaper when externalities associated with raw material extraction and landfill (or incineration) are included, especially environmental and health effects.

From the EPA we have the following summary on the 3 r’s:

**Reduce**

Waste prevention, or "source reduction," means consuming and throwing away less. It includes: purchasing durable, long-lasting goods; seeking products and packaging that are as free of toxics as possible; redesigning products to use less raw material in production, have a longer life, or be used again after its original use. **Source Reduction** refers to any change in the design, manufacture, purchase, or use of materials or products (including packaging) to reduce their amount or toxicity before they become municipal solid waste. Source reduction also refers to the reuse of products or materials. Source reduction actually prevents the generation of waste in the first place, so it is the most preferred method of waste management and goes a long way toward protecting the environment.

**Reuse**

Reusing items by repairing them, donating them to charity and community groups, or selling them also reduces waste. Reusing products, when possible, is even better than recycling because the item does not need to be reprocessed before it can be used again. During the past 35 years, the amount of waste each person creates has almost doubled from 2.7 to 4.4 pounds per day. The most effective way to stop this trend is by preventing waste in the first place. Waste prevention; also know as "source reduction," is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount or toxicity of trash created. Reusing items is another way to stop waste at the source because it delays or avoids that item's entry in the waste collection and disposal system.

Source reduction, including reuse, can help reduce waste disposal and handling costs, because it avoids the costs of recycling, municipal composting, landfilling, and combustion. Source reduction also conserves resources and reduces pollution, including greenhouse gases that contribute to global warming.
Recycle

Recycling turns materials that would otherwise become waste into valuable resources. In addition, it generates a host of environmental, financial, and social benefits. Materials like glass, metal, plastics, and paper are collected, separated and sent to facilities that can process them into new materials or products.

Recycling is one of the best environmental success stories of the late 20th century. Recycling, including composting, diverted 68 million tons of material away from landfills and incinerators in 2001, up from 34 million tons in 1990. By 1999, more than 9,000 curbside collection programs served roughly half of the American population. Curbside programs, along with drop-off and buy-back centers, resulted in a diversion of about 30 percent of the nation's solid waste in 2001.

There's more to recycling than setting out your recyclables at the curb. In order to make recycling economically feasible, we must buy recycled-products and packaging. When we buy recycled products, we create an economic incentive for recyclable materials to be collected, manufactured, and marketed as new products. Buying recycled has both economic and environmental benefits. Purchasing products made from or packaged in recycled materials saves resources for future generations.

Another form of recycling is composting. Composting is the controlled biological decomposition of organic matter, such as food and yard wastes, into humus, a soil-like material. Composting is nature's way of recycling organic waste into new soil, which can be used in vegetable and flower gardens, landscaping, and many other applications.

- **Backyard composting.** Hundreds of thousands of individuals across the country compost in their own backyards, typically in a fenced off area or bin. Backyard composting provides a convenient way to reduce the volume of trash a household produces. It also provides a valuable product that can enhance the soil and increase the growth and health of the yard.

- **Yard trimmings composting.** Composting also occurs on a large scale, operated by private sector firms or community public works departments. At these sites, the compostable material is taken to a central location. There, it is typically processed in aerated windrows, where organics are formed into rows or long piles. Some sites will add compostable MSW (Municipal Solid Waste) into the mix to keep items out of the landfill. The finished compost can be sold, given away, or used by the company or municipality in local landscaping projects.

- **Mixed MSW composting.** Composting of mixed municipal solid waste is another option. This generally occurs at a medium-to-large scale facility, operated by private sector firms or community public works departments. Generally, mixed MSW is received at the site. Recyclables such as glass and aluminum, and non-compostables are removed early in the process. The remaining organic material is composted, generally using aerated windrows. In-vessel composting, where the material is left to decompose while enclosed in a temperature and moisture controlled chamber, is another possibility. Final screening steps remove any remaining plastic film and similar contents. The finished compost can be sold, given away, or used by the company or municipality in local landscaping projects.
1.5.3 Pollution prevention and control

Under Section 6602 (b) of the Pollution Prevention Act of 1990, Congress established a national policy that:

- pollution should be prevented or reduced at the source whenever feasible;
- pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible;
- pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and
- disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

Definitions of Pollution Prevention and Source Reduction

Pollution prevention means "source reduction," as defined under the Pollution Prevention Act, and other practices that reduce or eliminate the creation of pollutants through:

- increased efficiency in the use of raw materials, energy, water, or other resources, or
- protection of natural resources by conservation.

The Pollution Prevention Act defines "source reduction" to mean any practice which:

- reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and
- reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The term includes: equipment or technology modifications, process or procedure modifications, reformulation or redesign or products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

Specific Pollution Prevention Approaches

Pollution prevention approaches can be applied to all pollution-generating activities, including those found in the energy, agriculture, Federal, consumer, as well as industrial sectors. The impairment of wetlands, ground water sources, and other critical resources constitutes pollution, and prevention practices may be essential for preserving these resources. These practices may include conservation techniques and changes in management practices to prevent harm to sensitive ecosystems. Pollution prevention does not include practices that create new risks of concern. See figure 1.1 below for a general list of source reduction methods.
Product changes
- Design for less environmental impact
- Increase product life

Input material changes
- Material purification
- Substitution of less toxic materials

Technology changes
- Layout changes
- Increased automation
- Improved operating conditions
- Improved equipment
- New technology

Improved operating practices
- Operating and maintenance procedures
- Management practices
- Stream segregation
- Material handling improvements
- Production scheduling
- Inventory control
- Training
- Waste segregation

Source reduction

Process changes

Fig. 1.1 Typical source reduction methods. (from Bishop, 2000)

(Also visit http://cfpub.epa.gov/schools/ from the EPA for more specific detailed approaches to pollution prevention and control on campuses.)

1.5.4 Combinations

Any educational institution can either focus on conservation practices of water and energy, recycling or pollution prevention as separate actions or construct a program that combine all this actions.
Chapter 2. ITESM System and the Guadalajara campus

2.1 The ITESM system and sustainability

2.1.1 Mission 2015

The ITESM System, a private non-profit nationwide University System, is comprised of 32 campuses spread throughout 26 Mexican cities. The Tecnológico de Monterrey University System has acknowledged the responsibility of promoting Sustainable Development by seeking its inclusion in the offer of consistent academic courses, as well as research and extension services towards the formation of people qualified to endorse and encourage Sustainable Development within their professional fields. In fact, such purpose of the institution is stated in the 2005 Mission of the Tecnológico de Monterrey University System: “To accomplish the formation of persons committed to their community development, while being competitive worldwide in their area of knowledge. The mission includes performing relevant research and extension for the Sustainable Development of the country.”

The latest vision of Tecnológico de Monterrey states: “In the year 2015, Tecnológico de Monterrey will be the most widely recognized educational institution in Latin America due to the leadership exercised by alumni in the private, public, and social sectors, and for the research and technological development it carries out to promote a knowledge-based economy, generate management and business incubators models, improve public administration and public policies, and create innovative models and systems for the sustainable development of the community.

With this latter comes the new mission for 2015 which is, to form persons with integrity, ethical standards and a humanistic outlook, who are internationally competitive in their professional fields; at the same time, they will be good citizens committed to the economic, political, social and cultural development of their community and to the sustainable use of natural resources.

Through its educational, research and development programs, Tecnológico de Monterrey prepares students and transfers knowledge to:

- Promote the international competitiveness of business enterprises based on knowledge, innovation, technological development, and sustainable development.
- Develop business management models to compete in a global economy.
- Create, implement and transfer business incubator models and networks in order to contribute to the creation of enterprises.
- Collaborate in professionalizing public administration; and analyze and propose public policies for Mexico's development.
- Contribute to the sustainable development of the community with innovative models and systems for its educational, social, economic and political improvement.

With this mission, Tecnológico de Monterrey and its community are committed to contributing to the educational, social, economic, and political improvement of Mexico.
After a close look to the systems latest vision and mission above it becomes clear that, at least on paper, there is an institutional commitment to work on education for sustainable development by this University.

2.1.2 Managing for sustainability

The system stated 15 principles in the issue of its new mission 2015 starting this year 2005. These principles constitute the foundation of the identity and unity of all Tecnológico de Monterrey campuses and academic entities. The regulations and norms that must be observed by all members of the educational community stem from these principles.

Principle number 5 clearly states sustainable development. Having chosen sustainable development as one of the core principles of the system puts yet more pressure on every campus to incorporate this in their overall management system.

Since 1995, as a reaction to the suggestions stated in Agenda 21 and as part of the strategies to support the former mission 2005 the system developed a core course for all undergraduate and graduate students. The course titled, “Ecology and Sustainable Development” main objective is, to create awareness among students of their responsibility toward a sustainable development in whatever field of work they will be. This course provides insight to the students regarding the understanding of environmental aspects and the relation that exists between this and their specific future career with respect to the making of decisions as well as their commitment to work as an agent of change. The course also aims to provide enough information on ecological and sustainable development aspects in order to develop positive attitudes in the students oriented to the improvement of the environment.

In order to really serve its goal the course had suffered several changes over the years. But it became clear to some in the academic community that a core course alone would not be sufficient to change attitude and to develop long lasting skills in the students. More or less 5 years later (it is difficult to really pin point the exact time frame) the main campus, campus Monterrey, and several others started the discussion on the importance of the role of the system in educating for sustainable development. These campuses decided to turn the attention and insight to themselves. Therefore, following the example led by different Universities throughout the World, and the concretion of their own strategies, campuses such as Campus Querétaro, Campus Monterrey and Campus Estado de México, have launched internal programs promoting thus sustainability or enhanced environmental performance within their operations and facilities.

For example Campus Monterrey has the program “Campus Sostenible”, Campus Estado de Mexico has the program “OLA” (Orden, Limpieza y Ahorro) and Campus Mexico city has the program “Campus Ecologico” to mention some. All these projects have their specific activities but as a common denominator they all concentrate on recycling and in lesser level on energy conservation. But all together there is no real system wide sustainable management program with clear guidelines and with historical data of improvements made. In the last couple of years during the developing process of the new mission 2015 it was clear that sustainable development was going to be taken seriously by this institution and that it even might become one of the core principles for the next 10 years of the new mission. This was taken as a wake up call by the campuses mentioned
above and others, to start doing research on “how” to implement a more integrated program that can impact all the stakeholders within and outside the Institution. In other words Tecnologico de Monterrey like many other universities around the world is just starting with the process of education for sustainable development. Here follows the case of campus Guadalajara where, several isolated, yet extremely substantial, efforts have taken place within campus intended towards the acceptance of its commitment as a leading institution in higher education for western Mexico on the one hand, and on the other hand its incongruent counterexample as an organization that consumes, depletes and wastes resources as part of its current operational procedures.

2.2 Guadalajara Campus

2.2.1 Benchmarking sustainability 2000-2004

Founded in 1991, the Tecnológico de Monterrey, Campus Guadalajara is located on 91 acres -close to 225 hectares- in the northwest outskirts of the city of the Extended Urban Zone of Guadalajara. Altogether, Campus Guadalajara serves over 5,000 students distributed among its curricular academic programs, such as High School, B.A. Degrees in Business Administration, Finances International Business, Accounting, Marketing Communications, International Relations, Architecture, Computer Systems Management and Industrial Design, B.Sc. Degrees in Electronics and Communications Engineering, Computer Systems Engineering, Electronic Systems Engineering, Industrial Engineering and Mechatronics Engineering, and other graduate programs such as MBA or virtual MSc Degrees.

The Tecnológico de Monterrey, Campus Guadalajara is comprised by fifteen areas (whether they are directions or divisions), which are as follows:

1. Rectory.
2. General Direction.
3. Administrative Direction.
4. Division of Graduate Students and Research.
5. Division of Engineering and Architecture.
6. Division of Administrative and Social Sciences.
7. Division of High School Education.
8. Direction of International Programs.
9. Direction of Students’ Affairs.
10. Direction of Student Services.
11. Direction of Promotion and Relations.
13. Direction of Human Resources.
15. Direction of Planta Fisica. (Equivalent to Facilities + utilities department)

Members of the University Community within Campus Guadalajara grew more concerned over the years with the apparent passive attitude of the institution towards
sustainability, thus deciding initially to take action in their own fields within campus. Among such initiatives, the following are worth mentioning:

- The Ecological Millenium Campaign, sponsored by a student group. This campaign achieved the “Adopt a land plot” permanent program at the La Primavera forest, and the annual cycle of conferences “The Ecological Week”.
- The programs of ecological culture towards society, coordinated by the High School’s Direction of Social Formation within campus.
- The consolidation of the Environmental Quality Centre as a research and extension area seeking the improvement of the environmental performance of the public and private initiatives in western Mexico according to its own mission: “To improve the Environmental Performance of both the Public and Private Sectors within the Region; hence, contributing to Sustainable Development through the offer of top quality Environmental Services relevant to the fields of Engineering, Applied Research, Job Qualification Strategies and Consulting.”
- The activities endorsed by the Direction of Planta Física (similar to facilities in U.S. context), such as composting, the design of logistics of the separation of common solid waste in campus, the keeping of wastewater treatment facilities, the testing of ecological urinals, the instalment of energy saving lamp devices, and the management of electric energy demand and consume patterns.

The case of Campus Guadalajara has set in motion a process with the desired objective of causing an impact among the alumni, faculty, staff, providers and the general community through the institution’s educational and formative labour: In such process, the design and execution of a Sustainability Audit is primal to the actual recognition of those aspects to be addressed by the emerging Sustainability Program. Such Sustainability Program for the Tecnológico de Monterrey, Campus Guadalajara, should therefore provide a continuous improvement of the educational curricula as well as the community culture by means of the efficient management of materials and energy, the compliance of regulations, and the knowledge of existing biodiversity through its understanding and respect while maintaining congruence with the values and attitudes promoted by the Tecnológico de Monterrey.

**Background and Precedents**

The group came together for the first time in the summer of 2003 when the Direction of Planta Física, entrusted with the keeping and maintenance of facilities as well as the provision of infrastructure and basic services, first sent out a call to other specific members of the university community concerned with sustainability issues. Besides members from the Direction of Planta Física, the group was nurtured also by the gradual alignment of faculty members (from the internal divisions concerning graduate and undergraduate students, as well as high school attendants), research and consulting staff within the university (people from the Environmental Quality Centre and the Strategic Studies Centre) and a key element responsible for the execution of the mandatory social community service program among students.
Together, the group decided on a name to be bestowed upon them: the Sustainable Campus Base Group [SCBG]. Though the SCBG suffered some modifications from its original configuration, its current affiliation of ten members represents the following areas, centres and departments within campus (the parentheses indicate the strategic motives for their inclusion in the SCBG):

- Academic Divisions (responsible for curricular education in general).
- Social Community Service Department (responsible directly for the institutional impact of the university in the community).
- Direction of Planta física (responsible for the maintenance of facilities and infrastructure).
- The Environmental Quality Centre (responsible for serving as a general consultant in sustainability issues).
- The Strategic Studies Centre (responsible for conducting specific applied research studies in western Mexico).

In the future, the SCBG is also seeking the inclusion in the group of the following departments:

- Institutional Quality Department (responsible for the evaluation and control of administrative procedures in campus).
- Student Groups Department (responsible for the inclusive participation of students in the projects of Campus Guadalajara).

The SCBG has been meeting every week or two since June 2003 in work and planning sessions with an average duration of 3 hours each. Due to this intensive work, the SCBG improved from a level of individual minds coming together to the level of one mind thinking uniformly. Besides the face-to-face work sessions, the SCBG used efficient non-synchronic means of communication, (an internet discussion group, with access restricted so far only to the SCBG members) where all documents and records of the work sessions are kept as a database.

One of the early tasks of this group was to conduct a benchmarking research, on both private and public, national as well as international, educational institutions, carried out by each SCBG member Table 2.1 gives a general overview of that list.
Table 2.1 Examples of National and international Higher Education Institutions that have applied environmental and/or sustainable concepts in their operations.

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<thead>
<tr>
<th>University</th>
<th>Information</th>
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<tbody>
<tr>
<td><strong>International</strong></td>
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<td>The Hong Kong Polytechnic University</td>
<td>Ho, Hin-Ming. “Environmental initiatives and further educational possibilities within the campus of the Hong Kong Polytechnic University” IJSHE Vol. 3, No. 2, 2002 pp. 164 – 173.</td>
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<tr>
<td>The University of Western Australia.</td>
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<td>The University of Newcastle.</td>
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<td>The University of New South Wales.</td>
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<td>Royal Melbourne Institute of Technology.</td>
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<td>The University of Melbourne.</td>
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<td>The Australian National University.</td>
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Upon completion of the latter the group discussed that the focus of the Sustainability Program should lie in the crossing realms of five core axes: Education, Congruence, Biodiversity, Regulations and the Efficient Use of Resources (including, for instance, water, waste, energy and population). A description of each of the five core axes is next included:

a) **Education axis**: it refers to the consideration of the inclusion of sustainability concepts in formal education. It includes the curricula of the study programs of all levels offered within the University campus (high school, higher undergraduate
education and graduate programs). In order for a Country to achieve Sustainable Development, future professionals need to deal with an updated academic curriculum portraying a holistic vision of sustainability. Such curriculum should allow them to develop both knowledge and skills sufficient for their role as citizens and professionals in accordance to sustainability principles. As such, it is not enough merely to include one subject dealing with sustainability issues, but to offer as many subjects as possible with a practical, useful approach to sustainability values.

b) **Congruence axis**: it considers the performance of the whole campus and its internal divisions as a proxy to the actual behaviour of each member of the University community inside and outside Campus Guadalajara. It is important that each organisation promotes the development of its members both professionally and personally, regarding not only academic or labour issues, but also in terms of society and the environment. The 2005 Mission of the Tecnológico de Monterrey University System acknowledges this priority and assumes the responsibility to create spaces where people can develop attitudes, values and habits towards the fulfilment of such need. Therefore, this axis evaluates how congruent is the behaviour of Campus Guadalajara regarding the 2005 Mission of the University System.

c) **Biodiversity axis**: it deals with the different plant and animal species within campus, seeking the choice of plants according to those available in the region, as well as the creation of an inventory describing existence and location of plants and animals onsite. This axis is thus responsible for the assessment of the degree of knowledge and respect of the University community towards the biodiversity in campus.

d) **Regulations axis**: it acknowledges that the campus is part of the society, and as such, is under the regulations enforced by the three levels of Government (i.e. Federal, State and Municipal regulations). Therefore, Campus Guadalajara needs to comply with regulations in terms of water quality, waste management, food and sanitary conditions, etc. Thus, this axis evaluates the degree of compliance of campus operations with respect to the corresponding regulations.

e) **Efficient use of resources**: it refers to those practices related to the use of electric energy, fuels, water, paper and the corresponding policies regarding wastewater and waste management by the campus population. Therefore, this axis evaluates how efficient such practices and policies are in terms of sustainability. It should be noted that this axis was further subdivided in the following specific aspects: energy, water, fuel, waste, population and maximum population.

While basing a work program in the well known Deming or PDSA Cycle (see figure 2.1), the SCBG decided that the first execution phase towards the establishment of the Sustainability Program in campus was, indeed, the application of a Sustainability Audit covering such five axes for the whole campus.
A description was elaborated for each core axis (see the preceding section) in order to allow the SCBG to have an efficient process in creating checklists (see the next section). This latter was very important in order to manage the same language, since each SCBG member had different backgrounds as mentioned above in this paper. Each responsible member for the design of any particular checklist was assigned by taking into consideration their specific professional backgrounds and/or fields of academic expertise.

![Diagram of the Deming or PDSA Cycle](image)

**Figure 2.1 The Deming or PDSA Cycle, adapted to the Sustainability Program intended for Campus Guadalajara**

Each checklist was revised in whole by the rest of the SCBG to add and/or to discard specific contents.

### 2.2.2 Managing for sustainability

The next important step was to have a well-elaborated strategy that could persuade the General Direction of the campus as to the relevance of a program like this. It was important to have the full support of the General Director in convincing his board of deans and directors to lead them into facilitating the execution of the audit. This was a priority for the audit, since based on previous experiences no program has any guarantee to succeed without the support of the General Direction.
To tackle this important step, the SCBG created a justification report with its corresponding presentation that included the following contents: justification, background of the group, project objectives, methodology, expected results, benefits, time table & schedule of activities, and requirements. (See appendix 2.1)

Planning the Audit

The SCBG developed formats for reporting in situ results and observations as well as a manual for the auditor as necessary tools for the audit. The manual for the auditor was important together with the design of a specific standardised process to be executed for the actual audit (see Figure 2.2).

Figure 2.2 Flowchart for the Sustainability Audit Process.

**FLOW CHART FOR THE AUDIT PROCESS**

System: Sustainable Campus Program
Procedure: Audit
Design: Trinidad Mendoza

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**Auditor and Contact**

1.1 Audit execution process per area.

- **Start**
  - Send an e-mail a week in advance to the Deans and Directors per area.

**Introductory meeting**
- With the Dean or Director of the area and their team
- Maximum duration of 20 minutes.
- Have the power point presentation ready
- Have a copy of the document with the main aspects to be audited ready to be filled out with the corresponding informants of each area upon completion of the meeting.

**Auditors**

1

- Interviews with the staff of each area

1

- Interview with the assigned informants
  - Here the list with specific question for each specific area will be used

2

- Interview with a at random selected staff member
  - Here the list with general questions will be used.

- Compilation of the information collected through the interviews.
To carry out this process, the SCBG had to distribute the 15 areas to be audited among its members, already broken down into fifteen subgroups (one for each of the different areas within campus). Each subgroup assigned three different roles among its members in order to deal with its corresponding area: auditor, observer and contact. The assignment of the roles had to follow some basic principles. The auditor and the observer of any specific area could not be staff members of the area to be audited. The contact on the other hand had to be someone with connection to the specific area in order to facilitate the introductory audit process. The specific description of each role is as follows: on the one hand, the auditor is responsible for the interviews and compilation of tangible data in each specific area. On the other hand, the observer is responsible for the compilation of the non-tangible data in each area (general attitude, emotions and reactions of the interviewed staff). Also the contact is responsible for making the first approach with each specific area and for providing the latter with general information of the sustainable program scope.

For the introductory audit process per area it was also important to have a specific presentation of less than 20 minutes, with the objective of informing each department director of the 15 areas, the most relevant phases of the project in order to count with their support and have them together with the division director assign the different informants for the audit (see Figure 2.2).

Formats, Checklists and Data Collection Matrices

In order to record the Audit findings, the SCBG came up with specific formats to be filled with the information and data gathered during the interviews with the key and base staff within the campus’ fifteen areas. Such formats are:

- **Headings & Informants Format.** Prior to the execution of the audit, this format is sent in advance to the Director or Dean of the area to be audited. Within each of the five core axes, this format puts together the general topics to be addressed during the audit. On the one hand, its purpose is informative to the Dean or Director as to the general contents of the audit. On the other hand, its purpose is to provide the auditor with a list of key staff to interview within the area (i.e. informants), as designated by the corresponding Dean or Director.

- **Audit Interview Format.** This format is used by the auditor to record the main arguments expressed by the informant during the audit.

- **Audit Observations Format.** This format is used by the observer to acknowledge the reactions and general comments expressed by the informant during the audit.

- **Checklists and Data Collection Matrices.** Checklists were developed by the SCBG after several work sessions. These checklists consist of the specific variables to be measured within the five core axes for each of the fifteen areas. There are sixteen versions of the checklist for each of the five core axes (including the subdivisions for the efficient use of resources axis): one version for each of the areas to be audited, and one more to describe the whole campus in terms of the other fifteen.
Together, the checklists for the whole campus is comprised by a total of 209 variables, distributed as follows: education (12), congruence (45), biodiversity (8), regulations (52), energy (34), water (13), fuel (7), waste (16), population (12) and maximum population (10).

These checklists were transcribed to the form of matrices in order to collect the data gathered during the audit process, as shown in Figure2.3. For each checklist, the variables are entered in the rows on the far left of the matrix (under the column named “concept”), while its findings are recorded in the cells to the right. These cells correspond to the following columns:

- Unit, $U_i$: Quantitative or Qualitative unit, for instance, $m^3/d$, kg or $W$ for continuous variables, or Yes/No for binary variables.
- Result, $R_i$: Expression of the measured concept in the given unit.
- Observations to the result, $O_i$: Any relevant comment with respect to the captured information.
- Historic result: Previous recorded results expressed in its former value $V_i$, and date $D_i$ of collection.
- Measured frequency, $MF_i$: Periodicity of the concept’s measurement.
- Recommended frequency, $RF_i$: Recommended periodicity of the concept’s measurement.
- Responsible, $Resp_i$: Individual who collects the information.
- Source, $S_i$: Individual who provides information.
- Reference, $Ref_i$: Information that backs up the result.

**Figure 2.3. Data Collection Matrix General Format.**

In the different column descriptions, the sub index $i$ denotes a different variable under consideration.

- **Non-Conformities Format.** This format is used jointly by the auditor and the observer in order to describe the deviations of the current procedures or practices from an ideal predefined status.

- **Summary of Non-Conformities Format.** This format is filled by the auditor listing the non-conformities described in the previous format, yet classifying them
as major or minor deviations. This format is also used to summarise the recommendations emitted by the SCBG to deal with the non-conformities.

2.2.3 Assessing the results

The first meeting with the General Director in October 2003 was a success. The General Director agreed upon giving his full support to this project and immediately ordered his Head of Administration to allow the inclusion of this project in the annual strategic plan of the campus. The General Director also asked the SCBG to give an approximate date where a formal presentation of this project could be given to his board of Deans and Directors during a second meeting.

Before this presentation to the board the SCBG reached a consensus as to the actual contents of the checklists and entries necessary to be collected, as well as the creation of formats for reporting in situ results and observations. These were necessary in order to further develop the sustainability performance indicators to be used later on during the final draft of the Sustainability Program, which is the main objective of the first phase of the program.

The second meeting with the General Director (and his board of Deans and Directors) in January 2004 started without the presence of the General Director and had less of an impact than the first meeting mentioned above. Some of the Deans, mainly the ones with a better knowledge of sustainability issues, reacted very positively towards the project while others with less knowledge on the subject had a more neutral reaction. The SCBG explained some basic concepts of Sustainability to the members of the board in order to level the comprehension of the potential impact of such a program in our campus. Upon completion of this meeting, it was generally accepted by the board to start the next day with the introductory process of the audit followed by the audit itself.

The Division of Graduate Students and Research, the Division of Engineering and Architecture and the Division of Students’ Affairs, are three of the total of 15 areas to be audited where the process had already started before one of the of SCBG members left for a 1 year masters in environmental and health management in the U.S.

Observations collected so far form these three areas during this process vary from very positive all the way to negative. It should be noted that since the first meeting with the General Director to the actual audit process in campus, the latter has suffered two important administrative changes: The general Director and the Dean of the Division of Architecture and Engineering have been replaced.

For instance, the auditor and the observer assigned to the Division of Engineering and Architecture, perceived a lack of importance given to the introductory meeting by this Division since: only 60% of the Department Directors attended the meeting and only the position of four informants were given without full names, extensions and / or e-mail as was stated in the document (i.e. the Headings & Informants Format) handed in advance to the Dean of the Division. Besides of the above, a lack of communication between the Dean and the lower hierarchy levels, concerning the information about the program given in the introductory meeting was also clear. This latter created an important obstacle in the process of gaining the information needed.
On the other hand the observations of the corresponding auditors and observers were very positive for the two other divisions. Both Divisions had the full team of Department Directors present in the introductory meeting. Besides this, another important observation was the basic level of knowledge of sustainability issues portrayed in general by these two Divisions. This latter could be related to the activities carried out by these two Divisions which demand a certain level of knowledge of sustainability, compared to the activities of the Division of Engineering and Architecture which not necessarily demand this knowledge.

The SCBG has initiated the Sustainability Audit as mentioned above in three areas, with the intention to be ended by May 28th, 2004 with all 15 areas. Upon the completion of the audit the analysis and final report were intended to be presented to the campus director and his board by June 2004. But by June 2004 the audit was not completely executed and since than there hasn’t been much work done on this matter. Possible reasons for the latter could be for example: The absence of two key members of the SCBG right at the beginning of the audit., the administrative change that happened very early in the process of the audit, to much and different workload for the remaining members. Etc. Through interviews with several remaining members of the team the main consensus was that the champion of the program had to be there. They considered one of the absent members of the team to be the champion behind the change.
Chapter 3. MIT and Harvard campuses

3.1 The Boston/Cambridge leadership in green campus planning

In November of 2002 an environmental commitment made, by the city of Cambridge to reduce the city’s greenhouse gas (GHG) emissions, called the City of Cambridge Climate Protection Plan was released. This document included the city’s first GHG emission inventory results for the years 1990 and 1997. It also demonstrated the city’s commitment to follow the emission standards set forth by the Kyoto Protocol, which calls for a 20% reduction in 1990 GHG emissions by the year 2010 (City of Cambridge Climate Protection Plan (CCP). 2002). This plan outlines specific areas of environmental concern, such as energy, transportation, land use, and waste management, along with specific strategies within each area that may be taken to achieve this goal. The city proposes actions needed to be taken by specific metropolitan sectors; city government, business community, institutions, and residents, realizing that commitment and dedication from all sectors is needed to achieve the city of Cambridge’s environmental goal.

3.2 A descriptive case on Harvard regarding sustainable resource management

3.2.1 Introduction

Harvard University has just recently issued a statement of sustainability principles in October 2004. (See appendix 3.5) This latter state, that the University is committed to developing and maintaining an environment that enhances human health and fosters a transition toward sustainability. Sustainability should be advanced through research, analysis, and experience gained over time. To that end, Harvard University is committed to continuous improvement in:
- Demonstrating institutional practices that promote sustainability, including measures to increase efficiency and use of renewable resources, and to decrease production of waste and hazardous materials, both in Harvard’s own operations and in those of its suppliers.
- Promoting health, productivity and safety of the University community through design and maintenance of the built environment.
- Enhancing the health of campus ecosystems and increasing the diversity of native species.
- Developing planning tools to enable comparative analysis of sustainability implications and to support long-term economic, environmental and socially responsible decision-making.
- Encouraging environmental inquiry and institutional learning throughout the University community.
- Establishing indicators for sustainability that will enable monitoring reporting and continuous improvement.

The implementation framework for these sustainability principles.
The frame work is based on the premise that in order to be successful over the long term, decisions concerning human health and sustainability must be economically sound and
seamlessly integrated with established management and financial systems. The initial implementation plan for the University’s Sustainability Principles is based on four closely related tracks:

- **Capital Planning and Construction** - The University’s capital planning and approvals process for new construction and major renovation of existing campus facilities will be expanded to incorporate the Sustainability Principles in its review. Each school and administrative department proposing a capital project will be required to establish specific objectives consistent with the Principles as part of the formal approval process for capital projects, as is done currently for numerous other priority financial, technical and regulatory issues.

- **Annual Financial and Budget Planning** - The University’s annual budget planning process will include explicit recognition of the Sustainability Principles in the commitment of operating funds. As part of its internal annual financial plan, each School and Department will be requested to set specific goals and to report on how expenditures for facilities, support services, procurement and other activities are consistent with the University’s commitment to continuous improvement towards campus sustainability.

- **Supporting the Schools and Departments** - The University will continue to invest in support systems for sustainability, such as the Harvard Green Campus Initiative (HGCI), to facilitate the implementation of the Sustainability Principles by providing schools and administrative departments with: a clearinghouse of proven planning tools, guidelines, preferred technologies, products and design solutions; campus specific research and innovation; cost effective financial incentives; training and expertise; assistance in meeting planning and reporting requirements; and a means of facilitating broad community engagement.

- **Broad-based Continued Review** - Recognizing that the concepts of sustainability will evolve over time through experience, research, economic analysis, and technological advances, the University will continue the work that led to the development of the Sustainability Principles by appointing a standing sustainability advisory group consisting of members of the faculty, administration and student body. This group will be charged with advising in the development of sustainability indicators, monitoring progress and providing recommendations for improving the Sustainability Principles and Implementation Framework.

Harvard University can be seen as a “decentralized system “conformed by the number of 9 schools. Each school has their own facility managers and manages their yearly budget. When starting with a research on sustainability actions and/or green campus activities at Harvard ones attention is directly drawn to a program called: The Harvard Green Campus Initiative (HGCI). Even though Harvard has been working for example with a robust recycling program for more then ten years its still the latter program that seems interesting with regard to the greening of a university campus.

In the year 2000 the university started with a university wide interfaculty program titled The Harvard Green Campus Initiative (HGCI). This was setup to drive campus environmental sustainability efforts. In the year 2000 HGCI had one staff person funded through a one-year budget of 70.000 dollars by the year 2003 the HGCI counted with an
operating budget of 750,000, funding 5 full time staff, 4 halftime staff and 2 students interns. and 17 part time students. (see appendix 3.1) According to Leith Sharp and staff in an overview report of 2000-2003 the HGCI has produced in those 3 years over 800,000 of annual savings, reducing annual green house gas emissions by over 10 million pounds. This savings are set to increase each year that the HGCI continues its range of programme efforts.

Focus of HGCI:
The focus of the HGCI is to support staff, students and faculty at Harvard University to address campus sustainability through the management of building design, construction, renovation, procurement, landscape, energy, water, waste, emissions, transportation, human health and productivity.

Engagement process of HGCI:
HGCI works to reveal largely hidden environmental impacts of daily decisions and to build new capacities to address and reduce these impacts. HGCI depends upon the engagement of thousands of people across the University influencing procurement practice, utility supply and consumption (energy, water etc), campus planning, landscaping, building design and operations, transportation and waste management.
To best reach these large numbers of individuals numerous steering groups that assist our efforts to develop and maintain the numerous programs, incentives and services have been established.
With a partnership focused, responsive and strategic style of engagement, HGCI is trying to ensure that each and every one of their programs and services proves its worth financially, organizationally and environmentally.
Each department and every faculty at Harvard University is approached as a unique partner, with unique interests and opportunities concerning campus sustainability. Over the years the HGCI has established a full range of programs, services, incentives and course.

HGCI communication process
The HGCI works with hundreds of students, staff and faculty across Harvard University. The HGCI has established numerous working groups, advisory groups and steering groups to allow for the many schools and departments to advise their work. The Director of the Harvard Green Campus Initiative sits on all groups to ensure effective cross-committee communication and information sharing.
The specific constraints, needs and opportunities of each School or Department must be thoroughly represented in the development of all new campus environmental initiatives. Establishing numerous localized advisory groups has been instrumental in advising and steering the HGCI to a series of productive and mutually beneficial outcomes. HGCI noticed that participation is constantly changing and expanding as new programs are established and as the interests of faculty, staff and students evolve. Here follows a list of the current HGCI decision-making groups below:
- Harvard Green Campus Steering Committee
- Harvard Green Campus Interfaculty Advisory Committee
- Campus-Wide Sustainability Principle Advisory Group
- Longwood Campus Energy Reduction Program Steering Committee
- Longwood Campus Energy Reduction Program Advisory Committee
- Green Campus Loan Fund Advisory Committee
3.2.2 Funding (Financial Incentives)

The Green Campus Loan Fund

The Green Campus Loan Fund (GCLF) provides interest-free capital for high performance campus design, operations, maintenance and occupant behavior projects. Basic project eligibility guidelines state that projects must reduce the University’s environmental impacts and have a payback period of 5 years or less. The model is simple: GCLF provides the up-front capital interest-free. Applicant departments agree to repay the fund via savings achieved by project-related reductions in utility consumption, waste removal or operating costs. This formula allows departments to upgrade the efficiency, comfort, and functionality of their facilities without incurring any capital costs.

Harvard President Lawrence H. Summers announced that the University will double the dollars available for campus conservation projects through the Green Campus Loan Fund - to $6 million - with the aim of financing greater energy efficiency, water conservation, and waste reduction across Harvard.

Summers made the announcement during a symposium on global climate change at Sanders Theatre on December 13 2004, sponsored by the Harvard University Center for the Environment. Summers said the projects financed through interest-free loans from the fund in recent years have had a high average rate of return, making them good investments as well as laudable environmental projects. (Gazette December 2004)

A short background on the GCLF

The Green Campus Loan Fund is not the first time such an interest-free revolving loan fund has been used at Harvard to create an economic incentive for energy and resource conservation. Between the years of 1993-1998, the Engineering and Utilities (E&U) division of University Operations Services (UOS) administered a program called the Resource Conservation Incentive Program (RCIP). The RCIP was a $1.5-million interest-free revolving loan fund designed to provide a financial incentive for energy and resource conservation projects. During the program's five-year existence, the RCIP financed 35 projects that achieved the financial and environmental benefits for the University shown in table 3.1.

Table 3.1 Summary of environmental and financial benefits RCIP

<table>
<thead>
<tr>
<th>Environmental Benefits</th>
<th>Financial Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8 million lbs annual reduction of CO₂</td>
<td>Over five years, the RCIP loaned $2.6 million</td>
</tr>
<tr>
<td>35,000 lbs annual reduction of SO₂</td>
<td>Projects yielded a 34% return on investment</td>
</tr>
<tr>
<td>19,000 lbs annual reduction of NO x</td>
<td>First-year annual savings estimated at $880,000</td>
</tr>
<tr>
<td>2100 lbs annual reduction of PM 10</td>
<td>Five-year savings estimated at $4.5 million</td>
</tr>
<tr>
<td>47 million gallons annual reduction of water</td>
<td></td>
</tr>
</tbody>
</table>
In 1998 the RCIP program ended. In 1999-2000 the Harvard School of Public Health conducted research to determine the efficacy of using an interest-free revolving loan fund as an incentive for reducing environmental and human health impacts of campus operations; the full report is entitled "Economic incentives for sustainable resource consumption at a large university." The HGCI utilized the report, authored by Jonathan Levy and Kumkum M. Dilwali, to generate a proposal for creating a second-generation, improved revolving loan fund program.

Here follows a summary of the report's findings and recommendations:

- The primary incentive for participation was the financial structure of 0% interest and the provision of funding that would not interfere with capital budget cycles.
- 1 of 8 participants cited environmental awareness as opposed to financial gains as their motivation for participating in the program.
- Most participants heard about the program through the facility managers network
- Perceived barriers cited to involvement:
  - Information barrier (what can we do with the money?),
  - Inability to identify projects that met the payback requirement,
  - Lack of staffing and time, and
  - The incentive was not worth the administrative effort

Recommendations are:

- Develop and implement an aggressive program management and marketing plan to reintroduce the RCIP across the Harvard campus
- Improve information flow by reinstating facility director meetings and using electronic media to disseminate and share project updates
- Provide high-level technical assistance to help facilities prioritize among competing projects and determine staffing needs
- Expand program boundaries to include "innovative initiatives" (e.g., campus-wide recycling program, variable-speed drives, digital direct control)
- Publicize project successes to ensure that the RCIP remains on the "radar screens" of key decision makers

The HGCI took all of these recommendations seriously into account, but one of the major recommendations gleaned from the Levy/Dilwali report was that any incentive program needed active and continuous management to stay visible to facility management departments. (Levy & Dilwali, 2000)

The Role of the Harvard Green Campus Loan Fund

The Harvard Green Campus Loan Fund Coordinator promotes and administers the fund while also developing services that will effectively increase engagement in high performance campus projects. The GCLF is further promoted and supported by all HGCI staff. The GCLF is independently evaluated and advised by a cross-faculty/department Advisory Committee. (See appendix 3.2 for a more detailed list of this committee) In addition to representatives from the HGCI, this committee includes members with expertise in and responsibility for engineering and utilities, environmental impact, health and safety, operations, finance and administration, and maintenance.

This program enables the HGCI to help interested partners identify, develop, finance, and earn recognition for GCLF projects through the following avenues:

- Providing project conception and development support
• Awarding interest-free financing to approved projects
• Facilitating communication between networks of empowered individuals concerned with reducing Harvard’s environmental impact
• Publicizing project successes and recognizing the work of individuals dedicated to improving campus sustainability

With this resource, the HGCI is able to provide a direct financial incentive for realizing the vision of sustainable campus living and operations at Harvard University.

**Green Campus Loan Fund Advisory Committee**

A very important aspect for the GCLF to be successful is the management and strategy support provided by the Loan Fund Advisory Committee. To ensure that the GCLF was promoted and understood within the disparate facility departments at Harvard, the HGCI enlisted the support of key central administration and department facilities staff to serve on the fund’s Advisory Committee. The purpose of the committee is to provide strategic advice and oversight of administrative and marketing approaches, as well as to provide crucial assistance and legitimacy to the project proposal review process. The responsibilities of the Advisory Committee are as follows:

• Creating GCLF criteria and establishing proper evaluation processes
• Identifying opportunity areas for GCLF promotion, providing general advice and support for continued loan fund development and expansion
• Reviewing project applications
• Monitoring and reviewing GCLF processes and procedures to gauge program effectiveness and accountability

When reviewing project applications, the Advisory Committee evaluates on the following criteria:

• Financial payback
• Environmental impact reductions
• Degree of project innovation
• Potential for project replication elsewhere at Harvard
• Community education/outreach opportunities

**Application for a Green Campus Loan Fund**

**Loan Fund Criteria and Eligibility Requirements**

Projects will be evaluated on their ability to contribute to one or more of the following areas of consideration:

• Greenhouse gas reductions
• Energy conservation
• Water conservation
• Sewage and storm water output reductions
• All types of pollution reduction
  - Hazardous waste
  - Solid waste
  - Liquid waste
  - Gaseous emissions
• Operations improvements that decrease environmental impacts
• Environmental procurement practices
• Environmental leadership development within the University
• Number of individuals with improved environmental literacy and increased levels of participation in conservation activities
• Education of and reputation building with surrounding community

Assessing your project's Loan Fundability
Projects that will be considered for GCLF review must meet both of the following core criteria, with exceptions and qualifications noted below:

• Projects must generate infrastructure or behavioral improvements that directly decrease Harvard University's current environmental impact. These projects must demonstrate an innovative design and implementation approach. Projects that are part of scheduled or routine maintenance will not be eligible for consideration unless they demonstrate environmentally beneficial design innovation.
• Projects must have a payback period of five years or less. (see exceptions below)

Eligibility Exceptions and Qualifications
The Green Campus Loan Fund Advisory Committee has approved four significant changes to the Loan Fund's eligibility requirements:

• Loan Funded applicants can now include any rebates in end calculations of payback periods (a rebate from an energy utility can reduce a 6 year payback period to 5 years, making the project eligible for loan funding).
• Loans of up to $20,000 are now available for Feasibility Studies supporting early project start-up efforts. Feasibility loans must either be repaid within 2 years or rolled into a repayment schedule of any loan funded project resulting from the feasibility assessment.
• Loan funding is now available for Photovoltaic (PV) Projects in support of renewable energy at Harvard University. Loans must still be repaid within 5 years even though actual payback periods are much longer for PV.
• The Loan Fund Advisory Group has approved the concept of "project bundling" which allows funding applicants to apply for one loan fund for multiple projects. The terms of this agreement are that the total payback period of the bundled projects cannot exceed 5 years. For example an applicant may apply for one loan to fund two projects including a 2-year payback lighting project and a 6-year payback ventilation upgrade as long as the combined payback does not exceed five years. The intention of this concept is to leverage very low payback projects to enable projects with longer paybacks.
Application processes
In order to comply efficiently with University accounting regulations, three different application processes to expedite the project review and approval process have been created. They are:

- Non-capital project application process
- Capital project application process
- Mixed capital and non-capital project application process

Non-capital project application
Projects that cost less than $50,000, that fund human resources, or that do not qualify, as capital projects as described in Harvard University's Policy on "Capitalization and Depreciation of Property, Plant and Equipment" will be scrutinized through the non-capital project application process. Such projects do not need to be reviewed by the Capital Project Services (CAPS) office; this application process is contained within HGCT's management structures.

Capital project application
In accordance with University accounting regulations, projects that cost more than $50,000, that do not fund human resources, or that qualify as capital projects as described in Harvard University's Policy on "Capitalization and Depreciation of Property, Plant and Equipment" will be scrutinized through the capital project application process. To streamline the approval process, the HGCI will first review projects and then give them financial pre-approval guaranteeing a loan. The CAPS office will be primarily concerned with the financial accounting of expenditures, compliance issues, and the proper asset reevaluation associated with the project. The GCLF Coordinator will serve as a point-of-contact for CAPS administrators for all GCLF capital projects processed through the CAPS office. CAPS forms associated with GCLF financing should not be submitted directly to the CAPS office. All CAPS forms must be processed through the GCLF Coordinator.

Mixed capital/non-capital project application
The application process for projects that contain both capital and non-capital expenses will first entail breaking out the project expenses along the capital/non-capital line. Then, these sub-projects will be analyzed in accordance with their corresponding project application.

Other means of funding:
In the specific case of Renewable energy there are several examples of projects on campus in Harvard that used other resources channels than the GCLF. Models include fundraising from among students and alumni, from outside organizations, or through creative reinvestment of monetary savings from energy conservation efforts.
Here follows some examples:

- Using financial savings from a successful energy conservation campaign to cover costs of renewable energy purchase
- Fundraising
3.2.3 Actions

3.2.3.1 GHG emissions Inventory:

The HGCI recently completed Harvard University's first ever greenhouse gas (GHG) inventory. The inventory accounts for greenhouse gas emissions resulting from Harvard's use of purchased electricity, chilled water, steam, natural gas, fuel oil (#2, #4) and diesel and oil for back up boilers, hot water heaters and emergency generators for the Cambridge and Allston campuses (1990 and 2003) and the Longwood Medical Campus (1992 and 2003). The inventory also accounts for emissions resulting from the daily commute of staff, students and faculty traveling to and from Harvard and from Harvard's trash going to landfill. HGCI will soon begin to conduct annual GHG inventories.

In the last 12 years, Harvard has increased its consumption of energy by over 40%, resulting in a directly proportional increase in greenhouse gas emissions. In 2003 Harvard University contributed around 295,000 Metric Tonnes of Carbon Dioxide Equivalent to the Earth's atmosphere. To put this in perspective, divided equally amongst every student, staff and faculty member, each person at Harvard is contributing roughly two times the GHG emissions of an average vehicle for a year. The inventory revealed that around 90% of Harvard's GHG emissions are directly related to heating, cooling and powering its 600+ buildings. Therefore we can attribute the 3-4% annual increase to the following factors:

- An increase in building square footage
- An increase in laboratory intensive research
- The proliferation of computers and associated peripherals and
- Increased building occupant expectations for more space and comfort

According to Jack Spengler and Leith Sharp the new GHG inventory is likely to become an important sustainability indicator for Harvard University as they move forward to implement the Campus Sustainability Principles. Without the inventory, it would be difficult to benchmark and measure progress. Furthermore, the inventory provides some significant clues as to where to turn the efforts. For example, a closer look at the inventory reveals that work must be done to address laboratory energy use, building occupant behavior and equipment purchasing. It reveals the importance of pursuing renewable energy sources, and energy efficient building design, especially for Harvard’s future campus expansion.

With the launch of the Campus Sustainability Principles, Harvard is looking to take significant strides forward in their effort to reduce negative campus environmental impacts. GHG reductions will be one of the primary considerations going forward.
3.2.3.2 Energy conservation

Renewable energy

The view of HGCI is that switching to clean and renewable energy sources will be a key element in any successful effort to reduce Harvard University's greenhouse gas emissions. According to the planners of the HGCI as the campus grows, conservation must go hand in hand with a switch to clean power. To date students and staff at Harvard have been taking some important steps to switch to clean power. According to the U.S. EPA’s current information Harvard University has become the second largest purchaser of renewable energy among universities in the U.S. This is the result of the combined purchase of Harvard school of Public Health (HSPH), Harvard Medical School (HMS), Kennedy School of Government (KSG), Faculty of Arts And Sciences (FAS) and Harvard Real Estate of green energy. The Harvard's Renewable Energy Fund has been established as a $100,000-per-year fund intended for Harvard's renewable energy purchases and to support further research on the issue. And Harvard Green Campus Loan Fund interest-free dollars can and have been used to finance onsite renewable projects such as the photovoltaic installation on the roof of Shad Hall at the Harvard Business School.

For a summary of case studies on renewable energy projects see appendix 3.3

(See case study funding was combined (MTC) Massachusetts Technology collaborative (http://www.mtpc.org/AgencyOverview/whatwedo.htm) the GCLF and HBS.)

Resource Efficiency Program (REP)

The Resource Efficiency Program (REP) is a peer-to-peer environmental education program. It relies on paid student representatives who communicate with other students in their residential communities and act as a liaison between students and administrators about sustainability, comfort, health, and efficiency issues. Twenty student employees, with the guidance of student program leaders and administrative partners, teach their peers why and how to conserve energy, water and materials. The Reps (as this students are titled) also suggest infrastructure and policy improvements that will remove barriers to student conservation.

Seventeen student representatives, one per upperclass dorm (including DeWolfe) and four in the Freshman Yard, are employed to work four hours per week on a range of dorm-based ecological education programs and energy-efficiency measures. Two student captains are employed for 10 hours a week to guide the student Reps. The Yard Reps also coordinate a volunteer entryway Eco-Rep program. An employee of the Green Campus Initiative coordinates the entire Resource Efficiency Program.

The Resource Efficiency Program now administers an annual Green Cup competition as a way of energizing and monitoring annual campus impact reduction activities. The Green Cup resource conservation competition has been a subcommittee of the Harvard College Environmental Action Committee since 1990, offering prizes to resource-efficient dorms with the sponsorship of the Faculty of Arts and Sciences (FAS) Office of Physical Resources.

REP continues to evolve and expand based on what they consider their “successes”.
A Steering Group (See appendix 3.2) guides the FAS Resource Efficiency Program, consisting of representatives from every funding partner, key student environmental leaders, and REP staff.

**Goals**
The goals of REP can be summarized as:
- Strategic coordination between students and operations staff;
- Utilize administrative partners to maximize Reps’ effectiveness; Pass on important information to providers of student services about barriers to student conservation/student perspectives;
- Sustained institutional memory;
- Action toward campus environmental impact reduction goals;
- Reduce the consumption of resources on campus, particularly energy and water used in residences;
- Increase the proportion of waste that is recycled (supporting Harvard’s goal of 50% waste diverted to recycling by 2005); Increase the proportion of waste that is recycled rather than trashed; Decrease refuse generated;
- Evaluation of initiatives and financial savings;
- Active mentoring of students;
- Develop student leaders to carry out these goals;
- Education for environmental sustainability;
- Create a norm of environmentally aware behavior among Harvard College students on campus and in their future roles;
- Contribute to making environmentally preferred behaviors convenient and natural parts of everyday life; Increase awareness of upstream and downstream effects of choices among dorm residents.

**The Faculty of Arts and Sciences (FAS) Computer Energy Reduction Program (CERP).** (the FAS is the school with the single biggest amount of buildings mainly 240 buildings over more than 8 million square foot.)

FAS CERP’s mission is to reduce the cost and environmental impact of computer use within Harvard University’s Faculty of Arts and Sciences. To achieve these goals, there is collaboration with administrators, IT professionals and students to develop technological and educational approaches that will be most effective in the FAS community. In addition to general resource conservation, FAS-CERP also promotes computer energy reduction through the following techniques.
- Enabling power management. They make it easy to save energy by offering software on our website that, when downloaded, helps computer users activate power management for monitors. They also provide guidance on how to manually enable power management for both computers and monitors.
- Shutting down. They encourage people to turn off their computers, monitors, and peripherals when not in use, and CERP work to dispel myths that often get in the way of shutting down.
- Buying right. CERP provide purchasing guidelines that help people choose energy efficient computers, monitors and peripherals. In addition, they
provide information about proper disposal of computers and recycling opportunities.

FAS CERP’s approach is geared toward FAS’ students and employees who have highly diverse interests and backgrounds. To reach this audience, campaigns are designed that not only inform computer users about energy conservation in an entertaining way, but that also encourage them to make a pledge or take an action that gets them one step closer to actualizing energy savings. Other projects focus on data gathering and the development of technical solutions to the computer energy problem.

FAS CERP’s Motivation for Action comes from the fact that computers contribute directly to the problem of global climate change by consuming energy produced by the burning of fossil fuels. This combustion process releases carbon dioxide, which is the greenhouse gas mainly responsible for climate change. Their self conducted research shows that one desktop computer and 17” CRT monitor left on 24 hours per day for one year can release over 1500 pounds of carbon dioxide. By encouraging students and employees to switch off their computers and enable power management, FAS-CERP works to limit the amount of CO2 released by the 13,000 computers in the Faculty of Arts and Sciences.

The manufacturing, distribution and disposal of computers, as well as the air conditioning often necessitated by their operation, release greenhouse gases due to energy consumption. In addition, these activities consume natural resources and release toxic chemicals into the environment. Manufacturing one 2-gram silicon chip requires 1.6 kilograms of fossil fuel, 72 grams of chemicals and 32 kilograms of water (Williams et al., 2002). FAS-CERP also educates the FAS community about the lifetime greenhouse gas emissions and other environmental impacts associated with computer use.

The Longwood Campus Energy Reduction Program (CERP)

The Longwood Campus houses the Harvard Medical School, Harvard School of Public Health and Harvard School of Dental Medicine. The schools are laboratory intense and as a result consume a significant proportion of Harvard University’s total energy.

The Longwood CERP is a joint collaboration between the three Longwood Schools and the HGCI to engage faculty, students and staff in developing and institutionalizing a commitment to campus sustainability arising from a shared mission to enhance human and ecological health.

The Longwood CERP works with all campus constituents to expand student, staff and faculty understanding of campus impacts. The Longwood CERP provides range of forums and programs that aim to develop new collaborations between staff, students and faculty; and to enable the community to institutionalize cost effective environmentally sustainable campus practices.

The Longwood CERP is largely focused on energy conservation and renewable energy.

During the 2003 and 2004 Thanksgiving Holidays, Longwood CERP teamed up with the FAS CERP Program for "Go Cold Turkey", an energy conservation campaign engaging the Harvard FAS and Longwood campuses in friendly competition to see who could report the most pledges, commitments to turn off all unnecessary energy consuming appliances and heat over the holidays and beyond.
In 2003 the Longwood Campuses first participated in the Go Cold Turkey competition. The Harvard School of Public Health (HSPH) was the winner with a 24% pledge rate. As part of the Go Cold Turkey Pledge Competition, HSPH administration offered a special challenge to residents of Shattuck House. If more than half of Shattuck residents took the pledge, then HSPH promised to buy renewable energy certificates equivalent to 50% of the building’s electricity consumption for the following year. Shattuck House was successful, resulting in HSPH’s first-ever wind energy purchase.

The Harvard School of Public Health (HSPH) administration recently purchased 7,487,472 kilowatt hours (kWh) of wind renewable energy certificates for one year. It is the largest single renewable energy certificate purchase ever made at Harvard. This purchase effectively offsets 20-25% of the Greenhouse Gas emissions generated by all of the HSPH buildings on the main HSPH campus, as well as Shattuck International House and the 4th Floor West of the Landmark Center.

The HSPH administration funded this purchase with energy savings resulting from what they considered “successful” behavioral change programs, such as the Computer Energy Reduction Program (see appendix 3.4) and a range of technology projects.

The Longwood CERP has hosted Best Practices Exchange (BPE) events, which bring together the Harvard community (including those directly involved in campus planning, building, design and maintenance) to share general information about Harvard environmental impact, as well as cost effective practices that conserve resources, improve efficiencies and reduce environmental impacts.

Here follows a list of summarized projects through the LGCI funded by Green Campus Loan:

- **HSPH Kresge Lighting and Controls**
  
  Completed in 2003
  
  This project replaced 317 overhead light switches with occupancy sensors and 370 lighting ballasts with T-8 ballasts throughout the Kresge building.
  
  Environmental Impact Reduction: 266,893 pounds CO₂

- **HSPH FXB Lighting and Controls**
  
  Completed in 2003
  
  This project replaced 137 existing overhead light switches with occupancy sensors, and 790 lighting ballasts with T-8 ballasts throughout the FXB building.
  
  Environmental Impact Reduction: 142,624 pounds CO₂

- **HSPH Building 2 Lighting and Controls**
  
  Completed in 2003.
  
  This project replaced 162 existing overhead light switches with occupancy sensors, 1,117 lighting ballasts with T-8 ballasts, and 295 light fixtures throughout the SPH-2 building.
  
  Environmental Impact Reduction: 305,300 pounds CO₂

- **HSPH Building 1 Lighting and Controls**
  
  Completed in 2004
  
  113 overhead light switches were replaced with occupancy sensors. 2,444 magnetic lighting ballasts were replaced with T-8 ballasts throughout the SPH-1 building.

- **HMS Parking Garage Lighting**
  
  Completed in 2003
This retrofit focused on the interior lighting system of the Harvard Medical School Parking Garage. Lighting Resource Management, Inc provided project management and turnkey installation. The original interior lighting system consisted of HPS (orange) lighting systems and some lighting fixtures with T12 lamps powered by magnetic ballasts that were left on 24/7. The system was upgraded with long-life T8 lamps powered with electronic ballasts, and automatic lighting controls. This resulted in savings of $18,872.55 (a 59% reduction in annual electric operating cost). The resulting electric load reduction was 17.23 kW, annual kWh savings of 163,824 kWh. A total of 228 fixtures were upgraded or replaced and 19 automatic lighting controls were installed.

3.2.3.3 Recycling

Harvard has been supported for 10 years with its recycling efforts by University Operations Services UOS, a University based service provider that manages a significant portion of the University’s waste stream. As part of UOS’ waste management services is a robust recycling program managed by Rob Gogan. Although Harvard’s recycling efforts are strong, there continue to exist many areas for increased participation in the recycling program, according to HGCI. The recycling program used the loan fund in an effort to improve its activities in a specific project titled: Recycling Enhancement Initiative. This recycling enhancement initiative was focused on increasing recycling participation specifically in undergraduate dorms. Compared with recycling rates for the University as a whole (31% in FY2001), dorm-recycling rates historically have ranged in the 15-20% range. UOS’ GCLF project focused on increasing access to and functionality of recycling receptacles, as well as creating more consistent and visible signage and recycling promotional materials. Project success that leads to increased recycling rates decreases the University’s overall expense for waste management (recycling being cheaper/ton than landfill tipping fees).

The main project goal was to increase recycling participation in undergraduate dormitories. But before proposing changes to the existing recycling program, UOS first worked with students, housemasters, and Faculty of Arts and Sciences Department of Physical Resources to identify potential reasons for low recycling participation in undergraduate houses. UOS calculated savings associated with increased recycling participation and submitted a Project Proposal for review by the Loan Fund Advisory Committee. UOS’ GCLF proposal included funding for the following recycling program improvements:

- The purchase of well-designed recycling containers that enable students to sort paper, cans and bottles, and trash in their rooms. Prior to the GCLF program there were several types of receptacles in use, the most common being blue curbside recycling boxes. Most students found those receptacles to be too large, unattractive, a hindrance to easy recyclables separation, and too easy to put to a use other than recycling. Many of the students used the boxes remaining in the Houses as laundry bins, trash bins, bag-lined beer coolers, etc. As an alternative, UOS specified smaller, stackable containers easier for students to transport to the main recycling receptacle.
- The creation of clear, consistent information about recycling, waste reduction, energy and water conservation. Although posters explaining recycling specifications existed in each trash/recycling area, there was no information for students in their room. To help remedy this, UOS created “do not disturb” door hangers that also served as a source of recycling specifications.
- The purchase of desktop recycling boxes for paper recycling. Recycling rates improve with convenience. If students are presented with the opportunity to recover paper right on their desktop, it increases the chances that they will separate it and set it into the recycling collection barrel in their House or Dorm. These boxes have the added benefit of offering advertising space for recycling promotions and conservation information that will also appear on the door hangers described above.

3.2.3.4 Water conservation

Computerized irrigation controls for Harvard Business School landscaping. The controls assess recent rainfall, humidity levels, and soil moisture before turning on landscape sprinklers, saving an estimated 5 million gallons of water a year. (Gazette December 2004)

3.2.3.5 Paper use

No specific project or program identified that specifically focuses on paper use. Paper recycling form part of the recycling program at Harvard.

3.2.3.6. Others

Providing a Forum for Best Practices
The Best Practices Exchange, hosted by the Harvard Green Campus Initiative, brings together the Harvard community involved or interested in the pursuit of environmentally sustainable campus operations. Best practices in planning, building, design and maintenance conserve resources, improve efficiencies, reduce environmental impacts and are cost-effective.
Events are designed to be educational and of practical relevance to campus decision-makers. Presenters can be Harvard staff, Faculty, or representatives of other leading organizations. Presenters provide 1-2 hours of concentrated, innovative and informative material with time for discussion.
The Best Practices Exchange gives busy campus decision makers the opportunity to learn about new practices relevant to campus sustainability with minimal time commitment and cost.

High Performance Building Service
From the start, the HGCI was concerned with engaging staff, students and faculty to ‘make the case’ for campus sustainability. Within one year of these efforts it became evident that many staff were very receptive and wanted the HGCI’s help to take action.
Over the next two years the HGCI assisted staff to introduce a wide range of new approaches to campus operations. As these experiences evolved, it became evident that staff across Harvard was eager to have a range of mature services for evaluating and implementing building performance improvement options.

In response to this emerging opportunity, the HGCI worked closely with leading departments such as University Operations Services and Harvard Real Estate Services to design trial and continuously improve a range of formal services. To help this process along, the HGCI recruited two student interns in the summer of 2002.

In early 2003, the HGCI consolidated its emerging building performance services into a single program with its own dedicated staffing. This program is now known as the HGCI High Performance Building Service (HPBS) and can be utilized by any department within Harvard that is seeking to generate cost-effective building performance improvements and related campus environmental impact reductions.

Since 2003, the HPBS has expanded its client list to University Operations Services, Harvard Real Estate Services’ Residential and University and Commercial groups, and the Harvard Divinity School.

With the believe that the many small improvements that are possible over a buildings life can add up to dramatic improvements in building performance, the HGCI also provides a full high performance building service to help staff throughout the university address the opportunities for improving building performances. This service includes the provision of building system assessments, envelop analysis, occupant comfort assessments, building project identification, evaluations of project costings and funding options, project management for project implementation, staff training and occupant education programs to support high performance building objectives, and the development of standards and guidelines of ongoing building management. Through this service a wide range of environmental performance and human health improvements are achieved in a diversity of building typologies.

**Specific services:**
The HGCI offers the following High Performance Building services to assist any Harvard University Faculty or Department:

- Leadership in Energy and Environmental Design (LEED) Support and Project Management
- Building Management Profiles and Occupant Surveys
- Energy Conservation Measures Project Identification
- Green Campus Loan Fund and Rebate Analysis
- High Performance Contract Language, Specifications and Guideline Support
- High Performance Building Seminar Development and Delivery
- High Performance Project Management
- Environmental Procurement Support

For more detailed information on each service see appendix 3.4.
A course titled, Sustainability: The Challenge of Changing Our Institutions

The Course Description:
“In order to operate within the limitations and capacities of the Earth to renew and sustain key life support systems, best estimates indicate that western society will need to reduce its natural throughput by 90% within one generation. This will require deep and rapid transformation within all of our institutions.”

The course begins by exploring the wide range of institutionally related environmental impacts and the associated roles of individuals within these settings. Harvard University is used as a primary case study to illustrate institutional practices including procurement, utility supply and consumption (energy, water), building design and operations, transportation, and waste production and recycling.

The principles and practice of environmental sustainability for institutions and individuals will be taught and demonstrated in this course. The course will focus on the university sector as a case study for examining how organizations with complex structures make a myriad of decisions with environmental consequences.

The course will provide students with a thorough exploration of methods and approaches that can be drawn upon to catalyze organizations, such as universities, to pursue environmental sustainability.

Illustrative examples of university sustainability programs, including campus planning, building design and operations, energy supply, purchasing practices, food services and waste management among others, will be presented. These examples will be further explored to reveal strategies for generating engagement, learning capacity and behavioral change at the level of both the individual and the organization. Financial, environmental, political, cognitive and organizational dimensions will be addressed. The course is designed to cover three key topic areas:

- Institutional Impact
- Institutional Operations
- Institutional Transformation

Students will ideally leave this course with the knowledge, understanding and confidence to develop their own capacities as change agents, leaders or catalysts for generating institutional commitment to environmental sustainability within a myriad of organizational settings.

3.2.4 Results and possible measurements

The following results of the programs and projects carried out as part of the HGCI are taken from the Harvard Green Campus Initiative webpage and papers provided by the director of HGCI, Lieth Sharp and HGCI board of advisors member Jack Spengler.

Green Campus loan fund
Since its inception on 2001, the Green Campus Loan Fund has funded 36 projects through 14 University departments. Over $2.6 million has been loaned, which is expected to save the University $889,000 per year with an average return on investment of 30.8% (excluding the photovoltaic project). The following case studies explain how these
projects were identified and implemented. Loan fund projects range from standard lighting upgrades to innovative behavioral change programs such as the Computer Energy Reduction Program (CERP).

<table>
<thead>
<tr>
<th>Department</th>
<th>Number of Projects</th>
<th>Total Loans</th>
<th>% Total Fund Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard Business School</td>
<td>9</td>
<td>$1,025,623</td>
<td>39%</td>
</tr>
<tr>
<td>Harvard School of Public Health</td>
<td>5</td>
<td>$307,335</td>
<td>12%</td>
</tr>
<tr>
<td>Harvard Real Estate Services</td>
<td>6</td>
<td>$113,519</td>
<td>4%</td>
</tr>
<tr>
<td>Harvard Faculty of Arts and Sciences</td>
<td>4</td>
<td>$465,287</td>
<td>18%</td>
</tr>
<tr>
<td>Harvard University Art Museums</td>
<td>1</td>
<td>$27,763</td>
<td>1%</td>
</tr>
<tr>
<td>Harvard Medical School</td>
<td>2</td>
<td>$113,195</td>
<td>4%</td>
</tr>
<tr>
<td>Harvard Graduate School of Education</td>
<td>1</td>
<td>$297,029</td>
<td>11%</td>
</tr>
<tr>
<td>Harvard University Dining Services</td>
<td></td>
<td>$23,225</td>
<td>1%</td>
</tr>
<tr>
<td>Harvard Universities Libraries</td>
<td>1</td>
<td>$79,572</td>
<td>3%</td>
</tr>
<tr>
<td>Harvard Kennedy School of Government</td>
<td>1</td>
<td>$22,443</td>
<td>1%</td>
</tr>
<tr>
<td>Harvard Radcliffe Institute</td>
<td>1</td>
<td>$6,840</td>
<td>0.3%</td>
</tr>
<tr>
<td>Harvard University Operations Services</td>
<td>1</td>
<td>$74,340</td>
<td>3%</td>
</tr>
<tr>
<td>Harvard University Dining Services</td>
<td>1</td>
<td>$58,000</td>
<td>2%</td>
</tr>
<tr>
<td>Harvard Divinity School</td>
<td>2</td>
<td>$21,411</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 3.2 GCLF projects per department

The Green Campus Loan Fund (GCLF) produces high returns and substantial environmental conservation.

- General Statistics and Department Participation
- Funding by Project Category
- Financial Savings by Project Category
- Average Return on Investment (ROI) by Project Category
- Environmental Impact Reduction Achievements
- Timeline of Fund Performance

**General Statistics and Department Participation**

Since becoming available to Harvard departments in January of 2002, the GCLF has created an impressive list of fiscal and environmental impact reductions. As of September 2004, GCLF projects are projected to save the University $889,000 per year with an average project ROI of 27.9%. The list below highlights the program's project engagement and fiscal achievements.

The 36 GCLF projects have been funded through 14 different University Faculties and Departments. In Table 3.2 is a list of each participating department and the number and total amount of funded or approved GCLF proposals:
Funding by Project Category

Projects range in type from lighting upgrades to onsite renewable energy production, and range in size from $4,150 to $361,110. All 36 projects are grouped into categories given in table 3.3.

Table 3.3 Project number per category

<table>
<thead>
<tr>
<th>Project Category</th>
<th># of Projects</th>
<th>Amount of Allocation</th>
<th>% Total Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lighting</strong></td>
<td>22</td>
<td>$998,870.75</td>
<td>37.90%</td>
</tr>
<tr>
<td>Heating, Ventilation, Air Conditioning (HVAC)</td>
<td>5</td>
<td>$377,694.68</td>
<td>14.33%</td>
</tr>
<tr>
<td>Computer Energy Reduction Program (CERP)</td>
<td>3</td>
<td>$503,150.00</td>
<td>19.09%</td>
</tr>
<tr>
<td>Co-generation</td>
<td>1</td>
<td>$243,429.11</td>
<td>9.24%</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1</td>
<td>$205,551.60</td>
<td>7.80%</td>
</tr>
<tr>
<td>Kitchen Renovation</td>
<td>1</td>
<td>$232,200.68</td>
<td>8.81%</td>
</tr>
<tr>
<td>Photovoltaic power generation (PV)</td>
<td>1</td>
<td>$23,225.00</td>
<td>0.88%</td>
</tr>
<tr>
<td>Project Category</td>
<td># of Projects</td>
<td>Amount of Fund Allocation</td>
<td>% Total Fund Allocation</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------</td>
<td>---------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Recycling Enhancement</td>
<td>1</td>
<td>$38,000.00</td>
<td>1.44%</td>
</tr>
<tr>
<td>Insulation</td>
<td>1</td>
<td>$13,460.00</td>
<td>0.51%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>2,635,581.82</td>
<td></td>
</tr>
</tbody>
</table>

Lighting and lighting control upgrades have been the most popular projects, accounting for 22 of 36 proposals at an average project cost of $45,403. While less numerous, HVAC, CERP, irrigation, co-generation, and PV project proposals usually command a significantly higher per-project cost. See figures 3.2 and 3.3.

% Fund Allocation by Project Category

Fig 3.2 % Fund allocation by Project Category
Savings by Project Category

As shown in Fig 3.3, the three behavioral change CERP projects account for 41% of the savings generated by the GCLF. The second largest category, lighting, accounts for 31% of annual savings. HVAC is the third largest category, accounting for 14% of annual savings. The remaining 6 categories all record a single digit share or less.

The savings attributable to the three CERP projects is significant. Historically, facility managers have concentrated on upgrading infrastructure to realize energy conservation goals. The success of the CERP behavioral change projects highlights the conversation opportunity in changing how users interact with the physical plant. The positive advances in this category, while more subjective, could be considered substantial enough to merit more consideration than they had previously been granted.

Average Return on Investment (ROI) by Project Category

Furthering the argument to pay more attention to behavioral change projects as mentioned above, HGCI considered the CERP projects generated average of 73.1% ROI as very relevant.
With the exception of the one PV project, on average all GCLF project categories achieve better than a 20% ROI, with 5 of 9 categories achieving better than 25% ROI. According to HGCI the high ROI of GCLF projects is one of the best indicators of the program’s success. Putting money into infrastructure improvements and behavioral change campaigns is increasingly being viewed as an intelligent and relatively low-risk investment opportunity, a statement that, according to HGCI, is well-illustrated by the numbers above.

**Environmental Impact Reduction Achievements**

Along with the fund’s financial achievements, GCLF projects have also created significant environmental impact reductions for the University, including the following reductions:

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenhouse Gases</td>
<td>14,849,058 lbs CO2</td>
</tr>
<tr>
<td>Water</td>
<td>7,278,498 gallons</td>
</tr>
<tr>
<td>Waste</td>
<td>200,000 lbs</td>
</tr>
</tbody>
</table>

The above impact reductions were achieved by projects that averaged an ROI of over 27.9%, further supporting the argument that environmental responsibility is often
synonymous with fiscal responsibility. The GCLF works on a model that ensures cost-effective solutions to environmental impact reduction goals.

**Timeline of Fund Performance**

Figure 3.5 illustrates the timeline of project proposal approvals since the program began in January 2002. It is important for the HGCI to track GCLF activity in order to gauge the effectiveness of marketing and network activities.

In a report authored by Harvard's School of Public Health on a precursor to the current loan program, the Resource Conservation Incentive Program (RCIP), caution was voiced about an immediate spike in fund activity followed by an equally rapid attrition of program participation.

**Table 3.4 Comparison on program participation between two Programs**

<table>
<thead>
<tr>
<th>Financing Program</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCIP</td>
<td>26</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>GCLF</td>
<td>14</td>
<td>9</td>
<td>11</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
As table 3.4 above demonstrates, though the GCLF did not field as many projects in its first year, it had a comparatively much stronger second and third year performance. Further, at the time of this report, year 3 still has three more months remaining. According To HGCI, it’s clear that GCLF has maintained a steady level of fund activity to date.

3.2.4.2 Green House Gases Inventory:

The following results are taken from the power point presentation of the Harvard GHG emissions Inventory given in June 2004 and form the HGCI webpage. It’s important to notice the fact that the Cambridge / Allston Electric factor varies over the years is a product of better data on the fuel ratios used to make electricity. The electricity for the Cambridge and Allston campuses comes from Nstar, which is required to publish fuel ratio and emissions data; Longwood’s supplier (MATEP) is not, and so the information is less precise.

**Direct GHG Emissions**

On the Cambridge/Allston and Longwood campuses, an overall increase of roughly 43% GHG Emissions between 1992 and 2003.

- Longwood Medical Campus: roughly 59% Increase in Direct Emissions 1992 – 2003 (see fig 3.7)
- Cambridge / Allston: 30% Increase in Direct Emissions 1990 – 2003 (see fig 3.8)

In 2003, Harvard’s three campuses emitted roughly 300,000 tons of carbon dioxide equivalents. To provide visualization for how much this means, the volume of one pound of CO2 is enough to fill 363 one-liter bottles or roughly 120 party balloons. The conversion of the 300,000 tons of CO2 equivalents to party balloons would mean each person at Harvard would have over 2 million party balloons by the end of 2003!

To put Harvard University's GHG emissions increase into perspective, consider the context of the general trend of emissions over this same period of time in the state of Massachusetts, "In 1990, Massachusetts emissions were estimated to be 115,632,000 tons of CO2 equivalent (including CO2, methane, and N2O). In 2001, Massachusetts released approximately 7% above 1990 emissions, or 123,726,240 tons." (Data from Massachusetts Climate Protection Plan Spring 2004.)

At standards temp and pressure, 1.977 grams per liter*1 pound/453*1 liter/0.0353 cubic feet = 8.1 cubic feet per pound of carbon dioxide.
Longwood Medical Campus shows a 59% increase in direct emissions from 1992-2003.

Cambridge and Allston Campuses show a 30% increase in direct emissions from 1990-2003.
GHG Emissions per Person

As explained above, the volume of one pound of CO2 will fill 363 one-liter bottles or roughly 120 party balloons. With roughly 8.75 Metric Tones of Carbon Dioxide Equivalent per person, each person at Harvard would have roughly 2.3 million party balloons by the end of 2003 (6,300 a day). To put that in perspective, this is roughly twice the emission of the average vehicle for a year.
The primary application for energy use at Harvard University is through its buildings. On the Cambridge/Allston Campuses, 86% (in 1990) and 88% (in 2003) of emissions were from steam, electricity, chilled water, gas and oil to heat and cool buildings. (see figures 3.10 to 3.13) On the Longwood Campus, 94% (in 1992) and 95% (in 2003) of emissions were from steam, electricity, chilled water, gas and oil to heat and cool buildings. (See Figures 3.14 to 3.17)

Cambridge and Allston direct emissions below shows steam and electricity (including electricity used on campus to create chilled water) to be the biggest cause for emissions. The largest increase was a 14% increase in purchase steam since 1990. The largest decrease is an 11% reduction in solid waste since 1990. It is interesting to notice the difference between the Cambridge / Allston emissions, which show transit, waste and stationary sources as a slightly larger percentage of the overall emissions than at Longwood. This can be explained by Longwood's much larger building energy use due to its research.

**Cambridge/Allston Campus Emissions**
On the Cambridge and Allston campuses, 86% of emissions in 1990 and 88% of emissions in 2003 were from steam electricity, chilled water, gas and oil to heat and cool buildings.

![Cambridge/Allston Emissions by Use 1990](image)

*Fig 3.10 Cambridge/Allston emissions by Use 1990*
Fig 3.11 Cambridge/Allston emissions by Use (with building as one category) 1990

Fig 3.12 Cambridge/Allston emissions by Use 2003
Longwood Campus Emissions

National research on laboratories across the United States shows that a laboratory typically consumes between four and five times the energy used by a typical commercial space per square foot. In addition, clean rooms consume between ten and one hundred times the energy, depending on the classification (Bell, et al. 2003, Mills et al. 1996).
Fig 3.15 Longwood emissions by use (with building as one category) 1992

Fig 3.16 Longwood emissions by use 2003
Building Energy Mix over time

Where is the energy used within the buildings? In Cambridge, Allston and Longwood, the largest energy user is steam, then electricity. See figures 3.18 and 3.19 below.

![Pie chart showing Longwood emissions by use in 2003](image)

**Fig 3.17 Longwood emissions by use (with building as one category) 2003**

![Graph showing Cambridge/Allston Building Energy Use 1990-2003](image)

**Fig. 3.18 Cambridge/Allston Building energy Use (KWH) 90-03**
3.2.5 Future plans

Lessons learned form the Loan Fund process.

The HGCI reported on their webpage that marketing and managing the GCLF has provided many insights into the facility management structures at Harvard. Here follows some of the lessons HGCI learned in the first two years of management of their program. The HGCI documented these lessons learned as a mean to be used for their future plans. These form part of their continuous improvement through the learning process philosophy.

- **Engaging Busy Facility Managers**
  Over time it has become evident that the most effective way to engage facility managers in using the GCLF is to invite them to participate in the loan fund approval process. This ensures that busy managers turn up to a meeting once a month to focus their attention on the topic of campus efficiency upgrades. It also enables peer-to-peer learning, encouragement and acknowledgement.

- **Accounting Structures: Hindrances or Enablers**
  The often rigid accounting separation between capital projects and operating budgets can make it difficult for building managers to avail of GCLF financing. Under the GCLF model, the HGCI provides the upfront project capital that enables a project sponsor to save money on its utility bills. Many department financial managers, however, are not used to repaying a loan out of savings derived from reduced utility bills. As a result of complex energy loads in buildings, project energy savings are often hard to pinpoint, further creating doubt in the minds of financial planners.
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If a project is properly planned for and managed, the savings are real. The GCLF allows departments to take money that would normally be sent to the local utility and invest it in infrastructure improvements. Where this is not immediately apparent to department financial managers, time must be spent working through this rationale before time is spent looking for projects. Unless this hurdle is breeched, the GCLF model will not achieve optimal department utilization.

- Additional Support Services
  While money is often cited as the primary impediment to efficient infrastructure management, there are actually many other impediments that are less apparent, the scarcity of time being the most significant. Working with facility managers, the HGCI has developed a range of services to support with:
    - Project identification and feasibility assessment
    - Rebates and grants
    - Project management and implementation
    - New technology identification and evaluation
    - Targeted education and training for building and facility managers, occupants and clients
    - Publicity and communication

The majority of “successful” loan funded projects have benefited from one or more of these HGCI services.

- Project Proponents
  Depending on a department’s size and the structure of its facility management department, GCLF projects can be proposed by many different employees. In some departments, the facility director will take an active role in directly managing the search for GCLF-eligible projects. In other cases, facility directors take a less active role, deferring to their building managers responsibility for project identification.

  The HGCI has found that the departments most effective in taking advantage of GCLF financing are those that have a facility director managing the search for and implementation of GCLF projects. This high level engagement sends a strong message to all facility employees that fiscal and environmental responsibility are a department priority, and that innovation and initiative to meet those responsibilities will be rewarded.

  In departments where facility directors take a more passive stance, project identification normally stalls and project proposals do not materialize. Facility managers are constantly under pressure to address any number of pressing issues. Unless they understand that efficiency is a priority in their work program, it will often be reprioritized as non-essential to building operations.

- Project Drivers
  While the benefits of GCLF financing are intuitive and produce immediate returns for participating departments, there are a number of different selling points of the program. Some of those participation drivers include:
- **Financial return** - Many departments are sold on the financial return on investment of GCLF projects.
- **Alternative source of capital** - Departments with capital financing constraints can look to the GCLF as an alternative source for new, interest-free capital.
- **Public relations** - Departments leverage the press generated by GCLF participation, or respond to seeing their name absent from the list of program participators. This inter-department competition and sense of accountability to university planners has generated initiative on many new project proposals.

- **GCLF Program Management**
The responsibilities associated with GCLF program management have changed dramatically over the program’s duration. We initially anticipated that the program manager would spend a majority of time marketing the program and administering the fund management. While expectations were met for the program’s first six months, over time position responsibilities have changed to direct greater focus to actively assisting departments in project identification and management capacities. Fund administration is less time intensive than is providing the department support necessary to identify and complete projects eligible for GCLF financing.

- **Continuing the Learning**
The Loan Fund has achieved significant environmental and fiscal benefits but must not be thought of as *the* incentive needed to drive sustainable building and infrastructure decisions. In fact, if anything, the Loan Fund program has been most helpful in identifying the numerous other competencies, services, and additional financial incentives that Harvard must develop if it is ever to approximate sustainable campus operations. This statement does not detract from the Fund’s significant achievements to date, but rather serves as a reminder that we are at the beginning, not the end, of the long sustainability learning curve.

**Recycling**

Recycling is set apart here because of the reasons mentioned before. This program is much older than the HGCI. But still it’s important to observe how this program is also benefiting from the HGCI.

Key lesson learned here, according to the program manager, is that a modest expenditure in recycling enhancement initiatives can provide a strong return on investment. This was observed after the purchase of new recycling bins, signs, and promotional material to increase participation in Harvard’s recycling program by UOS. Recycling rates in undergraduate dorms can be improved when administrators work with students to address the program needs as identified by the students themselves. Such program upgrades can be cost effective depending on the local cost of landfill tipping fees and recycling.

**“Green” cleaning products**

In the past few years, the green cleaning movement has gained additional momentum as the desire to build environmentally friendly buildings gained steam and as the LEED (Leadership in Energy and Environmental Design) green building rating system took into account cleaning practices in awarding its certification.
Antje Danielson, project manager for the Harvard Green Campus Initiative, worked with Jason Luke, custodial manager for Facilities Maintenance Operations (FMO) on the “green” cleaning products program. Danielson directed research into different green cleaning supplies labeling standards, settling on Green Seal as most appropriate for Harvard.

Danielson said the University plans to provide cleaning supplies to students beginning next year as a way to reduce the mountains of hazardous cleaning chemicals left behind each spring when students move out.

Roy Lauridsen, facilities manager at the Divinity School, where a two-year trial of the green cleaning procedures has run, said the program has produced results as good or better than previous cleaning services. He said the number of cleaning chemicals has been reduced from around 40 to just four.

3.3. A descriptive case on MIT regarding sustainable resource management

3.3.1 Introduction: (general characteristics, focus/approach, goal, stakeholders, organization, scope)

MIT has a centralized model in the sense that it has one facilities and utilities department that serves the entire campus. MIT is also a very lab intensive campus, compared to other campuses of the same size in the U.S, having a total of 4,597 (1,666,677 SQ FT) labs spread over a total of 161 (11,339,278 Gross SQ FT) buildings.

MIT was forced to re-examine its environmental practices after being cited for 18 violations of federal hazardous waste laws and the Clean Air and Water Acts in 1998. As part of the settlement of these, MIT agreed to fund over $400,000 of environmental projects. These projects included the creation of a computer-based campus compliance program designed to help universities determine whether or not they were in compliance with environmental regulations, a state-of-the-art storm water control and treatment system and several environmental education projects with Cambridge Public Schools.

As stated in the consent decree signed by both parties, these additional provisions are voluntary and not enforceable under the decree. MIT’s voluntary actions and MIT’s intent to take a highly automated and integrated approach to satisfying the required Environmental Management System (EMS) provisions have been taken into account in reaching the settlement of this enforcement action.

While MIT has begun educational programs in the surrounding community it is interesting to discover what is happening within the University itself. MIT’s Environmental Health and Safety webpage claims: “Environmental education is so pervasive at MIT it’s almost easier to describe where it doesn’t happen. Subject after subject, course after course, school after school, faculty and students are involved and connected. Perhaps the single best word to describe MIT’s approach is 'interdisciplinary.'”

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In the fall of 1999 MIT's managing director for environmental programs and risk management and senior counsel convened the Environmental Program Task Force (EPTF). The EPTF is a collaborative effort of faculty, staff, and students from different departments working on ways to make campus operations more environmentally friendly. Members come from the Campus Activities Complex, Copy Technology Centers, Publishing Services Bureau, Department of Facilities, and the Executive Vice-President's Office, as well as SAVE (Share a Vital Earth, a students environmental conservation group) and Prof. Jeff Steinfeld's Freshman Seminar.

One of the EPTF's early accomplishments was the expansion of the campus-recycling program. This began with just white paper and a limited collection of other recyclables. Now it includes all types of paper, cardboard, magazines and newspapers, glass bottles, aluminum cans, and plastics (#1 - 7).

The EPTF was also instrumental in creating the Green Building Task Force (GBTF) in the year 2000. GBTF main function was to study methods for improving energy conservation and the indoor environment.

In 2001, MIT pledged its commitment to environmental excellence with the adoption of the MIT Environment, Health and safety Policy by the Academic Council. This policy lays out the framework for simultaneously promoting excellence in research and education while minimizing the environmental and occupational health and safety impacts of their operations. (Van Schalkwyk 2005). It is important to mention that the main reason of this pledge was compliance to environmental health and safety regulations.

The Environmental Programs Office (EPO) and its Environmental, Health and Safety (EHS) office manage MIT-wide environmental, Health and safety programs.

In that same year 2001, MIT adopted an ambitious statement on short- and long-term environmental goals that had been developed by the Green Building Task Force (GBTF) mentioned above. This statement included specific goals and described a new approach for sustainable construction on campus. In 2003, the MIT Environmental Goals Task Force (EGTF) composed of members from the department of Facilities, The EHS Office, and the Laboratory for Energy and Environment, was formed as the successor to the GBTF. The EGTF is focusing its efforts on ten specific goals. Here follows the list of the goals taken form the EHS Web Page and the EPTF annual report 2003.

MIT's environmental goals:

- Conserve energy, seeking continuous reductions in our per capita energy consumption
- Reduce campus air emissions, including those from transportation, of greenhouse gases and regulated pollutants
- Reduce material and resource consumption, including office and laboratory supplies and water
- Increase the recycling and conservation of materials
- Increase the use of recycled-content products (environmentally friendly products & materials)
- Reduce the volume of toxicity of our hazardous waste streams
• Improve our indoor environment, including both the indoor air quality and the comfort and productivity of our work and living spaces, by considering sustainability in our design, operations, and maintenance policies
• Improve the urban environment, including landscape quality and the site and pedestrian environment
• Educate our students in sustainable concepts so that they may apply them in their professions
• Support community-wide and regional sustainability efforts

At MIT there is no single department and/or program that are in charge of specifically promoting and controlling the application of these general goals. Rather than one department and/or program, as can been observed above, several departments are involved in one or more specific projects aiming at the promotion and implementation of these general goals. MIT primarily uses task forces as a planning mechanism to carry out its beyond compliance environmental activities.

3.3.2 Funding

The EPO has a specific moderate annual budget to carry out the activities of its Pollution Prevention Programs. These programs are part of the core responsibility of this office and their commitment to the EPA. These programs can support a variety of initiatives, primarily in the form of seed money to leverage other departments to contribute. Large projects, dealing for example with renewable energy, are funded by external competitive grants.

In other words there is no internal funding system in the form of a loan fund, grant or initial investments by an Energy Services Company (ESCO), specifically designed for the implementation of environmental initiatives that go beyond compliance.

3.3.3 Actions

3.3.3.1 GHG emissions Inventory

In 2003-2004 MIT conducted its first GHG emissions Inventory. MS. Tiffany Groode, a masters in Mechanical engineering student did this by that time, working under the direction of Professor John Heywood. According to Tiffany Groode, this MIT campus emission assessment has been done in response to the City of Cambridge Climate Protection Plan, which is calling for a 20% decrease in greenhouse gas emissions from 1990 levels by the year 2010. (Groode, 2004)

This greenhouse gas inventory includes all emissions of carbon dioxide, methane, and nitrous oxide due to utility use from fiscal year 1990 to 2003 and estimates of transportation and solid waste emissions. It accounts for utilities purchased and utilities produced from the MIT Cogeneration Power Plant. The MIT cogeneration power plant produces steam, electricity, and chilled water for over one hundred MIT buildings. Though the plant provides approximately 80% of the total annual campus electricity
demand, additional electricity is purchased when the campus demand exceeds the plants capacity. Therefore, MIT is responsible for utility emissions due to the combustion of hydrocarbon fuels (consisting of natural gas and both #6 and #. 2 oil. Natural gas consists mainly of methane (generally over 85%) and varying amounts of ethane, propane, and butane.) by the MIT plant, and due to the energy utilized for electricity the campus purchases.

A methodology has been developed to allocate the MIT utility plant emissions based on produced electricity, steam, and chilled water. This allows facilities to develop programs that will directly impact the source of highest emissions.

In addition, the assessment includes carbon dioxide emissions due to the MIT commuting population from fiscal year 1999 to 2003, and accounts for equivalent carbon dioxide emissions from solid waste incineration from fiscal year 2000 to 2003.

A summary of the outcomes suggest that the 20% reduction target from 1990 emission levels sets a cap on campus emissions of 163,830 equivalent metric tons of carbon dioxide per year. At current levels, a 22% decrease in emissions would be required to achieve this target. Emissions released from utility use account for 90% of the campus emissions, with 9.5% attributed to commuters, and 0.5% due to campus solid waste. Therefore, reducing the amount of emissions caused by utility production and purchasing would have the largest effect on reducing the total campus greenhouse gas emissions.

3.3.3.2 Energy conservation

Energy conservation is, according to the EHS web-page, a priority at MIT, where the Department of Facilities initiates and supports a variety of efforts to conserve the energy it uses to serve the on-campus environment.

Lighting

- In 1996 the EPA awarded MIT its Partner of the Year award for the Institute's Green Lights program. The Department of Facilities installed T-8 lamps, compact fluorescent bulbs, and electronic ballasts throughout the campus, improving lighting while reducing peak power by 2,500 kilowatts and saving 12.5 million kilowatt per year overall. 200,000 lamps and 125,000 ballasts were replaced in 80,000 fixtures. Old lamps and ballasts were recycled, even though that was not a regulatory requirement at that time.

- The department of facilities together with utilities started in 2000 with the implementation of occupancy sensor installations in classrooms, Laboratory support spaces, offices and public toilets rooms. This project is still at pilot level because of the resistance of the population especially in toilets, offices and laboratory support spaces.
Cogeneration power plant

In 1995 the campus installed an on-campus cogeneration plant. The co-generation plant uses state-of-the-art technology with a new gas turbine, developed at MIT. Cogeneration is extremely energy efficient. A cogeneration plant uses a gas turbine to produce electricity, and then – rather than venting the turbine exhaust – it uses the hot exhaust to produce steam, which in turn is used to help heat and cool campus buildings.

During the years 2003-2004 a thermodynamic availability flow analysis has also been conducted on the gas turbine and heat recovery steam generator system of the MIT cogeneration power plant. (Groode, 2004) Availability losses within the system were targeted and appropriate actions can now be made to decrease losses and therefore increase plant efficiencies. As production efficiencies are maximized, fuel use and thus emissions are minimized.

“VendingMisers” pilot project

The Department of Facilities has installed 30 "VendingMisers" on cold beverage machines across campus. Using a custom passive infrared sensor, these systems power down vending machines when the area around the machine is unoccupied and automatically re-power the machines when traffic returns. The result is a potential 46 percent reduction in energy consumption on each machine. Over the course of a year, this translates to a savings of approximately $140 per machine. If the VendingMisers were installed on all 120 soda machines on campus, the savings for MIT could be as much as $17,000 per year.

3.3.3.3 Recycling

MIT has recycled for many years. Desk-side and common area paper recycling was expanded over the last 5 years from white paper only to mixed paper, newspaper, and magazines and cardboard. Large numbers of new recycling bins have been placed beside trash bins in campus common areas indoors for collecting mixed paper and commingled recyclables and outdoors for collecting commingled recyclables. Also included in the recycling program are scrap metals, wood, electronic equipment, cathode ray tubes, composted yard wastes and baled corrugated cardboard. MIT is continuously working to expand the recycling program to include other difficult to manage wastes. For example, in 2001 the Department of Housing recycled 198 discarded mattresses from student housing. (See appendix 3... for recyclables on MIT)

MIT’s annual waste management budget was of about 1 million U.S dollars by the year 2003. (EPTF annual report, 2003) The current recycle goal of MIT is of 40% recycling rate for this year 2005. This is a goal congruent to that of the Cambridge City for the year 2005. It would cost the institution 50% less to recycle the waste than it would cost to dispose of the same waste materials as trash. This translates into a potential annual savings to the institute of $100,000 to $200,000 if they where to reach their current recycle goal above mentioned. (Schalkwyk, 2005)
The EPTF report of 2003 stated some of the important institutional changes that took place in order to expand the recycling program at MIT. The most important of these changes included progress in several areas:

- **Strategic.** The Department of Facilities, WasteCap of Massachusetts, and the EHS Office began working closely to analyze MIT’s trash and recycling processes to identify opportunities to optimize the collection systems, increase storage capacity for recyclables, and reduce trash.

- **Operational.** The by than, Recycling Coordinator, started a more effective monitoring of recycling areas and trash containers for misuse and contamination. Observations are communicated to custodians and to Housing so that problems are remedied immediately. Closer observation of the trash containers also allowed Facilities to more closely align the pickup schedule to the actual needs, allowing further cost savings.

- **Opportunistic.** Several high volume opportunities for increased recycling were identified and the changes that were implemented succeeded in reducing waste. Specifically, Facilities dedicated one of the two trash compactors at Building 12 to paper and cardboard only. This simple step resulted in more than 12,000 pounds of paper and cardboard being recycled monthly. Similarly, a cardboard baler installed at W20 recycles more than 1,000 pounds of cardboard per day! Expanding the food-composting program to the Faculty Club means that 400 pounds of food waste daily is diverted from the waste stream. Despite the increase in the recycled tonnage and the program improvements, there remains significant room for improvement.

In their efforts to reach their current recycling rate goal several projects has been implemented with the collaboration of different actors in MIT. Some projects are continuously running while others where momentary activities. Here follow the most important of those projects.

- **Waste Audit**

In fall 2003, as the core activity of the freshman advising seminar “Achieving MIT’s environmental goals” taught jointly by the Laboratory for Energy and the Environment (LFEE) and the EPO, the seminar students together with volunteers from across campus conducted the first three-part waste audit with support from the Environment, Health, and Safety Office, the Department for facilities, and the Campus Activities Center. This was done with hundreds of pounds of trash taken from the Stratton Students center, the dorm New House and an Academic office building. This project gave important insights into MIT’s community recycling behavior and how it could be improved.

- **Purchase of recycled products or Environmentally Preferred products (EPPs)**

EPPs are everyday items that have lesser or reduced effects on human health and the environment when compared with competing products that serve the same purpose. EPPs
are competitively priced, many times costing less than regular virgin products, and offer a high level of durability and quality. In fall 2003 MIT’s Executive Vice President formally directed all departments reporting to the Office of the executive Vice president to buy EPP products whenever possible with the double intention to primarily save money and to meet environmental goals. (EPTF report 2003). Remanufactured toner cartridges were specifically highlighted in the Executive Vice President’s policy. In 2003, MIT purchased almost $380,000 in toner cartridges that have a remanufactured equivalent. A typical 30% savings on these purchases would have saved the Institute $114,000. (See also Appendix 3.6 for a list of EPPs)

- **Construction and demolition (C&D) debris**

Construction waste includes cardboard, wood scraps, metals, pallets, containers and plastic, while renovations also generate a wide variety of waste materials depending on the building. In 2001 MIT developed and implemented stringent specifications for recycling “Construction and Demolition” (C&D) debris. These guidelines are now used by the Department of Facilities for all capital projects. (A standard specification was written for capital projects; its first use at the Media Lab demolition resulted in a 96 percent recycling rate for that project.)

- **Composting**

In 2000 the director of campus dining by that time started the management of the composting pilot project. MIT collects food waste from the kitchens all over the campus and turns these materials into compost that is used to support tree growth at a local nursery. It’s important to clarify here that this is pre-consumption waste. (These are known as “prep-waste” from the kitchens). MIT also has a 100% landscaping yard waste composting. Both type of composting or done by different vendors outside campus that picks up the raw material and transform it into compost. Since 2000 this program has expanded to reach 23 tons a month of food waste last year.

3.3.3.4. Water conservation

When looking at water conservation just as in the case with energy conservation there is no real continuous program or project to be found that belong to a specific department in MIT. Most of the efforts done in this area come from Utility and facility department. Most of the time these projects are the result of the drive and effort of a few staff members and in the departments mentioned above, that recognize the opportunities and take them.

- In 1995 MIT received the American Institute of Plant Engineers’ Facilities Management Excellence (FAME) Award of Merit for introducing a highly effective water reclamation and reuse system in a campus building 13. This
project reduced water consumption from 27.6 million gallons a year to 3.6 million. Cost of the project was $140,000. Annual savings are $160,000.

- A Utility engineer was recognized in 2003 for steadily reducing water use through water conservation programs. He oversaw the installation of low-flow showerheads and toilets, the replacement of "once-through" cooling equipment, and the installation of a centralized irrigation system. This initiatives save MIT 70,000,000 gallons of water per year.

- Storm water system with bio-filtration at the Stata center. This is innovative storm water Retention/Management System that employs bio-filtration, re-circulating storm water with a solar powered pump for irrigation and flushing toilets. This system can contribute with the improvement of the health of the Charles River by filtering the storm water from the roof and surrounding area before any water not reused on site enters the storm water drainage pipes.

3.3.3.5 Paper use

Before December 1999, MIT's Paper recycling was restricted to white paper only. Since the beginning of the year 2000, colored paper, newspapers and magazines, envelopes and even Post-It notes and carbonless forms can also be recycled. Desk-side and common-area paper recycling bins where made available through campus in all indoor public areas by the facilities department. (See appendix 3.7 for a complete list of recyclables on MIT campus)

Besides recycling of the paper used, in the year 2000 the Procurement Department, Copy Technology Centers, and the Environmental Programs Task Force (EPTF) collaborated on a green goods procurement program with an initial focus on the largest volume goods - paper products. Procurement identified and coordinated testing of recycled papers and then worked with Office Depot to acquire these papers at very competitive pricing and to highlight them on the electronic catalog (ECAT) for ordering.

3.3.3.6 Others

Renewable energy

The Massachusetts Renewable Energy Trust awarded MIT $455,701 for Solar-to-Market Initiative. This grant was part of $2.6m that was awarded on October 10, 2002 at the semi-annual meeting of SEBANE

The project was basically the installation of approximately 75 kW of Photo Voltaic PV systems on schools, homes and businesses in Cambridge, Watertown, Arlington, Lexington, and Waltham as well as on the MIT campus.

The grant required MIT campus installations to be used as pilots for demonstration, research, and educational purposes. MIT has also developed a cooperative relationship with the Cambridge Public Schools that will result in several PV installations on public school buildings. MIT expected to oversee the installation of approximately 40 PV installations through this grant. The primary partners to MIT are Conservation Services
Group and Evergreen Solar. The project was coordinated through the MIT Department of Facilities in conjunction with the MIT Laboratory for Energy and the Environment. Edward Kern, a research engineer in the Laboratory for Energy and the Environment (LFEE), and Laxmi Rao, a senior project manager in the Department of Facilities' Utilities Group, directed the project. Peter Cooper, the utilities director in 2002 utilities, arranged for providing additional MIT expertise, personnel and access to Institute facilities.

The MIT Community Solar Power Initiative reflects Institute support for renewable energy research and uses MIT's own buildings and personnel to test the feasibility, effectiveness and consumer acceptance of photovoltaic power generation. The MIT Community Solar Power Initiative has several educational objectives. Students will become aware of the potential of solar power. Towns will integrate this power source into their conventional systems, and gain experience in the performance of the technology. Additionally, Cambridge high school and middle school teachers are designing projects for their students based on their experience in a four-week summer 2002 program on environmental issues.

Each panel in a system measures approximately 2 feet by 5 feet, contains 72 solar cells and will produce 100-150 kWh of electricity per year, equal to about a week's demand for a typical home. Each location will have 12 to 24 panels in a modular configuration that works best for the building.

**Green Building**

From The web page of MIT facilities department its known that MIT established U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Silver Certification as a minimum standard for all new Capital Projects in design from 2001 forward. MIT's commitment to environmentally sustainable building goes even further to include development of a customized component covering items important to the Institute.

Facilities staff develops standards to assure that environmental and conservation initiatives are designed into each construction project. MIT is undertaking a significant capital projects program, presenting an immediate opportunity to make progress toward its 10 environmental goals in MIT buildings.

Consequently, as an interim measure to achieve a minimum standard and support progress toward these general environmental goals, MIT has determined that new projects (including, renovations and new construction) and programs will be designed to meet or exceed the "LEED Silver Plus" standard (the Leed Silver standard has been adopted - as soon as possible the "MIT Plus" will be added). The LEED Silver Plus standard is the LEED Silver standard enhanced to reflect additional requirements that are necessary to support progress toward MIT's environmental goals. Included are new projects and programs that are in early stages of design, are as yet to be designed, or are capable of being feasibly revised to meet MIT's environmental goals taking into account all factors and circumstances. MIT actively encourages the pursuit of environmentally innovative projects and use of innovative technology.
Three new MIT buildings illustrate the many levels of environmentally conscious practices MIT is adopting:

- Stata center
- Simmons Hall (student dorm)
- Brain and cognitive science project

See the results section for further summarized details on these projects. It’s important to notice though that both the design of the “Simmons hall project” and the “Stata center project” were done before 2001 when this “green building” initiative was adopted by MIT.

**Commuting to MIT.**

The Office of parking and transportation at MIT provides several commuting options that can support MIT’s environmental goals. On their web page: http://web.mit.edu/parking/ commuters at MIT can find information on Bicycling, carpoole, public transportation and shuttles.

- MIT provides discounted parking rates for Carpoole and Vanpoole on campus.
- MIT also promotes the use of public transportation by subsiding the cost of several types of passengers passes.
- MIT provides a vast infra structure for bicycles campus wide. And runs together with the MIT police a bike registration and theft prevention program.
- MIT also provides several shuttles services: Safe Ride provides a safe means of transportation at night within and around the MIT campus. The TECH Shuttle and the Northwest Shuttle provide a safe means of transportation around the campus on weekdays. Airport Shuttles, the Winter Boston Shuttle, and the Winter Campus Shuttle are other services that are temporarily provided by MIT.

**Environment related courses**

LFEE created and manages a web site titled “enviroclasses” since 2002. The web site provides students with a database of environmentally related classes at MIT. This site is a powerful and useable tool for students to find classes that meet their environmental interests and the requirements of their degree programs. The web site address is http://enviroclasses.mit.edu. The site highlights subjects taught at MIT with environmental themes, case studies, and/or examples. It may be browsed by department or category, and searched by requirement, academic level, academic term or keyword.
3.3.4. Results and measurements

3.3.4.1 GHG emissions Inventory

Tiffany Groode’s study found that, utility, transportation, and solid waste emissions account for approximately 90%, 9.5%, and 0.5% respectively of the total campus emissions. Figure 3.20 represents the total equivalent GHG emissions for the MIT campus from 1990 to 2003. To reach the desired 20% GHG emission reduction, from 1990 levels, by the year 2010 the campus would have to decrease emission rates by 29% of 2003 emission levels.

![MIT Total GHG Emissions vs Fiscal Year](image)

The 1990 level considered, for the emission reduction target, only takes into account emissions due to utility use, since data for transportation and solid waste were not available till fiscal year 1999 and 2000. An adjusted emissions reduction target can be calculated to take into account emissions due to transportation and solid waste. If one assumes that in 1990 10% of the total emissions were due to transportation and solid waste emissions than the reduction emissions target would increase to 163,830 metric tons of equivalent CO₂, and the campus would have to decrease 2003 emissions levels by 22% to meet Cambridge’s emission reduction goal.

In other words, since utility use accounts for 90% of all MIT campus emissions, strategies aimed at more efficient utility production and use will have the greatest impact.
Figure 3.21 represents emissions due to transportation, which are included after fiscal year 1999, and emissions from campus solid waste disposal, starting the 2000 fiscal year. Solid waste emissions account for approximately 0.5% of the total campus emissions and therefore are difficult to see on the graph.

Another important finding in this study was that the indicator used to compare GHG-emissions among institutions has to be carefully defined. If the amount of GHG emissions is given per square foot of floor space it has to take into account the various purposes of floor space. (For example laboratory space versus classroom space)

3.3.4.2 Energy Conservation

Lighting

From approximate calculations by the utility and facilities department it can be assumed that 25% of all classrooms, laboratory support spaces and office spaces on the MIT campus is currently provided with a occupancy sensor system of lighting.

See appendix 3.8 for a summary of lighting controls energy Investment Opportunity for MIT provided by the utilities and facilities department. MIT could have a potential annual saving of $511,782, with an initial investment of $1,609,820 and a payback period of 3.14 years if the total lighting program would be implemented.

Cogeneration plant

In 1996, the first full year the plant operated, emissions dropped more than 30% from the 1990 level (see fig 3.20). However, after 1997 emissions began to increase. In the GHG-
emissions inventory study carried out by Tiffany Groode she tried to identify the reasons for this sudden increase. She found out that the heat recovery steam generator effectiveness has decreased 11% from 42.1% to 37.4% during the past 6 years. The problem proved to be a decrease in the heat recovery steam generator’s performance attributed to fouling Effects on the heat transfer surfaces between the hot exhaust gasses and the water stream. In other words the buildup of deposits on the heat transfer surfaces within one of the main boilers. So it’s important to have an effective monitoring process of the performance of the cogeneration systems. Several other factors helped push up emissions, especially during 2003:

Temporarily effects:
- The winter of 2003 was unusually cold. MIT burned more fuel on side (in particular, more oil) and thus produced more emissions.
- Campus demand was so high so extra electricity had to be bought. (This can be translated to more reliability on coal-burning plants)

Permanent effect:
- In 2003 MIT had begun a construction campaign, introducing several energy intensive buildings to the campus.

3.3.4.3 Recycling

![Graph of Trash and Recycling Since 2000]

From figure 3.22 it’s clear that the total recycling number has been increasing over the entire period of 2000 to 2004 while the total waste number has been decreasing from 2002 to 2004. In 2004 MIT reached a 36% recycling rate which is getting close to the recycling rate goal of Cambridge city of 40% by this current year 2005.
Waste audit 2003

The volunteers separated the trash into different categories – paper, plastic, glass, cardboard, food waste, computers, and so on. They then weighed the piles and catalogued their results.

The participants in this project do recognize that getting a true picture of MIT’s overall waste stream would require a far more comprehensive audit. Nevertheless, results from the three-day pilot audit illuminated opportunities for both increasing recycling and reducing the overall volume of trash.

- New House dorm results:
  Evidence from the audit suggests that residents of New House could recycle twice as much of their trash as they do now, bringing their recycling rate up to 50%. (Defining recycling rate as the weight of material recycled as a percentage of total waste.)
  Much of the non-recyclable waste sorted in the audit was organic material that could be composted rather than trashed. New House does have a composting program, run by a New House resident. If all food waste was composted, only 20% of New House’s overall solid waste would be considered trash.

- Stratton Student center:
  Here, as much as 80% of the material thrown out as trash could have been recycled.
  The non-recyclable material included substantial amounts of polystyrene-foam food containers and paper cups, both of which could be replaced by reusable materials.
  Potential gains are significant, as the Student Center is the third largest trash generator (by volume) on campus.

The seminar suggested that the top priority is to increase the community’s awareness and understanding of MIT’s existing recycling program. The latter through:

- Special events
- Print and radio advertising,
- Freshman orientation activities

This could help people take better advantage of current recycling opportunities, encourage them to buy environmentally friendly products, and to adopt simple but important habits such as two sided copying.

Purchase of recycled products or environmentally preferred products. (EPPs)

In an effort to stimulate the use of EPPs, MIT’s Procurement Office has developed an alliance with current vendors such as Office depot to find ways to by EPPs whenever feasible. Procurement has published a list of frequently purchased recycled products in the “My Saved Lists” portion of the Office Depot® ECAT web site. Besides this, Office Depot also provides direct assistance. (See also Appendix 3.6 for a list of EPPs)

Anecdotal data received from a member of the EHS office shows that in the first quarter of 2003 (July - September 2003, FY 2004) 30% of all toner cartridges purchased were remanufactured with a saving of $14,553. For the same period in 2004 (FY 2005) 33% of all toner cartridges purchased were remanufactured.
Construction and demolition debris

The first project to use the C&D specifications – the 2001 demolition of E10 and E20 for the Media Lab expansion – resulted in a 96% recycling rate, with 4,519 tons of materials recycled.
The two buildings razed in 2003 – Building 45 and the East Garage – set new records for recycling. At Building 45, nearly 1,500 tons of material was generated during the demolition, and all but 60 tons was recycled, for a 96% recycling rate. Later, the East Garage set a new standard for recycling when the entire structure, including 920 tons of scrap iron and 7,170 tons of concrete, was recycled resulting in a 100% rate.

Composting

MIT composted nearly 100 tons of food during 2003, which was over 50% higher than the amount generated in 2002.
With a higher involvement of students in this “green dinning“ effort across campus 165 tons of food was composted by the year 2004. Students are running education programs in the Baker dinning hall, New House and East Campus, informing students of the composting effort.
To have the compost hauled away has proven to cost the institute less money than it does to get rid of its trash, according to ground services of the Facility department.

3.3.4.4 Water conservation

Since there is no real program dedicated to water conservation there was no data available on the current situation.

3.3.4.5 Paper Use

From the data on recycled product given by EHS office a 34.8-ton monthly paper recycling was done last year on MIT campus.

The last calculated overall percentage of the Institute purchase of copy paper available is that of 2003. In that year 70 % of the institute purchases of copy paper were of recycled content. (EPTF annual report 2003)
Nevertheless here follows some specific important results since the start in 2000 of the green goods procurement program focused on paper:

- The office of procurement itself has completely switched to recycled content paper.
- The Athena clusters one of the largest users of paper on campus started in the year 2000 by ordering 10 cases of 30 percent recycled paper. Once they realized that the latter was not causing any problem they step forward and order 10 cases of 50% recycled paper. In 2001 they were using 50% Envirographic paper in all
Athena clusters. Now (2005) they are using 30% to 50% recycled by fiber paper in all clusters.

- Copy Technology Centers, the largest paper user on campus, uses recycled-content paper for virtually 100% of their standard copies and well over 95% of their specialty copying. (This latter includes colored text papers and cover-weight stocks) They calculated that about 98% of the 36 million sheets of paper purchased (by the year 2003) contained recycle content.
- The operation services team of the Information Systems (IS) in the data center and the media laboratory is now using recycled paper for their copiers, printers and fax machines.

3.3.4.6 Others

Green buildings

Stata Center (designed prior to LEED Standard adoption)

- Innovative Storm water Retention/Management System that employs biofiltration, recirculating storm water with a solar powered pump for irrigation and flushing toilets. This system will help improve the health of the Charles River by filtering the storm water from the roof and surrounding area before any water not reused on site enters the storm water drainage pipes.
- Providing the capability to reuse reject water from adjacent buildings for flushing toilets.
- Extensive use of displacement ventilation utilizing a raised floor system.
- Monitoring and controlling CO levels in garage. Activates demand controlled ventilation system.
- Minimizing refrigerants and eliminating Halon, a fire retardant, in the building.
- Fully commissioning the building in accordance with MIT standards for all new projects including commissioning planning by Facilities’ Systems Engineering Group, use of an independent commissioning agent, and improved monitoring systems for follow-up after occupancy.
- Operable windows for natural ventilation and individual control.
- Abundant use of daylight in all interior space. Solar control through motorized blinds.
- Landscape design for Northeast Sector that uses native vegetation and water efficient design.
- Rooftop terraces with landscaping for shading and storm water retention. White reflective roof and vegetated surfaces reduce heat island effect.
- Irrigation system connected to central weather station for minimization of watering. System uses weather data and rain gauges to control water flow. Central system can identify leaks and cut off water flow.
- Light pollution reduction.
- Management plan by contractor to recycle construction waste.
- Demolished an above grade parking structure and replaced with a park. New parking is all below grade under the building.
Demolition of garage utilized MIT’s Construction & Demolition Recycling and Reuse specification and achieved a 100 percent recycling rate.

Recycling timbers from Building 20 for flooring.

The Brain and Cognitive Sciences Project

Reusing wastewater reject from reverse osmosis and de-ionization (RODI) for gray water.

Heat recovery methods incorporated into HVAC systems. VAV system and balanced sizing of HVAC equipment used to reduce energy use.

Extensive metering and full building commissioning planned. Building flush-out planned before occupancy.

Reverse osmosis and de-ionization (RODI)/rainwater collection for water recycling, low-flow water fixtures, control of lab waste, storm water management.

Efficient lighting design, controls and daylight controls.

Low emitting materials used.

Construction waste management plan in place. Demolition of Building 45 achieved 96 percent recycling rate.

Eliminated surface parking. No parking provided on site for the project.

Simmons Hall (designed prior to LEED standard adoption)

Unique structural system integrates ventilation system, 6,000 operable windows, and solar shading.

Innovative ventilation/dehumidification mechanical design to supplement natural ventilation with low-energy usage of dehumidification for peak cooling periods. This allows the dormitory to be used year-round without requiring air conditioning.

Exterior concrete wall creates effective thermal barrier. Exposed interior concrete takes advantage of night ventilation to cool and the thermal lag of the concrete to maintain cooler temperatures during the day.

3.3.5. Future plans

Funding system

Currently MIT is looking into a creative and efficient funding mechanism specifically dedicated to the accomplishment of their environmental goals. This funding system would be designed for the initiatives regarding environmental improvement beyond compliance.

From an interview with the former director of Utilities, who is now in charge of spearheading this innovative funding mechanism it is clear that the final format of this mechanism is not yet established.

It could be a grant, a revolving loan fund, a third party initial investment or some mix of the former.
MIT is doing his research in what would be the most effective mechanism for this Institution.

**Bio diesel project**

The City of Cambridge and MIT will collaborate to significantly reduce diesel pollution from their respective vehicle fleets over the next two years, thanks to a grant from the U.S. Environmental Protection Agency announced Feb. 23 this year. The grant is one of 18 awarded nationwide from a pool of 83 applicants.

Through the Clean Diesel Collaborative for a Healthy Cambridge, MIT and the city will retrofit 34 medium- and heavy-duty vehicles with advanced pollution control equipment (including catalyzing equipment and filters). The goal is to reduce emissions per vehicle 40 to nearly 70 percent for some pollutants.

The Clean Diesel Collaborative for a Healthy Cambridge is a joint effort with MIT's Environmental Programs Office and Department of Facilities, and Cambridge's Departments of Public Works and Community Development.

The EPA grant of $83,467 through the agency's Voluntary Diesel Retrofit Grant Program will launch the new initiative and cover the implementation costs.

According to Steven Lanou of the MIT's Environmental Programs Office MIT intend to use this collaborative project not only to make significant reductions in the institutions own emissions, but also to share the experience and demonstrate to others the feasibility of the technology so that it can be more widely adopted. The more diffusion of the technology across diesel fleets, the greater environmental benefits can be achieved.

The collaborative marks an expansion of MIT's efforts to improve the environmental performance of its vehicles; through the program, MIT will introduce biodiesel for the first time into its diesel vehicles.

**Green building improvement**

It is high priorities for MIT to expeditiously develop a more comprehensive model for evaluating the total cost/benefit of project/program components, taking into account initial investment (including capital cost), lifecycle cost, performance, and environmental benefits and impacts. MIT commits to undertaking consultation and review of projects among MIT experts, the MIT client team, and designers at the very earliest stages of design concept development, and periodically throughout the design process to incorporate objectives and mechanisms for achieving MIT's long-term environmental goals in projects and to evaluate total costs.

The LEED Silver Plus standard also will be revisited in the short term to determine whether further customization is necessary to meet MIT's long-term goals. MIT seeks to develop as quickly as possible a more performance-based standard that can be tailored to individual projects.
An integrated program

From Interviews with EPO members it’s clear that organizationally; MIT is discussing how to merge all these seemingly separate actions into one strategy that can ensure continuous development in all aspects of their general environmental goals.

3.4 Brief discussion of the MIT and Harvard descriptive case studies.

Altogether we can observe that both American universities encountered similar obstacles to implement their sustainable resource management projects. What makes a difference though is the manner in which they confront these obstacles.

For the funding of these projects Harvard created an innovative revolving loan fund through its integrated program, HGCI. This fund made it possible to confront the risk-averse attitude of the institution with respect to the initial investment required for the design and implementation of sustainable projects. MIT on the other hand, with a more individual and opportunistic approach relies on competitive grants and/or surpluses in their budgets to carry out their sustainable initiatives. Grants in general, do not guarantee performance whereas a loan fund with a certain payback period obliges the responsible of the project to seriously consider performance.

Another major obstacle encountered by both institutions was time constraints. Harvard chose to have a core staff that is 100% dedicated and committed to the task of supporting the design, implementation, promotion and evaluation of each sustainable initiative on campus. This is a strategic way for them to ensure a continuous improvement of the program. MIT is still dealing with this problem and is currently using task forces assigned for specific projects to confront this obstacle.

In addition to the obstacles mentioned above is the “resistance to change”. People find it difficult to change their way of acting, even more so their way of thinking. With a closer look at the Harvard’s HGCI model, it can be observed that to confront this obstacle, they work as facilitators in every step required to convince the stakeholders of the importance of the changes. The HGCI has been improving a system that provides basic information, training, expert consultations, communication workgroups, to mention some, that contributes to a smoother transition into a green campus. In the case of MIT, there seems to be a gap between all the activities they have been carrying out and the awareness of its community in general. This gap could be an important opportunity for improvement in their initiatives.
Chapter 4. General lessons learned from the U.S Experience

Taking into account the initial propositions stated at the beginning of this study, a series of lessons were learned from Harvard and MIT sustainability programs that will lead to a specific proposal for the ITESM campus in Guadalajara, which will be focused more directly into Sustainable Resource Management.

Before starting with the lessons learned through the analysis of the two U.S campuses, it is important to point out that rather than having an integral program like the HGCI in Harvard, MIT has a series of projects coming from different areas within its organizational structure and are mainly spearheaded by the facilities department. This latter is important for the comparison between the two Institutes mainly because of organizational reasons, which will help get a clearer idea of how an institution’s commitment can be expressed by different types of Universities regardless of their size, prestige or economical status.

This chapter is completely based on the qualitative table of comparison presented in appendix 4.1. This table gives a good visual overview of the most important areas for an effective resource management program on campus and how these two institutions are rated relative to each other.

4.1 General criteria

As the main general criteria for both programs we can find the “zero enforcement principle”. In both Universities the implementation of whatever project or program dealing with the effective management of resources is completely voluntary. In the case of MIT where the campus management has a centralized model (see chapter 3.1) Facilities and Utilities promote their projects through prospective savings in yearly budgets. In the case of Harvard which has a rather decentralized model, projects are promoted both through savings in yearly budgets and through competition among schools for a more effective resource management. In other words both campuses basically seek cost efficient and cost effective projects.

In a centralized model the cost efficiency and effectiveness of this type of projects not necessarily creates direct incentives for specific departments whereas in a decentralized model for campus management the cost effectiveness creates direct incentives for continuous improvement.

Another important general criteria coming from the HGCI program at Harvard is building the University’s capacity to be a learning organization and a living laboratory for research and development into campus sustainability. This is important for continuous improvement of similar projects in the future within the program.
4.2 Organization

There are basically two types of organizations while analyzing these campuses with respect to their green campus initiatives. On the one hand there is Harvard with an external entity that integrates all green initiative activities on campus. (External in the sense that the HGCI does not belong to any department in the organizational structure of the institution) and on the other hand there is an internal multifaceted structure imbedded in the existing organizational structure of MIT.

With this said the following important areas of an organization will be further detailed for both structures.

- **Human resources:**
The HGCI of Harvard has its own staff that is 100% dedicated to all the activities related to the specific program. From the design, implementation and promotion on, there is specific staff working.

In the MIT structure there is no specific staff for their projects. Staff members that participate in the design, implementation and possible promotion of the specific projects do this in addition to their specific positions in EHS, EPO, Facilities and utilities departments and offices. Here they rely on the creation of task forces to carry out projects.

- **Financial resources (Budgeting):**
Here we can find what could be the biggest difference between the two institutions regarding environmental initiatives. The HGCI manages a Green campus Loan fund. Schools in Harvard can apply for this revolving loan fund to help in the projects that will have a direct impact on the ecological footprint of the Institute. Apart from this, they also rely on the conventional capital budget money and/or grants.

MIT depends on capital budget, grants and occasional surpluses in budgets to carry out their beyond compliance environmental projects. However, the latter is merely opportunity based, which means that it is not part of a strategic plan or program.

- **Material /infrastructure resources:**
What is taken into consideration as materials and infrastructure here are among other things, promotion materials and/or information material such as flyers, posters stickers etc. Besides that for any recycling program there is need of an efficient infrastructure providing the right amount of separation containers, bailers, pick up trucks etc.

All materials needed for the design, implementation and promotion of the projects carried out at MIT come form the same departments and offices where these projects are generated. (Mainly EHS, EPO, LFEE, Facilities and Utilities).

In Harvard each school that joins the HGCI program will provide the materials and infrastructure required as part of the project.
4.3 Documentation (Handbooks, plans, programs, procedures and methodologies)

For a continuous improvement of an Institution in any area, well-documented historic information and data is crucial. Effective resource management is no exception to this rule.

A valuable lesson that can be learned form the HGCI is the extensive and detailed documentation of all their activities. This program has also designed a complete up to date web site with all this information available to the public. This latter is really helpful for both inside and outside the institution communities that are seeking to start with similar projects or programs. Chapter 3 section 3.2 the case of Harvard together with the appendices belonging to that section gives a good idea of the benefits of having such extensive documentation.

MIT does have a web site from the EHS office with relevant information concerning regulatory issues, but beyond compliance environmental projects (good actions project) and activities are not up-dated leaving a gap in the publicly accessible information.

4.4 Audit (internal or external)

According to the literature discussed in the previous chapters on Higher Education for Sustainable Development, the conduction of internal audits (done by institutions members) or external audits (done by outsiders) as a first step toward greening a campus and as a means to provide a continuous improvement is very important.

At MIT we can find waste audits done on regular basis in order to improve the recycling program. These audits give the Institution insight as where to concentrate their efforts. But it is important to mention that this audit results should be constantly documented something that is not carried out by MIT. Harvard through its HGCI is constantly applying internal audits as a tool to improve several of the implemented projects on the different schools. But none of the institutions really reported having done a start up audit on sustainability of any kind before generating their sustainable projects or programs for the specific institution.

It’s interesting to notice though that both institutions recently carried out a GHG-emissions inventory. This is not an audit but a helpful tool as part of an internal audit to have insight on the specific areas within the campus operations that need extra attention regarding their impact on the environment.

4.5 Education and training (Communication internal or local community)

One effective way of educating toward a change in behavior or way of thinking is by modeling (demonstrating) the desired change. But an even more effective way for retention of the learning is by getting people involved in the practical side of the lesson. Based on the study done by the National Training Laboratories, Bethel, Maine we have the following learning pyramid fig 4.1.
Translating this into the institutions programs for a more efficient resource management, it is important that this program creates enough space for demonstration and participation of all stakeholders on campus as a means of education toward the desired change. Communications of all activities related to the program must be a priority in order to both inform and attract more people to these programs.

The HGCI proves to be very concerned about this and shows it in the design of their campaigns by specifically taking into account the stakeholder they are targeting. They also encourage the participation of students, faculty and staff and administrative in almost all of the projects. Through the several advisory, working and steering groups meetings they host throughout the year they are trying to ensure the representation of all stakeholder groups from each school and departments at the table.

HGCI takes every opportunity they have to present results of old projects and of the ones currently ongoing to the entire campus community. An interesting approach of this program is the development and implementation of a course that does not simply teaches about sustainability in higher educations but gives practical first hand tips coming from their experience with the implementation of their own program. The HGCI also has an updated web page mentioned above, which might be less effective in reaching that part of the uninformed population, but that as part of the whole communication network is complementary. Having a single program that integrates most, if not all of the efforts in

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The learning pyramid originates from the National Training Laboratories (NTL) for Applied Behavioral Science, 300 N. Lee Street, Suite 300, Alexander, VA 22314, USA. The percentages represent the average “retention rate” of information following teaching or activities by the method indicated. In fact this diagram was originally developed and used by NTL in the early 1960s at NTL’s Bethel, Maine, campus, but the organization no longer has or can find the original research that supports the numbers given. In 1954 a similar pyramid with slightly different numbers had appeared in a book, Audio-Visual Methods in Teaching, published by the Edgar Dale Dryden Press, New York. Bligh (1998) gives some evidence for the effectiveness of different teaching methods.
efficient resource management can be very effective since the entire institution's community could easily recognize the program and what it stands for. The HGCI program also provides space for training for all stakeholders on the importance of their role in a sustainable resource management program.

MIT does have a webpage as mentioned above, but this should be complementary to a communication network and not the communication network. There is a lot being done in MIT as described in chapter 3, but there is a big gap between those actions and the awareness of the MIT community. MIT has no specific program that can be identified with a specific name by anyone on campus. This, for starts, makes the challenge of educating through demonstration and participation a little more complicated. Through the MIT case description it was evident that the same number of people were always the ones spearheading efficient resource management projects through their different task forces.

4.6 Academic curriculum (students)

One of propositions stated at the beginning of this study on important aspects/areas of the institutional life that need to be addressed in order to create a real commitment towards sustainability is:

"The university should provide a curriculum that has a significant impact on their students' comprehension of, and skills regarding sustainability issues. Rather than designing a sole core course in sustainable development and/or environmental education universities should strive to connect this knowledge throughout the curriculum of any academic program offered. Complementary to this, a fair amount of electives on sustainability and/or environmental issues should also be provided."

Both MIT and Harvard have been doing important efforts on this aspect. MIT has a Laboratory for Energy and the Environment (LFEE) since 2001 which created a database with a list that provides "centralized" access to classes at MIT that specifically address environmental themes. Students can choose from several particular environmental topics of their interest. This database can be accessed on LFEE's website in the section titled EnviroClasses. (http://enviroclasses.mit.edu/)

Harvard has a similar system created by HUCE (Harvard University Center for the Environment). The environmental Course guide has the same purpose of guiding undergraduate and graduate students in their choice of environmental subjects of their interest (http://environment.harvard.edu)
Thus, a general comparison between the two different approaches to sustainable resource management presented here suggests that the more integrated approach of Harvard allows for:

- Building the Institutions capacity to be a learning organization.
- The concentration of detailed documentation of all activities carried out. This serves as an information tool (historical data) for future projects on campus and for other institutions that are trying to become greener.
- An overall assessment of the performance of the program in the entire campus through the generation of internal audits.
- A single recognizable image for all stakeholders on campus. Additional to the latter, the program creates opportunities for all stakeholders to participate in the evolvement of the program
- A more holistic view of the complementary impact each separate project has on the ecological footprint of the campus.

On the other hand, MIT with an individual and opportunistic approach is missing these opportunities, which makes the transition process to a green campus even more complicated.
Chapter 5  Key ideas for specific applications for the ITESM Campus Guadalajara

Having analyzed the two U.S cases and documented the general lessons learned, these can now be applied to the situation at the Tecnologico de Monterrey Campus Guadalajara. My proposal offers a tailored program for the ITESM campus, but at the same time it has general application to campuses with similar characteristics in Guadalajara. It is important to point out that this proposal is mainly focused on one of the core axis created by the SCBG; efficient resource management. This chapter is divided in two main sections. Section 5.1 presents some crucial strategic planning ideas. Section 5.2 offers operational guidance regarding the efficient management of paper, water, electricity and residues.

5.1 Strategic planning to accomplish a step forward to a sustainable campus.

5.1.1 Community Involvement

In order to have a continuous improvement regarding efficient resource management on campus, it is important to design an extensive communication network. This network will serve to inform, attract and educate the campus community. The better way to start is by analyzing the existing communication network of the campus and if required add to it.

The communication network of the campus right now is conformed by:

- Internal newspapers: The campus prints 3 different newspapers. One specifically for students and one specifically for faculty and staff and the other one for the entire population.
- Web site: This is the main web page of the campus that can provide links to other specific web pages created by specific departments and or programs on campus.
- Department meetings: These meetings are held per department with an average frequency of 2 per semester. Faculty come together to discuss several issues.
- Campus meetings: This is a biannual meeting hosted by the campus director together with the rector where the entire staff, faculty and administration come together to analyze performance indicators of the campus.
- Student organizations meetings: These are meetings with an average frequency of 6 per year where the student organizations come together with the coordinator of the student affairs office to discuss several issues.
- E-mail: every student, faculty and administration staff member of the campus has access to an e-mail account provided by the institution. So mass mails to the whole campus is possible by using the e-mail database under certain specific conditions.
- Bulletin boards: Each campus building (except for the administration building) has an average of 3 boards per floor facing the corridors. These can be use for advertising events. The information that can be posted on these boards is controlled by the direction of Image & communication.
This existing communication network can very well be used as such to promote an efficient resource management program. By using this existing network the program can be promoted both bottom-up and vice versa. But the following additional effective communication opportunities observed primarily from the Harvard case and also in less extent from MIT are important.

- Periodical conferences
  The campus has been having its yearly ecological week event that provided a series of conferences on several environmental and sustainable issues. But rather than a yearly one week event the suggestion here is to have 3 to 4 conferences a year with 2 to 3 speakers presenting relevant issues that can have a direct impact on the campus operations. (For example, renewable energy, certifications in Mexico or possibilities for green purchase, to mention some.)

- Informal events with guest speakers
  This could be a coffee hour where a guest speaker will be brought in to have a discussion on ways to do better energy saving for example.

- Focus groups
  It is important to create some focus groups that are comprised by representatives of each stakeholder group on campus. These should start during the design phase for the program and go on through the implementation and evaluation. These small focus groups could be really helpful in figuring out the right opportunities to work on.

- Training programs for specific areas within the campus. All staff members and faculty should receive at least basic training in sustainability issues through the use of case studies promoting creativity and continuous improvement

- The campus Guadalajara should also have a curriculum analysis in order to pin point those current subjects offered that have space for environmental and or sustainable topics. Once this is done, the specific academic coordinators of those subjects should receive support of the academic coordination for sustainable development through this program, with the inclusion of case studies, problems, collaborative teamwork activities or projects on the specific content in relation to the environmental and or sustainable issues.

This communication network together with one single recognizable image for the promotion of the sustainable resource management program is essential as observed in the case of HGCI. The campus community must be able to connect every project directly to this integrated program on campus.

The campus should strive to create a core staff that is 100% dedicated and committed to all the activities of the sustainable resource management program on campus, especially their image and credibility.

Another important aspect to consider while working towards involvement is the incentives. Guadalajara campus just like MIT has a centralized model for the organization of campus regarding Facilities and Utilities. In other words, the several divisions on campus pay a flat overhead rate for their electricity and water consumption.
In order to really get these involved in the sustainable resource management program, it is important to rely on the commitment of the direction board so they include sustainable management variables in the internal performance evaluation system of the campus as an incentive.

5.1.2 Fund raising

The funding of a continuous project like this is always a challenge. Due to the fact that the Guadalajara campus has a centralized model, it is difficult to find incentives that can trigger the participation of each division and their specific departments, as mentioned above. There is one overhead flat rate that each division pays regarding utilities. The campus, just like MIT, is not provided with single metering systems per building, which makes it difficult to separate the utilities bills and present it to the divisions. So the accounting system of the campus just as Harvard and MIT is an obstacle. The people that handle the money are not necessarily the same ones that make important decisions, creating a troublesome gap.

Procurement and facilities are left as the main direct actors for the potential savings that can be achieved directly through an efficient resource management program like this. This would leave the divisions as important contributors to the savings but as secondary actors in the process.

Having said the latter it is obvious that the program should rely only on an initial capital to start off, and prove to be auto sufficient in the long run.

This initial capital could come from a grant given by the private sector or it could come from the campus capital budget or a combination of both.

In order to extract funding out of the capital budget of the campus this program must appeal to the potential general savings it can generate for the campus as a whole. The program must prove to be cost efficient and effective.

The total cost in any project could involve funding from a variety of sources, including funding for initial capital development, for operating, repair and maintenance costs, and for replacements. Like Harvard and MIT, the following factors that affect total cost should be taken into account throughout all stages of projects and programs: initial investment; life cycle costs; and environmental costs that are neither initial investment nor life cycle costs. These include environmental costs such as greenhouse gas emissions, indoor air quality and use of nonrenewable materials.

5.1.3 Networking

One of the very first steps to be taken in networking is broaden the already existing relationship with the city government and its municipalities. Right now this relationship is mainly based on planning and research.

But it is important to conduct a thorough analysis of city goals concerning air, water and soil pollution (if any) and work together to create, promote and achieve these goals. An important lesson learned from both US institutions is the relationship with the private industry with regard to renewable energy technology and use. It is very important to have a network of what is called “Green” companies willing to work with the campus on pilot
projects of mutual benefits. To do this effectively a historical documentation must be assembled of past experiences with this type of companies in order to repeat, prevent, expand and or improve the results. It’s also important to have a network with other Higher Educational Institutions in Guadalajara. Institutions like ITESO, UDG and UNIVA have already been working on other issues with this campus.

5.2 Specific actions for an efficient resource management on campus

In this section a series of specific actions for the efficient management of water, paper, electricity and residues resource are suggested. These actions, in contrast to the above, form part of the operational aspect of the sustainable resource management program proposal for the campus rather than the strategic planning aspect.

5.2.1 Efficient use of water

For a more efficient use of water there are several examples of actions that can be taken out of the experience of MIT and Harvard. For this proposal, where the main focus will in general be on low investment actions, the suggestions will be presented as “minimum to none investment” actions and actions that require a significant initial investment but with a relative short pay back time. This latter will be done from here on whenever considered pertinent.

The campus Guadalajara has his own chemical waste water treatment plant that combines a primary with secondary water treatment system. The treated water is used to irrigate their natural grass soccer fields and the football filed.

Gardening

- **Minimum to none investment actions**
  - Irrigation time. The best time to irrigate is in the early morning hours or at night in order to prevent evaporation as much as possible. Especially with a water sprinkler system (which is the current system on campus) this is highly recommended.
  - Localize leakages and repair those.

- **Significant initial investment actions**
  - Install sub-ground dripping irrigation systems. This will reduce the time needed to water the gardens since there is no spilling of excess water. This system also minimizes evaporation related to the time of day.
- Expansion of the installation of a centralized irrigation system.

Sanitation

- **Minimum to none investment actions**
  - Leakage control program

- **Significant initial investment actions**
  - Installation of low-flow toilets
  - Installation of waterless urinals.

For the implementation of these actions it is recommended to start with a pilot project on a small scale in controlled areas. This will create the opportunity to pinpoint important obstacles in the project and find ways to handle those before the big scale implementation. These obstacles could be of several sorts: behavioral, technological, maintenance etc. just to mention a few.

**Drinking water dispenses**

In the year 2003 the Guadalajara Campus has installed a total of 10 stationary water dispensers that are operated by the facilities department. These dispensers came to replace a number of mobile water dispensers that didn’t require electricity for their functioning.

**Cleaning**

In the past two different “green cleaning products” companies have approached the Guadalajara campus. These companies were not able to convince procurement and facilities to switch over to their products.

The proposal here is a change in approach as observed from the HGCI ongoing research through a pilot project on campus. Instead of relying simply on the companies’ presentation and demonstrations of their products it is better to work together on a pilot project on campus.

The campus can collaborate with the company to set up a specific period when the products will be tried out in a controlled area of the campus. This pilot project can involve for example students to carry out surveys, the company to deliver the necessary products and training for the optimum use of these, to the cleaning staff.

The benefits of these cleaning products could be multiple. For example: less chemicals needed for the water treatment plant, dramatic decrease in the amount of different cleaning products needed and possible heath advantages for the cleaning staff.
5.2.2 Efficient use of Paper

In general the campus should strive to switch over to 100% recycle content paper for all its operations. This should be gradually done through careful tryouts at all printing centers on campus. IKON, the equivalent of Copytech at MIT, should be convinced to participate in this process.

An important first step could be an elaboration of a list that contains the available recycling content papers in the market, through the collaboration of procurement and their providers.

Office use

Currently each department uses their own printers and copy machines with an average of 40 people per machine. Each office area has the copy and printer corner where paper is made available to reload the machines whenever necessarily. It is a common everyday situation to find 30 to 50 printed sheets that are never picked up.

This is a massive waste of paper per month.

A simple obstacle in the process of reloading the machines could help improve the situation above. The inclusion of the department’s secretary in this by taking away the stock of paper from the printing and copy area and having the secretary record the amount of paper used by each faculty could have the desired "in the spot light effect" without having to limit the amount of prints or copies. In other words it could function as a self enforced system.

Each department should have the infrastructure for paper recycling. Besides the latter visual reminders both in the work space as through e-mail messages promoting double sided printing and copying must be provided.

Class materials

- All class material handed out by teachers should be double sided.
- Teachers should promote reused paper for all “hand in” class activities with the exception of final projects if so desired.
- Pop quizzes should be done in the format of more than one copy per sheet whenever possible.

Advertisement and public relations

Here the basic proposal is to make each individual, group, organization, department etc. responsible for the advertisement material used on campus. The focus would be specifically on posters, flags and displays. In other words all these materials used for promotion and /or information need to be collected upon completion of the specific event by the responsible party. The responsible is then in charge of including this material into the recycle stream on campus. If carried out the right way this will be another auto-enforced process in the program.
The direction of Image and communication has to play a major role here. This direction has to expand the control of what type of advertisement can be posted with this additional responsibility policy. This system should also hold through for public relations activities of the campus outside the physical boundaries of the campus.

Publications

The Campus Guadalajara should promote recycled content paper for all internal and external publications. Each publication should provide the statement that the material used is recycled content material in order to model the change in an explicit way.

5.2.3 Efficient use of electricity

Equipments

In order to have an efficient resource management program electricity control plays a key role. Facilities should have an up to date inventory of all type for equipment used on campus. In other words they should have a registration process not only for the equipment both through procurement by the campus but also all those other equipment on campus brought in by individuals in office spaces, cafeterias, common areas and lab spaces.

Computers

HGCI campaigns on Harvard campus for the computer energy reduction (CERP) should be adapted for the Guadalajara campus.(See chapter 3, 3.2.3.2) The Guadalajara campus already has the necessary infrastructure to carry out this campaign. Collaboration among the direction of Informatics, students organization, direction of student’s affairs and the direction of image and communication should design and promote a creative image and process for this campaign.

Appliances (microwaves, Coffee makers, refrigerators, stoves, vending machines, TV and multi media equipments)

As mentioned above there must be an up to date registration of all appliances on campus. Procurement can create and promote through the direction of Image and communication a list of the most energy efficient appliances in the market. This list should be created as a strongly recommended or even mandatory tool to be used for any appliance that is bought through or not the procurement office for on campus use.
Vehicles

The Guadalajara campus has the “Expresso TEC”, a private company with buses to transport students and faculty members with several routes across the city. The facilities department, Rectory, direction of Image and communication and direction of promotion and relations also has vehicles that are used both on and off campus. As minimum requirements all this vehicles should be regularly tuned-up and serviced, and catalytic converters should be used whenever possible. The possibilities of switching to bio-diesel for the “Expresso TEC” vehicles should be a medium to long-term project. The Tecnologico de Monterrey Campus Monterrey has been experimenting and using on campus produced bio-diesel for more than 4 years. That experienced can be valuable for this specific project.

Lighting

The Guadalajara campus, thanks to the excellent work of the facilities department, has already been working on an extensive lighting project very similar to MIT. This project focused both on using lighting control as on using more energy efficient lights. But this project as in the one in MIT lacks a behavioral change component. The sole implementation of new technology is often not enough to acquire the desired change. There is need of proper information to the general public of the benefits that come with these changes. The lighting project in Guadalajara campus has suffered from the latter resulting in a hold in the projects expansion. The main reason for this hold is people resistance against for example occupancy sensors in toilets and offices.

- **External lighting**

  External lighting should be strictly a matter of safety and not of esthetics. With the latter in mind the campus should consider introducing daylight sensors for all corridors lighting.

- **Internal lighting**

  Classrooms are the best spaces to have occupancy sensors, but indeed in campus Guadalajara the lighting project started first in office areas and toilets leading to a complete hold in its progress. Funds must be found to promote occupancy sensors for all classrooms on campus and at the same time to inform the campus population of the project’s benefits and reach.
5.2.4 Efficient management of residues

Labs residues and hazardous wastes

Networking could play an important role here. The campus itself is not a lab intensive campus at all. But there are several nearby companies that are very lab intensive and several of these companies have from a good to an excellent relationship with the campus regarding training programs for their employees and research. In other words the campus should negotiate collaboration with one or more of these companies regarding the management of the labs residues and hazardous waste.

Cafeterias

The campus should promote a composting program in all cafeterias on campus. Facilities already started with a pilot project on campus using “worms” to compost “prep waste”. This efficient resource management program should further support this ongoing pilot project. The amount of plastic cups can also be further reduced. A pilot project should be started in the main cafeteria of the campus where every member of the campus should have his or her own reusable containers for all non pre-packed liquid beverages sold in the cafeteria. In simple words “we can not serve you any non pre-packed liquid beverage if you don’t have something to pour it in.

Offices

Besides paper, one of the most important waste products in the sense of cost and quantity, are the toner cartridges. There are two things that should be done:

1. This program with the collaboration of procurement and its providers should start promoting remanufactured toner cartridges. A list containing the several remanufactured toner cartridges information in the market should be created together with a campaign promoting cost savings and the quality of these toners.
2. This program together with facilities should develop a correct process of collecting used toner cartridges and sell this to recycle companies that are dedicated to this remanufacture business.

Students Residence

The campus has only one residence building on campus. This building should have a complete program on recycling with the same focus as the rest of the campus. The resident building could be used as a perfect pilot scenario for several of the projects proposed with the direct participation of students.
Classrooms

The classrooms in this campus are non-smoking and no food spaces. In other words, there should not be any other waste in classrooms other than class materials such as paper, empty pens, and broken chalks.
This latter is not observed on the Guadalajara Campus, so the role of the faculty members is crucial to limit the waste of classrooms to what it should be. Faculty has to be encouraged to enforce the classrooms rules posted on each blackboard in each classroom.

Gardens

The institution should keep on improving on its composting project of the gardening waste on campus. This type of project could also be strategic to have as workshops during environmental events on campus. Here both the campus community, as well as visitors can receive practical first hand training in how to apply this at their particular homes.
This is another way to get people involved on a hands-on project in order for them to experience in a practical way the importance of recycling.

Thus, it can be seen there are operational as well as strategic planning variables involved while changing an institution to being more sustainable. Nevertheless, it is important to keep in mind that getting the key personnel committed to having continuous quality improvement while having a cautious follow-up of the program is what could truly make a difference towards a greener campus.
Chapter 6 Conclusions

This study was conducted in the attempt to find possible answers to important questions such as how to create a community commitment for involvement in sustainable actions, what exactly should a sustainable resource management on college campuses involve and how to measure success.

In an effort to find answers to these questions, this thesis explored how MIT and Harvard as U.S Universities are doing with their efforts towards an efficient management of resources in order to explore any important lessons to be learned out of their experience.

First of all, it is important to point out that even though there are important differences in the organization of the two U.S universities green campus initiatives, both universities in general seem to be expanding their initial efforts, but at considerable different paces. More people are getting involved, the existing projects are growing and new projects are ongoing or on their way.

But with a closer look at the experiences of both Universities with efficient resource management the following conclusions are stated:

First of all, the Guadalajara Campus should continue and finish their internal Audit on sustainability, which will give the program less obstacles compared to other programs that started without an initial audit or parallel to an initial audit and later on created their performance indicators, if any. Afterwards, a strategy should be designed to comply to these indicators in order to assure continuous improvement.

MIT, as is the case of the Guadalajara Campus, is not signed into any declaration on HESD. This latter is not a prerequisite for effectiveness in an efficient resource management program on campus, but it is a way of showing genuine commitment to certain principals to your community.

Also internally there is no sustainability and/or green campus principles document signed by the president of the institution. There is a list of 10 general sustainability goals created by taskforces and committed people doing the most they can to implement these whenever possible. The closest thing to a serious commitment on this matter at MIT is a part the consent decree signed in 1998. Nevertheless, there are important projects carried out by MIT that can give valuable lessons in steps to take toward an efficient resource management program on a university campus.

Harvard on the other hand, has a list of sustainable principles signed by the president since last year. This helps to reinforce the actions already taken and the ones to come.

The System Tecnologico de Monterey has clear specific references to sustainability in their mission 2015. As such, The Guadalajara Campus in pursuing the accomplishment of this mission should be consistent into actually being sustainable in order to promote the values it is intending to foster in students.

The organizational structure difference form a centralized to a decentralized model may create specific potential advantages and disadvantages for an institution that is trying to become a green campus. The decision to act upon these advantages and disadvantages is what is relevant.
A centralized model:

- Advantage:
  There is direct general overview on the efficient resource management dimension of a green campus initiative. In this particular case the management of water, electricity, paper and solid waste.

- Disadvantage:
  It is difficult to create incentives for the different divisions, departments and/or schools to actively participate in the projects related to an efficient resource management.
  The program must be very creative in providing specific incentives for specific schools, department and or divisions. This on its own could be another interesting area of master’s research.
  The other extreme would be to switch for some aspects of the program to mandatory instead of voluntary participation.

A decentralized model:

- Advantage:
  A possible competition process among different schools, department and/or divisions serves as an incentive to participate in these cost effective and efficient projects. These projects have at the same time a positive general impact from the institution on the environment.

- Disadvantage:
  It could be more complicated to have a general overview on what is going on in the entire institution regarding the efficient resource management dimension of a green campus initiative program. This could be act upon by for example creating or having a semi-external entity that can function as an umbrella organization upon the entire campus activities in this regard. The HGCI could be a good example of this latter.

It can also be concluded that there is the perception by both US universities that providing a curriculum with a significant impact on their students’ comprehension of, and skills regarding sustainability issues is important. This can be observed by the efforts of these universities to put together databases and or guides with complete information of all their environmental and sustainability related courses for all students.

The role of champions, as mentioned in chapter 1, is one of the 7 critical conditions for programs like these. In Harvard we can see the important role played by a well-respected faculty member, Jack Spengler, in the whole process of designing, implementing and evaluation of the HGCI. He was there before at the beginning and during the whole initiative.

In MIT several champions could be detected during the years, but no constant present champion is to be found. This raises the question of whether the existence of champions for programs like this is the critical condition or if it is the durability of those.
This could be an area worth researching for the future.
The presence or image of an efficient resource management program seems to be very important for the target community to relate and get involved. Based on several at random short interviews to students and staff members on both U.S campuses I carefully state the following conclusion.

Having one recognizable name for the project as in the case of HGCI is a good start to inform the target population that there is something going on and the “who’s, how’s, where and when’s” are related to that specific program.

At MIT, where the “initiatives” are not really part of the responsibility or function of a specific program the target population tempt to see the recycled garbage bins together with the recycled content paper use as the main “green” activities on campus.

Judging on the growth of the HGCI staff, the budget and the increasing number of different schools and specific stakeholders (students, staff, faculty, providers, etc) participating in the program, it seems that a massive well-designed internal communication network is very important. The HGCI has been providing constant opportunities for all stakeholders to be represented in their ongoing and new projects. Their philosophy of building the university capacity to become a learning institution is another area for more indebted master’s research.

Having a fixed staff that is 100% dedicated to the design, implementation evaluation, improvement and promotion of a sustainable resource management program on campus can help a great deal regarding the “Time” obstacle many institutions encounter. This can be observed in the case of Harvard where there is a fixed staff and where the program has clearly been growing in a considerable faster pace than at MIT where there is no fix staff for their “green initiatives” projects. (See also table 1 appendix 4.1)

Finally, as shown in table 2 Appendix 4.1 these types of programs need to have well designed performance indicators. Both U.S campuses carried out a GHG emissions inventory later on in the process of implementing sustainable resource management project to analyze the possible effects of actions taken in the past and to program new actions. It is important to have these carried out on a yearly basis to truly use them as indicators. In addition to these, Health indicators are an example of another interesting group of performance indicators to be considered in the future.
Appendix 1.1

International Declarations on Sustainability Relevant to Higher Education for Sustainable Development

This list comes from the work of Calder and Clugston 2003 and the report on Higher education Sustainability Activities prepared by Laboratory for energy and the environment at MIT (2004).

Since 1990, a series of international declarations have converged on the challenge of fostering the higher education community’s transition to sustainability. According to one researcher, this trend shows that there is “an international consensus on priorities for the reform of higher education.” (Calder and Clugston 2003)

Tbilisi Declaration, 1977
- First intergovernmental conference on environmental education
- Organized by UNESCO in cooperation with the UN Environment Programme
- Recommends adoption of ten “criteria which will help to guide efforts to develop environmental education at the national, regional, and global levels”
- Three goals: foster awareness of interdisciplinary interdependence; provide equal opportunity for environmental education; and create new patterns of human behavior toward the environment.
- Five objectives: awareness, knowledge, attitudes, skills, and participation
- Eleven guiding principles for environmental education

Talloires Declaration, 1990 (http://www.unesco.org/iau/sd/talloires.html)
- First declaration specifically concerning institutions of higher education
- University presidents and leaders from every continent participated in a 1990 conference convened by Tufts University; see Clugston and Calder (1999) for more detail on the origin of the declaration
- Currently 300+ signatories from 40+ countries; ULSF serves as secretariat
- Embodies a statement of deep concern “about the unprecedented scale and speed of environmental pollution and degradation,” and outlines a ten-point action plan:
  - Increase awareness of environmentally sustainable development;
  - Create an institutional culture of sustainability;
  - Educate for environmentally responsible citizenship;
  - Foster environmental literacy for all;
  - Practice institutional ecology;
  - Involve all stakeholders;
  - Collaborate for interdisciplinary approaches;
  - Enhance capacity of primary and secondary schools;
  - Broaden service and outreach nationally and internationally; and
  - Maintain the movement.

Kyoto Declaration, 1993 (http://www.iisd.org/educate/declarat/kyoto.htm)
- Calls for “universities of the IAU to seek, establish and disseminate a clearer
understanding of Sustainable Development - development which meets the needs of the present without compromising the needs of future generations - and encourage more appropriate sustainable development principles and practices at the local, national and global levels”


University Charter for Sustainable Development, 1993 (http://www.copernicuscampus.org/sites/charter_index1.html)
- 300+ European universities have adopted
- States that it is the role of the universities “to propagate environmental literacy and to promote the practice of environmental ethics in society,” and that “they must therefore commit themselves to an on-going process of informing, educating and mobilizing all the relevant parts of society concerning the consequences of ecological degradation, including its impact on global development and the conditions needed to ensure a sustainable and just world."
- Establishes ten “principles of action”

Thessaloniki Declaration, 1997 (http://www.mio-ecsde.org/old/Thess/declar_en.htm)
- This declaration “makes the fundamental assertion that poverty reduction is a condition for sustainability, and affirms that the reorientation of education requires that all disciplines address SD and that this requires ‘a holistic, interdisciplinary approach’” (Calder and Clugston 2003,).

Lüneburg Declaration on Higher Education for Sustainable Development, 2001 (http://www.lueneburg-declaration.de/frame_start.html)
- Joint position statement issued by GHESP and addressed to the WSSD; intended to help the education community “speak with one voice” at the WSSD and during the preparatory process

- Issued at WSSD by eleven organizations, including UNESCO, GHESP and its partner organizations, the United Nations University, and several academies of science and engineering
- Calls for “an initiative to strengthen science and technology education for sustainable development”
- Goals include curriculum development, North-South networking, strategic educational planning and policy-making, and capacity building in scientific research and learning (See 9 September 2002 press release at http://www.unu.edu/hq/rector_office/pressarchives/press2002/pre37.02.html.

Earth Charter (http://earthcharterusa.org/ec_document.html)
- Has evolved via a process of international consultations since 1994; final version
released in 2000
• Development suggested at close of Rio summit; non-governmental process
• Elaborates four main principles: respect and care for the community of life; ecological integrity; social and economic justice; democracy, nonviolence, and peace
• Used as an educational tool; network of Earth Charter national committees and partners; ULSF is developing educational materials based on the Earth Charter (http://www.ulsf.org/programs_earthcharter_edproject.html)
Appendix 2.1

MAIN OBJECTIVE

The development of a sustainability program for the Tecnológico de Monterrey, Campus Guadalajara, that allows a continuous development of its educational programs and the culture of its community through the efficient use of materials and energy, compliance to regulations, knowledge and respect of the biodiversity and conserving congruency with the values and attitudes promoted by the Tecnológico de Monterrey System.

SPECIFIC OBJECTIVES

- Establish the basis to develop a sustainable program in campus and agree upon a follow-up.

- Carry out an internal auditing that will allow us to actually know the Campus current situation in Guadalajara regarding the following areas:
  - Efficient use of energy and materials
  - Fulfillment of the rules
  - Biodiversity
  - Education
  - Congruency

- Create an indicator system to measure sustainability that allows for constant improvement.

- Introduce or instill basic principles for an Environmental Management System [EMS] (establish an environmental policy, objectives and goals, etc.).

- Establish an internal net to promote information exchange: Facilities-CCA-Faculty-Students.

- Reflect an ecological and ethical conscious behavior towards the community, which will promote a culture of sustainable development.

EXPECTED BENEFITS

The benefits that we will be able to obtain through the introduction of a sustainability Program in campus are:

- Decrease of the negative impact of the environment at the University, which will show congruency with the principles that any university should comply with especially the ITESM in Guadalajara according to the mission statement.

- Savings related to the decrease in the consumption of water, energy, materials, as well as in the amount of waste and the prevention of fines.

- Greater sensibility and commitment from the students and the personnel regarding the sustainability principles and not solely towards the protection principles.

- Greater value in the university training.

- Promotion of communication among different areas.
• Competitive advantages regarding evaluations of institutional quality. Leadership shown at regional and system level at the Tecnológico de Monterrey.
• Contribution to the campus image.
• There will be congruency between the services provided by the DGI and the performance of the campus.
• Contribute with tested methodologies in order to promote sustainable development programs in the community.
• A sustainable program applicable to any university campus.

ASSUMPTIONS

- Participation of the teaching and administrative staff.
- Global tendency towards a sustainable development.
- Resistance to change.
- Lack of environmental culture.
- Non-sustainable current practices in campus.

REQUIREMENTS

- Support and commitment from the directorship.
- Consideration of the importance of including the program within the strategic planning of the campus.
- Involvement of teaching and administrative staff.
- Promotion and internal circulation of the program.
- Allocation and resource availability.
- Making sure there is continuity of the program.
- Financial support.

BASE GROUP MEMBERS

- Teaching Staff
- Social Service.
- Facilities.
- Environmental Quality Center.
- Institucional Quality.
- Students’ Groups.
Appendix 3.2

HGCI Steering Committee

Purpose
- Provides regular advice and oversight of HGCI development.
- Meets monthly.

Participants
- Tom Vautin, Co-Chair, Associate Vice President for Facilities & Environmental Services
- Jack Spengler, Co-Chair, Professor of Environmental Health & Human Habitation, School of Public Health
- Joe Griffin, Advisor, HGCI; Director, Environmental Health and Safety
- Leith Sharp, Director, Harvard Green Campus Initiative

Harvard Green Campus Interfaculty Advisory Committee

Purpose:
The purpose of the Harvard Green Campus Interfaculty Advisory Committee is to provide a forum for faculty, students and administrative staff to jointly advice the Harvard Green Campus Initiative Co-Chairs and Director on the strategic direction of the HGCI. The Advisory Committee gives special advice on fundraising objectives and briefings to the Provost and President. The Advisory Committee directly supports the core mission of the HGCI which is to:
- Institutionalize a commitment to cost effective, environmental impact reduction in association with Harvard's campus operations
- Utilize the campus as a living laboratory for teaching and research in support of environmental sustainability
- Establish a learning organization capacity to support continuous improvement in the economic, social and environmental well being of the campus
- Meets twice a year.

Participants:
Co-Chairs:
- Tom Vautin, Associate Vice President for Facilities & Environmental Services
- Jack Spengler, Professor of Environmental Health & Human Habitation, School of Public Health

Faculty:
- Fred Abernathy, Professor of Mechanical Engineering and Engineering, Faculty of Arts and Sciences
- Naill Kirkwood, Professor and Chair of Landscape Architecture
- Spiro Pollalis Professor of Design Technology and Management Projects
- Ken Kao, Lecturer in Architecture
- Paul Epstein, Associate Director, Center for Health and Global Environment; Instructor, Harvard Medical School
- Dan Goodenough, Takeda Professor of Cell Biology
- William Clark, Harvard Brooks Professor of International Science, Public Policy and Human Development
• Henry Lee, Director, Environment and Natural Resources Program, Belfer Center; Lecturer, Kennedy School of Government
• Max Bazerman, Faculty, Harvard Business School

Staff:
• David Zewinski, Associate Dean for Physical Resources and Planning in the Faculty of Arts and Sciences
• Michael Lichten, Assistant Dean for Physical Resources, Faculty of Arts and Sciences
• Jay Phillips, Director of Building and Maintenance Operations, Faculty of Arts and Sciences
• Beth Shepard-Rabadam, Assistant Director, Harvard Planning + Allston Initiative
• Peter Riley, Director for Project Management, Harvard Real Estate Services
• Frank Hayes, Chief of Operations, Harvard Business School
• Danny Beaudoin, Manager, Facilities, Energy and Utilities, Harvard School of Public Health
• John Horst, Director of Facilities and Administrative Services, Radcliffe
• Roy Lauridsen, Facilities Superintendent, Harvard Divinity School
• Joe Griffin, Advisor, HGCI; Director, Environmental Health and Safety, University Operations Services
• Rob Gogan, Manager, Recycling and Waste, University Operations Services
• Leith Sharp, Director, Harvard Green Campus Initiative

Students:
• Michael Keating, Graduate School of Design
• Zach Liscow, Harvard College
• Allison Rogers, Harvard College

Campus-Wide Sustainability Principle Advisory Group

Purpose:
To advice the HGCI in the development and implementation of campus wide sustainability principles.

Participants:
Faculty:

HSPH
• Jack Spengler - *Akira Yamaguchi Professor of Environmental Health and Human Habitation* - Co-Chair, Harvard Green Campus Initiative
• James Hammitt - *Associate Professor of Health Policy and Management*

HBS
• Max Bazerman - *Jesse Isidor Straus Professor of Business Administration*

GSD
• Niall Kirkwood - *Professor of Landscape Architecture*
• Robert France - *Associate Professor of Landscape Ecology*
• Michelle Addington - *Associate Professor of Architecture*
• Ken Kao - *Lecturer in Architecture*

KSG
• Robert Stavins - *Albert Pratt Professor of Business and Government*
- William Clark - *Harvey Brooks Professor of International Science, Public Policy and Human Development*
- Henry Lee - *Director, Environment and Natural Resource Program*

**HMS**
- Daniel Goodenough - *Takeda Professor of Cell Biology*
- Paul Epstein - *Associate Director, Center for Health and the Global Environment*

**FAS**
- Michael McElroy - *Gilbert Butler Professor of Environmental Studies*
- Frederick Abernathy - *Abbott and James Lawrence Professor of Engineering, Gordon McKay Professor of Mechanical Engineering*
- Daniel Schrag - *Professor of Earth and Planetary Sciences - Associate of Pforzheimer House*

**Staff:**
- David Zewinski - *Dean of Capital Planning and Development*
- John Collins - *Librarian, Harvard Graduate School of Education*

**HP+AI**
- Kathy Spiegelman - *Chief University Planner and Director, HP+AI*
- Beth Shepard-Rabadam - *Assistant Director, HP+AI*
- Charles Studen - *Public Approvals Planning Assistant Director, HP+AI*

**UOS**
- Tom Vautin – *Associate Vice President Facilities & Environmental Services - Co-Chair, Harvard Green Campus Initiative*

**VPA**
- Carter Wall – *Project Manager*

**HGCI**
- Leith Sharp - *Director, Harvard Green Campus Initiative*

**Students:**
- Zachary Liscow (FAS)
- Allison Rogers (FAS)
- Michael Keating (GSD)
- Justine Kwiatkowski (GSD)
- Amy Sheehan (GSD)

**Longwood Campus Energy Reduction Program Steering Committee**

**Membership:**
Harvard Medical School, School of Public Health and Harvard Dental School
Meets monthly.

**Purpose:**
To guide the efforts of the Longwood Campus Energy Reduction Program.

**Participants:**
- Peter Stroup, Associate Director of Facilities and Operations, HMS
- Jane Garfield, Director of Campus Operations, HMS
• Daniel Beaudoin, Manager of Facilities Energy and Utilities, HSPH
• Craig Campbell, Energy Manager, HMS
• Jessica Woolliams, Program Manager, Longwood Campus Energy Reduction Program
• Jaclyn Emig, Program Coordinator, Longwood Campus Energy Reduction Program

**Longwood Campus Energy Reduction Program Advisory Committee**

**Membership:**
Harvard Medical School, School of Public Health and Harvard Dental School
Meets twice a year.

**Purpose:**
This Advisory Committee is modeled from the Harvard Green Campus Interfaculty Advisory Committee in that it is a forum for faculty, students and administration staff from the three Longwood schools to jointly advise the Longwood Green Campus Coordinator. This Advisory Committee provides a critical link to constituencies from the three schools, supporting a shared mission to:

- Institutionalize a commitment to cost effective, environmental impact reduction in association with the Longwood campus operations.
- Utilize the campus as a living laboratory for teaching and research in support of human and environmental health.
- Establish a learning organization capacity to support continuous improvement in the economic, social and environmental well being of the campus.

This group meets two times a year.

**Participants:**

**Faculty:**

- John D Spengler, Co-Chair of the HGCI Director, Environmental Science and Engineering Program, HSPH
- Eleanor G. Shore, Dean for Faculty Affairs, Harvard Medical School
- Edward Seldin, Associate Professor of Oral and Maxillofacial Surgery, HSDM
- Daniel Goodenough, Director of Medical Education, Takeda Professor of Cell Biology, HMS
- Eric Chivian, Director, Center for Health and the Global Environment, HMS
- Dr. Joan Reede, Dean for Diversity & Community Partnership, Assistant Professor of Medicine, HMS
- Paul R. Epstein, Associate Director, Center for Health and the Global Environment, HMS
- Robert Cleveland, Professor of Radiology, Children's Hospital and Associate, CHGE, HMS

**Staff:**

- Leith Sharp, Director, Harvard Green Campus Initiative
- Jessica Woolliams, Coordinator, Longwood Green Campus Initiative
- Dr. Jacquelyn Smith-Crooks, Director, Community Outreach Programs, HMS
- Jane Garfield, Director Campus Operations, HMS
- Brian Frederick, Staff, HMS
Robert Christiano, Associate Manager of Custodial Services, HMS
Vin Troisi, Unicco Site Facility Manager, HMS
Joan Reede, Dean for Diversity and Community Partnership, Assistant Professor of Medicine, HMS
Gerald A Greenhouse, Director of Administration, Cell Biology, HMS
Danny Beaudoin, Manager of Operations, Energy and Utilities, HSPH
Lia Sgourakes, Special Assistant to the Dean, Harvard School of Dental Medicine

Students:
Paul Rosenau, Student, HMS
Shruthi Mahalingaiah, Student, HMS, Harvard Medical Students for Health and the Environment
Supinda Bunyavanich, Medical Student (HMS)
Miranda Loh, M.S. Candidate, Environmental Health Harvard School of Public Health (HSPH)
Matt Lloyd, MS Candidate, Industrial Hygiene, HSPH

Green Campus Loan Fund Advisory Committee

**Membership:**
University wide.
Meets every month.

**Purpose:**
This Advisory Committee formally reviews and approves Green Campus Loan Fund applications from all Harvard schools and departments. The group also advises the HGCI staff on the development of policy, promotions and performance relating to the Green Campus Loan Fund.

**Participants:**
- Danny Beaudoin, Manager of Operations, Energy and Utilities, Harvard University School of Public Health
- Susy Bunanta, Senior Engineer, Engineering and Utilities
- Craig Campbell, Energy Engineer, Harvard Medical School
- Bob Christiano, Manager of Custodial Services, Harvard Medical School
- Michael Crowley, Interim Green Campus Loan Fund Coordinator, Harvard Green Campus Initiative
- Roger Edgerly, Area Supervisor, Facilities Maintenance Operations
- John Horst, Director of Facilities and Administrative Services, Radcliffe Institute of Advanced Studies
- David Kirby (GCLF Financial Advisor), Manager, Financial Administration, Harvard UOS Finance and Administration
- Roy Lauridsen, Facilities Superintendent, Harvard Divinity School
- Jeff Martin, Assistant Director of Operations, Kennedy School of Government
- Larry McNeil, Facilities Engineer, Harvard Real Estate Services
- Jay Phillips, Director of Building Maintenance and Operations, FAS Physical Resources
- Karen Powers, HPRE Facility Safety/Environmental Officer, Environmental Health and Safety
Doug Scatterday, Director, Facilities Operations, Harvard Business School  
Leith Sharp, Director, Harvard Green Campus Initiative  
Mary Smith, Energy Strategist, Engineering and Utilities  

**Sustainable Buildings Program Steering Committee**  

**Membership:**  
Harvard Real Estate Services  
Sub-groups meet every month  

**Purpose:**  
This Steering Group advises and directs the development of the HPRE Sustainable Buildings Program. All departments within HPRE are represented, ensuring full inter-departmental involvement.  
Sub groups of this wider group meet monthly. The full group meets twice a year.  

**Participants:**  
- Peter Riley, Director for Project Management  
- Ed Reiss, Director of University and Commercial Real Estate  
- Ted LeBlanc, Assistant Director of University and Commercial Real Estate  
- Jeffrey Ganem, Senior Project Manager, University and Commercial Real Estate  
- Susan Keller, Vice President of Residential Real Estate  
- David Dower, Assistant Director, Residential Real Estate  
- Michael Cahill, Senior Manager, Physical Resources, Residential Real Estate  
- Elizabeth Shepard, Assistant Director for Campus Planning  
- Leith Sharp, Director, Harvard Green Campus Initiative  

**FAS Undergraduate Resource Efficiency Program Steering Group**  

**Membership:**  
Made up of representatives from each of REP’s major partners.  
Meets monthly  

**Purpose:**  
The Steering Group is the core body that advises REP and provides strategic assistance to the program.  
Click on each Steering Group members’ name below to read their brief bio. You’ll see that the Steering Group brings a multitude of talents, skill sets, knowledge, and a range of exciting achievements which all contribute to the great success of REP.  

**Participants, Fall 2004:**  
- Tasha Bartch ’06 REP Captain, 2004-05  
- Lindsay Crouse ’06 REP Captain, 2004-05  
- Antje Danielson Program Manager, FAS Computer Energy Reduction Program (CERP)  
- Rob Gogan Manager, Recycling & Waste Management University Operations Services  
- Robert Leandro Assistant Director, Residential Dining Harvard University Dining Services  
- Jayne Loader Quincy House Co-Master
• Jay Phillips Director, Building Maintenance & Operations FAS Office of Physical Resources
• Allison Rogers ’04 REP Captain, 2003-04 REP Coordinator, 2004-05
• Leith Sharp Director, Harvard Green Campus Initiative
• Lexi Tuddenham ’05 EAC (Environmental Action Committee) Co-chair, 2004-05
• Esther Tian ’05 REP Captain, 2003

Past & Emeritus Steering Group Members:
• Megha Doshi ’04 REP Captain, 2004
• John Hsu ’03 EAC Co-Chair, 2002
• Rachelle Gould ’03 REP Founder, Captain 2002-2003, and Co-Chair, EAC, 2002-2003
• Zach Liscow ’05 EAC Co-Chair, 2003-2004
• Wendy Liu ’03 REP Captain 2002
• Alexandra McNitt Director, Marketing & Communications Harvard University Dining Services
• Steve Quinlan ’04 EAC Co-Chair, 2003

Emily Sadigh ’99 REP Coordinator, 2002-2004
Appendix 3.3

Renewable Energy Project Case Studies

Graduate Student Housing – One Western Avenue
Harvard Real Estate Services has purchased a two year contract that will provide 3,990,000 kilowatt-hours of Renewable Energy Certificates annually in order to offset the Western Avenue graduate student housing electricity usage. The addition of clean energy to the building’s list of green features earned this project key points as it achieved LEED Silver Certification.

Business School – Shad Hall Solar Array
Last fall, an ambitious student-initiated project at the Harvard Business School led to the installation of a 192 panel photovoltaic array above Shad Hall – the second largest of its kind in Boston. The 36 kilowatt installation prevents the emission of about 75,000 lbs of CO2 per year.
To learn more about the Shad Hall Photovoltaic Panel Project, including the funding sources and grant proposal, visit the web site.

Harvard College – Quincy House
Beginning in Earth Day 2004, Quincy House ran exclusively off of wind power for a week and prevented the emission of about 25 tons of CO2 gas. The funds were raised through equal contributions from Quincy residents (1/3), the House masters (1/3), and the Undergraduate Council (1/3). This project, led by Dave Thompson, Tutor for Quincy House, earned the Quincy House a prize in the HGCI/FAS Resource Efficiency Program Green Cup Challenge. For more information on the project, visit the Quincy House Wind Project web site.

Kennedy School of Government
In February, 2004, students at the Harvard Kennedy School of Government voted to pay $5 each semester on their term bills to purchase clean power accounting for 100% of the school’s electricity load. Through this process, KSG would have had approximately $9,000 annual fund with which to purchase renewable energy.
The KSG Administration has been extremely supportive in putting this decision into effect; the KSG Administration had originally volunteered to purchase the difference to bring the purchase up to 100% wind energy. Now, in fact, the Administration is "giving back" the money to the students and in fact is making the entire purchase from its operations budget to satisfy 100 percent of its electricity needs through clean energy.

University Operations Services – Diesel Fleet
Biodiesel began fueling the 25 diesel vehicles in Harvard’s fleet during Spring 2004 as the University Operations Services constructed its very own biodiesel filling station. The 20% soybean oil, 80% diesel oil blend promises to reduce the emissions of particulates and greenhouse gases. The University will save an estimated 15 cents per gallon with biodiesel over the cost of diesel fuel at retail pumps.
Work first began on this project in Summer 2001 when the HGCI secured funding from the Ford Foundation to research alternative fuel vehicles. By the end of this summer research project, the team had uncovered that biodiesel out-performed conventional gasoline, diesel fuel, compressed natural gas and electric vehicles in relation to net environmental impact and cost. University Operations Services, Transportation Services was so impressed with this research that they became seriously committed to bringing biodiesel to Harvard University. Over an 18 month period, a trial was undertaken, an assessment of fuel access and storage options was conducted, all necessary approvals were gained and an onsite facility established. For more information, visit the UOS Transportation Services website.

School of Public Health
The Harvard School of Public Health has purchased wind energy certificates to offset 50% of the electricity of all buildings at HSPH's main campus and additionally Shattuck International House and the Landmark Center 4th Floor West. In Shattuck, the certificates were funded specifically through energy savings generated by the students in response to the Longwood Campus Energy Reduction Program's Go Cold Turkey campaign, which prompted students to pledge to turn off lights, heat and appliances during the Thanksgiving holiday break and beyond. In Landmark, the purchase was specifically part of an effort to achieve LEED certification for the office buildout. For more information on the purchase of renewable energy at the Harvard School of Public Health, visit the Renewable Energy section of the Longwood HGCI website.

Harvard Medical School
Five HMS buildings have won wind energy in Go Cold Turkey 2004: Vanderbilt Hall, 160/164 Longwood, Countway Library, Gordon Hall and TMEC won wind energy certificates for 25-percent of their electrical load from January 05 to the end of December 05.

Faculty of Arts and Sciences
Ten buildings at FAS have won wind energy in Go Cold Turkey 2004: Paine Hall, 38 Kirkland Street, 1705 Mass Avenue, Eliot House, Quincy House, Weld Hall, 3 Sacramento Street and Farlow Hall. Certificates for about 1,500,000 kWh of electricity will be purchased for these buildings, an amount equivalent to 50-percent of their annual consumption.
Appendix 3.4

Leadership in Energy and Environmental Design (LEED) Certification Support

The LEED (Leadership in Energy and Environmental Design) Green Building Rating System has quickly become the number one green building standard in the United States, with projects in 11 countries worldwide, and all fifty states in the US. As of April, 2004, LEED has certified 105 projects, and registered 1300 projects. LEED Certification requires a full commitment from the project team at the earliest stages in the design process. Team members must commit to achieving a range of building performance goals and following LEED submission guidelines. The HGCI provides the following services to support design teams in their efforts to achieve LEED certification:

- The provision of language for initial design team RFPs
- Basic training and education of design team to support LEED
- Early Design Team Charrettes to identify design solutions and approaches
- Allocation and Oversight of team data collection and submittal responsibilities for LEED
- Assistance in registering projects with the USGBC for future certification
- Ongoing evaluation of project to assess LEED performance
- Review of design to assess opportunities for improvement
- Administration of the LEED application process

LEED is a very useful tool for sustainable building design at Harvard. However, LEED alone is not enough. LEED works best when:

- Design teams are selected on the basis of their previous environmental design experience,
- Sustainability commitments are made at pre-design,
- Clients undergo extensive education about green building design (including tours of local examples)
- Design charrettes are used to explore team based design solutions
- Adequate time is put into researching, modeling and thoroughly considering alternatives to standard design solutions
- Full life cycle costing is undertaken and
- The integrated performance of building systems are considered

The HGCI has gained much experience in managing LEED projects at Harvard. This experience has been invaluable for Harvard as it grows its capacities for green building design.

Past and present HPBS-led LEED projects include:

- Western Avenue (LEED Silver)
- Landmark Center
- 90 Mt. Auburn Street
- Schlesinger Library
- Mather/Dunster Kitchen Renovation
The HGCI works to encourage the wide-scale incorporation of LEED standards across Harvard University while also offering direct support and assistance for addressing other elements that have proven to be pivotal to the success of any LEED project.

**Building Management Profile and Occupant Surveys**

Building profiles serve as a tool to document vital building management and utility consumption information. In general, building profiles capture the following information:

- Historical utility consumption
- Current utility consumption
- Management and budgeting structures
- Current contract specifications and protocols
- Vendors and partners in the building's operations
- Occupant demographics and schedules
- Historical changes in building use and capital projects

**Energy Conservation Measures Project Identification**

Energy Conservation Measures (ECMs) are projects that yield clear energy savings, and are funded based on payback periods and returns on investment. The HGCI will identify "low hanging fruit" ECMs, which have quick payback periods, as well as ECMs that will benefit the building's longer term life-cycle.

A partial sample of "low hanging fruit" ECMs include:

- Lighting upgrades
- Motor replacement
- Variable Speed Drive installation
- Insulation and air sealing
- Simple HVAC controls (time clocks, outside air sensors, thermostats, self-actuating valves)

A partial sample of longer term life-cycle ECMs include:

- Building envelope upgrades (green or cool roofs, windows, wall insulation)
- Energy Management Systems (Direct digital control, centralized computer software)
- HVAC upgrades or replacements

**Green Campus Loan Fund and Rebate Analysis**

All projects reviewed by the HPBS will be screened for Green Campus Loan Fund (GCLF) and NSTAR rebate eligibility.

Projects that are eligible for a GCLF meet the following criteria:

- Conservation as a major project focus
- Energy or material savings payback of five years or less - either as single projects or as bundled projects
NSTAR has allocated over $500,000 to Harvard per year for energy efficiency rebates. Since 2001, Harvard has earned over $480,000 in rebate money. NSTAR offers prescriptive, comprehensive, and other rebates for energy efficient lighting fixtures, controls, high-efficiency mechanical equipment, and other energy saving strategies. Up-to-date information is available at http://www.nstaronline.com/your_business/solutions.asp.

**High Performance Contract Language, Specifications and Guideline Support**

The HGCI evaluates opportunities to institutionalize new protocols in contract language, specifications, and guidelines that support high performance building operations. Service contract specifications define the products and/or services that contractors supply for an organization. Contracts that specify requirements for environmentally-preferred products and services are a powerful way to institutionalize environmental best practices, while sending a clear message to your business partners that you have made a strong commitment to moving toward sustainable operations. Specifications can be highly technical, broad and “principle driven,” and/or defined by pre-established product certifications and best practices. Each organization must decide which approach or approaches are most appropriate for them. The HGCI uses GreenSpec specification guidelines that were developed by buildinggreen.com.

**Training and Education**

High performance building technologies and management strategies are continually changing and evolving. Keeping up with the latest trends can be a daunting task even for the most seasoned professionals. To this end, the HGCI offers a variety of high performance training and education services that are directly applicable to on-the-job needs.

Key training seminars include:
- LEED Workshops
- Peer to Peer High Performance Training Seminars
- Building Operator Certification Courses

Key educational materials include:
- HGCI High Performance Building Management Toolkit (PDF: 1316k)
- HGCI Building Performance Assessment Methods
- Technology Reviews

**LEED Workshops**

HGCI occasionally organizes private LEED workshops (Leadership in Energy & Environmental Design) on site, which are provided by the USGBC (US Green Building Council <http://www.usgbc.org>). The LEED rating system is fast becoming the standard green building rating system in the US. The workshop may be taken as a precursor to taking the LEED exam and becoming LEED certified, or simply to learn about green building design. The workshop also counts towards 7 AIA HSW continuing education credits. Following is an overview of the material that is covered:
- **LEED at Harvard** A brief overview of LEED projects undertaken at Harvard University, key lessons learned and in-house resources available.
• **Introduction to LEED** This section will provide an overview of the concept of green design, outline the benefits, and use case studies to demonstrate core concepts and strategies.

• **LEED Technical Review** We will discuss how the LEED rating system is designed to quantify the benefits discussed in the previous section. Each credit within the five environmental categories in the LEED rating system will be presented, summarizing the technologies and strategies for achievement.

• **LEED Resources and Process** We will discuss the LEED resources available to workshop attendees, including the referenced standards list, documentation requirements, the LEED Reference Guide, the LEED technical support website, the LEED accreditation exam study guide, and other LEED program materials.

• **LEED in Practice** This section of the workshop will review how to integrate LEED into your practice, and how to manage the LEED process.

• **LEED Rating System** The LEED Green Building Rating System version 2.1 is the second edition of the standard that improves environmental and economic performance of new construction. We will discuss the five environmental categories covered in the rating system.

**Peer to Peer High Performance Training Seminars**
The HGCI recently launched a peer to peer high performance training program with Harvard Real Estate's University and Commercial (U&C) group. Peer to peer learning models are designed to give staff an opportunity to train their peers on topics of their own expertise. Emphasis is placed on teaching from real examples of projects that staff have initiated or participated in.

**Northeast Energy Efficiency Partnerships (NEEP) Building Operator Certification Courses**
The Building Operator Certification (BOC) course is a competency-based training and certification for building operators designed to improve the energy efficiency of commercial buildings. Certification is offered at two levels: Level I emphasizes energy efficient building systems maintenance, while Level II focuses on equipment troubleshooting. For more information on NEEP and the BOC course, visit the [NEEP or BOC web page](#).

**High Performance Project Management**
The HGCI offers professional project management to implement high performance building projects. Project management services typically include:

- Budget development and administration
- Development of requests for proposals (RFPs)
- RFP response review and vendor selection
- Contract writing and management
- Project team facilitation
- Project closeout
Environmental Procurement Support

The HGCI has developed a User's Guide to Environmental Procurement that provides a list of products and procurement practices that have been tested and proven to be successful and cost effective at Harvard Real Estate Services. This guide is a "living document", a direct product of four Harvard Green Campus Initiative internships. Indirectly, it is the product of innumerable contributors, encompassing all the purchasers, vendors, researchers, and consultants who have worked alongside the interns and HRES staff to improve the environment through their daily actions. The Guide is continuously being updated.
Appendix 3.5

Harvard University
Statement of Sustainability Principles

Introduction

Harvard University contributes to the global environment and human well being in several important ways. Through its primary mission of research, education and outreach, Harvard’s faculty have made significant advances in science, economics, public policy, design, medicine and public health. The University’s academic preeminence and respect throughout the world also provides a considerable opportunity and responsibility to consider the example set by the economic, human health, and environmental performance of its campus. Harvard also influences generations of students whose future behaviors and decisions are shaped by what they learn from their campus experience and the actions of the University’s leaders.

The University has an affirmative record of responsible compliance with environmental and safety regulations and a proven effective system of environmental management accountability. As Harvard plans its future growth, these considerations should support planning decisions that reflect a balance of economic, environmental, and socially responsible values.

The following principles are intended to guide Harvard’s practices toward sustainability through the management of building design, construction, renovation, procurement, landscape, energy, water, waste, emissions, transportation, human health and productivity.

Sustainability Principles

Harvard University is committed to developing and maintaining an environment that enhances human health and fosters a transition toward sustainability. Sustainability should be advanced through research, analysis, and experience gained over time. To that end, Harvard University is committed to continuous improvement in:

• **Demonstrating institutional practices that promote sustainability**, including measures to increase efficiency and use of renewable resources, and to decrease production of waste and hazardous materials, both in Harvard’s own operations and in those of its suppliers.
• **Promoting health, productivity and safety** of the University community through design and maintenance of the built environment.
• **Enhancing the health of campus ecosystems** and increasing the diversity of native species.
• **Developing planning tools** to enable comparative analysis of sustainability implications and to support long-term economic, environmental and socially responsible decisionmaking.
• **Encouraging environmental inquiry** and institutional learning throughout the University
community.

- **Establishing indicators for sustainability** that will enable monitoring reporting and continuous improvement.

**Implementation Framework**

In order to be successful over the long term, decisions concerning human health and sustainability must be economically sound and seamlessly integrated with established management and financial systems. The initial implementation plan for the University’s Sustainability Principles is based on four closely related tracks:

I. **Capital Planning and Construction** - The University’s capital planning and approvals process for new construction and major renovation of existing campus facilities will be expanded to incorporate the Sustainability Principles in its review. Each school and administrative department proposing a capital project will be required to establish specific objectives consistent with the Principles as part of the formal approval process for capital projects, as is done currently for numerous other priority financial, technical and regulatory issues.

II. **Annual Financial and Budget Planning** - The University’s annual budget planning process will include explicit recognition of the Sustainability Principles in the commitment of operating funds. As part of its internal annual financial plan, each School and Department will be requested to set specific goals and to report on how expenditures for facilities, support services, procurement and other activities are consistent with the University’s commitment to continuous improvement towards campus sustainability.

III. **Supporting the Schools and Departments** - The University will continue to invest in support systems for sustainability, such as the Harvard Green Campus Initiative (HGCI), to facilitate the implementation of the Sustainability Principles by providing schools and administrative departments with: a clearinghouse of proven planning tools, guidelines, preferred technologies, products and design solutions; campus specific research and innovation; cost effective financial incentives; training and expertise; assistance in meeting planning and reporting requirements; and a means of facilitating broad community engagement.

IV. **Broad-based Continued Review** – Recognizing that the concepts of sustainability will evolve over time through experience, research, economic analysis, and technological advances, the University will continue the work that led to the development of the Sustainability Principles by appointing a standing sustainability advisory group consisting of members of the faculty, administration and student body. This group will be charged with advising in the development of sustainability indicators, monitoring progress and providing recommendations for improving the Sustainability Principles and Implementation Framework.
### Appendix 3.6

**Office Depot® & Environmental Programs Task Force (EPTF) Quick Reference Recycled Products Office Listing**

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<th>Description</th>
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<th>U/M</th>
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<tr>
<td>945901</td>
<td>EA</td>
<td>51645A remanufactured ink cartridge</td>
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<tr>
<td>753761</td>
<td>EA</td>
<td>51645A refill ink cartridge, black</td>
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<td>EA</td>
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</table>

If you have questions or need further assistance, call Office Depot at (617) 253-4760 or Judi Bean at kbeau@mit.edu.

To learn more about recycling at MIT, email bc-gcproem@mit.edu.
Environmental Programs Task Force (EPTF)

How to Order Remanufactured Toner Cartridges

1) Locate your manufacturer and model on the following chart.

2) Select your product from the options listed.

3) To place your order, use the SKU #.

<table>
<thead>
<tr>
<th>OEM Manufacturer/Machine</th>
<th>OEM Mfr #</th>
<th>Office Depot Mfr #</th>
<th>Office Depot SKU #</th>
<th>Nu-kote Mfr #</th>
<th>Nu-kote SKU #</th>
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<tr>
<td>Canon Fax L700 Series, FX-1</td>
<td>CANFX-1</td>
<td>ODFX-1</td>
<td>406071</td>
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<tr>
<td>Canon Laser Class 5000 Series, FX-2</td>
<td>CANFX-2</td>
<td>ODFX-2</td>
<td>FT15R</td>
<td>844652</td>
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<tr>
<td>Canon Laser Class 8500, 9000, 6500</td>
<td>CANFX-4</td>
<td>ODFX-4</td>
<td>406391</td>
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<td></td>
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<tr>
<td>Epson ActionLaser EPL 6000 Action Laser +</td>
<td>S1B301</td>
<td></td>
<td>LT60</td>
<td>162271</td>
<td></td>
</tr>
<tr>
<td>Hewlett Packard LaserJet 4V BX/BXII Cartridge</td>
<td>C3900A</td>
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<td>LT96R</td>
<td>275879</td>
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<tr>
<td>Hewlett Packard LaserJet 5L AX Cartridge</td>
<td>C3906A</td>
<td>ODD6A</td>
<td>490821</td>
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<tr>
<td>Hewlett Packard 5P, 5MP, 6P 6MP VX Cartridge</td>
<td>C3993A</td>
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<td>406361</td>
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<td>ODD6A</td>
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<td>ODD9X</td>
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<td>ODD9A</td>
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<td>Hewlett Packard I/II/Si/NX Cartridge</td>
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<td>ODD9A</td>
<td>406151</td>
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<td>Hewlett Packard IIP/IIP LPX Cartridge</td>
<td>92275A</td>
<td>ODD75A</td>
<td>406201</td>
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<td></td>
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<tr>
<td>Hewlett Packard LaserJet 4L PX Cartridge</td>
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<td>ODD74A</td>
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<td></td>
<td>LT77R</td>
<td>521519</td>
<td></td>
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<tr>
<td>IBM/Lexmark 4019/4029 High Yield</td>
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<td></td>
<td>LT77R+</td>
<td>986429</td>
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<tr>
<td>IBM/Lexmark Optra L &amp; R 4039 Model 10+</td>
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<td></td>
<td>LT104R</td>
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<td></td>
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<tr>
<td>IBM/Lexmark Optra L &amp; R 4039 High Yield</td>
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<td></td>
<td>LT104RM</td>
<td>985500</td>
<td></td>
</tr>
<tr>
<td>IBM/Lexmark 4039 Models</td>
<td>1380850</td>
<td></td>
<td>LT87R+</td>
<td>986358</td>
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<tr>
<td>Lexmark Optra S</td>
<td>1382625</td>
<td>ODD55A</td>
<td>775181</td>
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</tbody>
</table>

Quality Guarantee

Your complete satisfaction is guaranteed on all laser cartridges. Office Depot and Nu-kote guarantee that your laser cartridges are free from defects in material and workmanship. Under normal use and storage, this supply is guaranteed to perform to your complete satisfaction.

More cartridges than listed here may be available. For more information or if you have questions on how to order remanufactured toner cartridges call:

Office Depot at (617) 253-4760

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Appendix 3.7

RECYCLE WHAT?

What CAN be recycled at MIT?

- Newspapers
- Catalogs
- Memos
- File folders
- All Paper
- Glossy paper
- Phonebooks
- Carbonless forms
- Colored paper
- Magazines
- Post-It-Notes
- Broken down cardboard
- White paper
- Junk mail

*****Paper products cannot be contaminated with food/beverage*****

Commingles

- Aluminum cans & foil
- Glass bottles
- Plastics (1 – 7)
- (1-7- usually appears on the bottom of container)

****Commingles need to be empty, but do not need to be cleaned****

Computer Monitors / CRT’s / Electronics*

(Cathode Ray Tubes)

- Computer Monitors
- Electronic Equipment
- Televisions

*To recycle your CRT’s or for more information about MIT’s recycling program please contact <recycling@mit.edu>

The Environmental Programs Task Force (EPTF) is sponsored by the Environmental Programs Office and the Managing Director for Environmental Programs and Risk Management/Senior Counsel and has an Institute-wide membership. If you would like to join the Task Force or if you have questions about any of the EPTF’s environmental initiatives, please visit Information at www.mit.edu/environment or Get Involved, Email <be-green@mit.edu>
Appendix 3.8

Summary of Lighting Controls Energy Investment Opportunity at MIT

I. Classrooms

2. Assume each occupancy sensor installation in a classroom saves $73.24\text{year}$ (see attached payback analysis).
3. Assume that 25%(60) of all classrooms already have occupancy sensors.

Projected savings = 241 x 0.75 x $73.24\text{year} = $13,238\text{year}.
Projected Investment Required: 241 x 0.75 x $250 = $45,187.

II. Lab Space

1. Lab Space: 1,374,352 square feet; 3,209 labs, lab support spaces.
2. Assume each occupancy sensor installation in a lab saves $101.57\text{year}$ (see attached payback analysis).
3. Assume that 25% of all labs already have occupancy sensors.

Projected savings = 3,209 x 0.75 x $101.57\text{year} = $244,453\text{year}.
Projected Investment Required: 3,209 x 0.75 x $250 = $601,688.

III. Office Space

1. Office Space: 1,944,938 square feet; 9,128 offices, office support spaces.
2. Assume each occupancy sensor installation in an office saves $34.61\text{year}$ (see attached payback analysis).
3. Assume that 25% of all offices already have occupancy sensors.

Projected savings = 9,128 x 0.75 x $34.61\text{year} = $236,940\text{year}.
Projected Investment Required: 9,128 x 0.75 x $125 = $855,750.

IV. Public Toilet Rooms

1. Public Toilet Rooms: 89,000 square feet; 581 public toilet rooms.
2. Assume each occupancy sensor installation in a public toilet room saves $32.80\text{year}$ (see attached payback analysis).
3. Assume that 10% of all toilet rooms already have occupancy sensors.

Projected savings = 581 x 0.90 x $32.80\text{year} = $17,151\text{year}.
Projected Investment Required: 581 x 0.90 x $205 = $107,195.
Summary of Lighting Controls Energy Investment Opportunity at MIT

Total Program Potential Annual Savings: $511,782
Total Program Initial Investment: $1,609,820
Overall Program Payback Period: 3.14 years.
Appendix 4.1

Table 4.1 Qualitative comparison between two approaches

<table>
<thead>
<tr>
<th>ORGANIZATION</th>
<th>ECOLOGICAL FOOTPRINT - MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANNING RESOURCE MANAGEMENT</td>
<td>ACADeMIC PROGRAM</td>
</tr>
<tr>
<td>Statement</td>
<td>Staff</td>
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<tr>
<td>MIT</td>
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<tr>
<td>HARVARD</td>
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</tbody>
</table>

Codification:
- These are the minimum important aspects for the start of a green campus initiative (with focus on resource management).
- This color means none to little done by the specific University according to this study.
- This Color means that it is being done but not as part of a general formal program.
- This color means that it forms part of a general formal program.
Table 4.2 Quantitative data required for the evaluation of performance

<table>
<thead>
<tr>
<th>ECOLOGICAL FOOTPRINT - ACTIONS</th>
<th>AIR</th>
<th>WATER</th>
<th>SOLID WASTE</th>
<th>ENERGY</th>
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<tbody>
<tr>
<td>1. GHG Reduction Baseline</td>
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<tr>
<td>2. Carbon Segregation</td>
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<tr>
<td>3. Emissions Compliance</td>
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<td>4. Storm Water Reuse</td>
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<tr>
<td>5. WWT &amp; Reuse</td>
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<tr>
<td>6. Water Use</td>
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<tr>
<td>7. Recycle</td>
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<tr>
<td>8. Energy Use</td>
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<tr>
<td>9. Energy Intensity</td>
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<table>
<thead>
<tr>
<th>SO₂</th>
<th>NOₓ</th>
<th>CO</th>
<th>PM</th>
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<table>
<thead>
<tr>
<th>Paper</th>
<th>Aluminium</th>
<th>Plastic</th>
<th>Glass</th>
<th>Heating</th>
<th>Cooling</th>
<th>Lightning</th>
<th>Labs</th>
<th>Dorms</th>
<th>Acad Area</th>
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Note: Here follows the variable and/or unit per given number in the table.

1. % Reduction or % of Goal
2. (Ton CO₂/year seq.) / (Ton CO₂ emitted /year)
3. % below regulatory standard
4. % of storm water collected and reuse:
   (Roof Surff.[m²] * Percip.[mm/year]) = [m³/year]
5. % of waste water treated and reused
6. Lt/day/student or Lt/dia/m² of green area
7. % of wastes recycled + $ revenues
8. kWh /student and/or kWh/ m²
9. kW/ m² Labs, kW/student in dorms etc.
References

- 1-6 Understanding and addressing the complexity of energy efficiency.Policy framework.
- University Leaders for Sustainability Future (2001), Lüneburg Declaration Presented to United Nations Secretary-General Kofi Annan.ULSF’s The declaration v. 5, no, 1 December. 3 pages.
- Massachusetts Climate protection plan


• Environmental Program Task Force (EPTF) annual report 2003, issued by the Environmental Health and Safety office, MIT Cambridge USA.