

2008

UC Berkeley

Campus Sustainability



University of California,
Berkeley

October 2008

Introduction

The [Chancellor's Advisory Committee on Sustainability \(CACS\)](#) was created in 2003 to promote environmental management and sustainable development on campus. An early initiative of CACS was the [2005 Campus Sustainability Assessment](#) that established a baseline for measuring progress toward sustainability and provided guidance for future actions.

The Assessment was designed to be a living document. In that spirit, the Office of Sustainability has worked with CACS and others around campus to compile an update that captures progress since 2005 toward becoming more sustainable. We are pleased to share the results of this update and are particularly encouraged by the progress the University has made towards addressing its carbon footprint, as well as the reductions in water and waste and the numerous innovative projects of faculty, students, and staff. The campus has also made strides toward incorporating sustainability into broader policies and plans. The "Statement of Our Commitment to the Environment" is a prime example (see page 3). Another has been the creation of the new Office of Sustainability.

This Assessment update takes a slightly different approach from its 2005 predecessor. The topical sections that follow provide important metrics and include existing campus goals for these areas. Relevant benchmarks as reported by other universities are also presented. These benchmarks are an unscientific attempt to provide information on what other universities have accomplished. Unless otherwise noted, the data presented is from the Cal Climate Action Partnership (CalCAP) and the campus greenhouse gas emissions inventory. A simple milestone system shows how well the campus has implemented the opportunities identified in the 2005 Assessment. The report also showcases a few relevant academic courses and successes in each area; more information on these and other courses can be found at enviro.berkeley.edu.

The Office of Sustainability undertook the task of updating the 2005 Campus Sustainability Assessment as a way to compile information on project-level accomplishments and metrics and on progress toward goals set by the campus. It has been a busy three years on campus, and this updated assessment documents the numerous achievements on campus. The Office of Sustainability is committed to regularly measuring and reporting our overall progress toward a more sustainable campus. The Assessment may include additional metrics in the future, especially as more research is done. Its main contribution, though, will be to provide accurate and transparent data and to be the basis for continued campus discussion.



Lisa McNeilly

UC Berkeley Director of Sustainability

<http://sustainability.berkeley.edu/OS/>

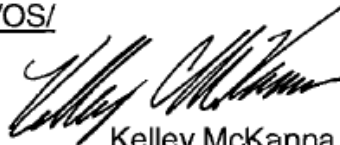

UNIVERSITY OF CALIFORNIA, BERKELEY Office of Sustainability



Jonathan Winters

Chancellor's Advisory Committee on Sustainability Co-Chairs

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Kelley McKanna



Introduction

Opportunities Achieved Since 2005

The 2005 Assessment listed opportunities -- in each of the nine original categories -- to improve sustainability on campus in both the short and long term. These were suggestions based on the data, information, and technology available at the time and were not formal commitments. However, many of these proposals have been accomplished or are underway. Each section that follows includes a milestone that is meant to give a rough, qualitative evaluation of the implementation of the suggestions. Projects were defined as complete if 90% or more of the goal had been met; projects that are planned and moving forward or are in progress are defined as “partially completed”; and projects are defined as “not completed” if no tangible actions have been made to implement it. Additional information on these opportunities is contained in Appendix A. A small number of recommendations were determined to be no longer feasible and were dropped from the milestones.

Acknowledgments

We would like to recognize all of those who contributed to this report, while acknowledging that any errors or omissions remain our responsibility:

Kelley McKanna, TGIF Campus Research Associate, primary author and investigator

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The Green Initiative Fund (TGIF) for their generous support

The report also relied heavily on multiple campus stakeholders for up-to-date information on projects and initiatives and for reviewing the document and providing comments. Thanks to the following for their time and attention:

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Karen Salvini

Matt St. Clair

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CE 292A Technologies for Sustainable Societies

UNIVERSITY OF CALIFORNIA, BERKELEY

Statement of our Commitment to the Environment

University of California, Berkeley students, faculty, and staff are committed to taking a leadership role as responsible stewards of the physical environment and to using educational and research activities to promote environmental awareness, global thinking, and local action. This commitment includes:

- Protecting and enhancing the campus environment;
- Purchasing environmentally preferable products, minimizing the use of toxic substances, and handling wastes responsibly;
- Conserving natural resources through their sustainable use in building projects, transportation, and campus operations;
- Significantly reducing campus greenhouse gas emissions;
- Conducting innovative research on sustainable technology and practices;
- Increasing awareness of these values through instruction and example; and
- Collaborating with a diverse and engaged campus community on these issues to help fulfill the University's mission.

We are making this commitment because:

- UC Berkeley is a world leader in education and research, and must also be a leader in environmental stewardship;
- Realizing these values will create a healthier educational and work environment;
- Resource conservation helps save valuable resources for future generations and lowers operating expenses; and
- Our commitment serves as the foundation of a system to assess, prioritize, and implement campus environmental programs and sustainability initiatives.

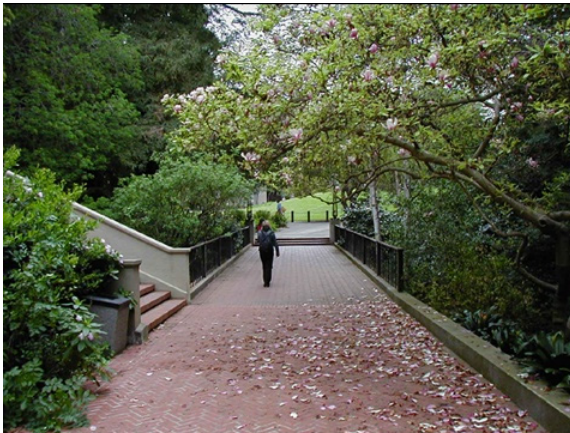
By embracing these values and integrating them into all University activities, we can better fulfill the University's mission of teaching, research, and public service.

November 29, 2007

Executive Summary

Is the University of California, Berkeley, more sustainable than in 2005? This campus assessment is an attempt to answer that question. The campus has made progress in each of several key areas, and has done well at completing or initiating opportunities identified in the 2005 Assessment. In fact, over half of them were completed, with an additional 30% partially achieved. By setting goals and measuring success, we will continue to ask whether we have made progress and report the results regularly.

The University has made great progress on **climate action** by completing an inventory of greenhouse gas emissions (GHG) and formalizing its commitment to reduce these emissions. In April 2007, soon after the release of an extensive Climate Action Feasibility Study, Chancellor Birgeneau adopted the [Cal Climate Action Partnership \(CalCAP\)](#) goal to reduce GHG emissions to 1990 levels by 2014. The inventory process also generated data in several areas – going back to 1990 – for many of the topical areas covered in this Assessment, allowing a longer look back on the impacts and changes in that time period.



UC Berkeley has and will continue to pursue **energy efficiency and conservation** as a way to reduce the campus' energy footprint. Facilities Services is developing a [Strategic Energy Plan](#) (SEP) and has committed to a suite of projects that could reduce emissions by up to 23,000 metric tons carbon equivalent. Electricity usage has grown by 37% since 1990, but by just 1% since 2005. This slowing growth reflects the efforts made by the University to improve energy efficiency and reduce greenhouse gas emissions.

Even without a campus-wide **water conservation** target campus consumption has dropped 6% since 1990. Most of this improvement can be attributed to the increased efficiency of irrigation.

The University is now embracing [the US Green Building Council's Leadership in Energy and Environmental Design \(LEED\)](#) building ranking system by seeking certification for new construction and existing buildings. The first UC Berkeley LEED certified project was the [Haste Street Child Care Development Center](#). The Center received a Silver rating and opened in Spring 2008. The campus has plans to certify ten buildings under the New Construction (NC) or Commercial Interiors (CI) category and four under the Existing Building Operations and Maintenance (EBOM) category.

UC Berkeley's current solid waste **diversion rate** is 57% (including construction waste). The campus has also significantly improved its diversion of organic waste, increasing the tonnage composted by over 100% since 2000, when the program began. The campus has continued to decrease the amount of waste sent to landfills despite a growing population. The per capita tonnage of landfill waste has actually decreased 21% between 1995 and 2006.

Executive Summary

[Parking & Transportation](#) has instituted numerous programs to reduce the number of commutes made in single occupant vehicles, including the release of the first [Campus Bicycle Plan in 2006](#). The percentage of staff that commute by public transit has more than doubled since 1990, while 92% of students commute to campus by foot, bike, ridesharing, or transit. Since 2005, the number of alternate fuel vehicles in the campus fleet has tripled.

[Cal Dining](#) has increased the amount of **local and organic food** that is purchased and offers 100% organic salad bars in all four dining commons. Cal Dining has also partnered with [“Buy Fresh Buy Local”](#) and committed to buying at least 10% local produce with a goal of 25%. In fact, 18.9% of Cal Dining’s total purchases were sustainable – either local, organic, fair trade, or humane. All four dining commons have received [Green Business certification](#) and organic certification. Waste has also been reduced through composting and other measures, takeout packaging is compostable, and waste oil is turned into biodiesel.



The campus has implemented projects to improve **stormwater quality** and reduce stormwater runoff. The [Grinell Glade](#) was redesigned to divert parking lot runoff through a series of vegetated treatment systems to reduce the pollutants reaching the creek. Strawberry Creek is now monitored to provide realtime water quality data online. Sections of the riparian corridor around the creek have been restored by volunteers from the community, who remove invasive species and plant natives.



Sustainability Goals

The campus has set numerous sustainability-related goals, although none were created as a result of this Assessment. The goals come from four sources and are identified as follows:

CalCAP – [Cal Climate Action Partnership](#)¹

UCOP -- [University of California “Policy on Sustainable Practices”](#)²

LRDP -- [UC Berkeley’s 2020 Long Range Development Plan](#)³

SCMP – [Strawberry Creek Management Plan](#)⁴

Energy and Climate

- Reduce greenhouse gas emissions to 1990 levels by 2014 (CalCAP)
- Reduce growth-adjusted energy consumption by 10% by 2014 (UCOP)
- Procure 20% of electricity from renewable sources by 2010 (UCOP)
- 10 Megawatts of local renewable power by 2014 system-wide (UCOP)

Water

- Minimize water consumption of buildings (LRDP)

Built Environment

- All new buildings must be at least 20% more efficient than [Title 24](#) (California’s building energy efficiency requirements) (UCOP)
- UC will design and build all new buildings except lab and acute care facilities to the minimum standard of LEED 2.1 certified equivalent (UCOP)
- Design and build all new labs to minimum LEED 2.1 certified equivalent and Labs 21 EPC (UCOP)
- Renovation projects with cost of \$5 million or more should at minimum comply with UC equivalent to LEED commercial interiors certified rating and register with Savings by Design program (UCOP)
- Minimize energy consumption of buildings through commissioning, efficiency upgrades, and the installation of renewable energy components (LRDP)

Waste

- 50% diversion rate by June 2008 (UCOP)
- 75% diversion rate by June 2012 (UCOP)
- Zero waste by 2020 (UCOP)

Purchasing

- Multiple Environmentally Preferable Purchasing Practices (UCOP), including:
 - Standard of 30% post consumer waste (PCW) recycled content paper
 - Uncut paper, including janitorial supplies, will be 100% PCW recycled content
 - Preferential purchase of Energy Star appliances
 - Purchasing decisions should be made that minimize packaging waste and consider lifecycle assessment
 - Work to phase in Green Seal Products

Land Use Impacts

- Improve the health of Strawberry Creek (SCMP)
- Improve the quality and reduce amount of runoff (LRDP)
- Increase the number of natural spaces and native plants (LRDP)
- Reduce the number of pesticides, herbicides and fungicides used (LRDP)
- No increase in impervious surfaces (LRDP)
- Reject remote campus development (LRDP)

Transportation

- Reduce drive alone rate (LRDP)
- Increase student campus housing and housing accessible by transit (LRDP)
- Continue to improve transportation measures (LRDP)
- Expand parking but will not build out to maximum if bus rapid transit comes to Berkeley (LRDP)

Sustainability Metrics

Annual Sustainability Metrics for UC Berkeley

	1990	1995	2000	2005	2006	2007
Electricity (kWh)	153,681,818	171,709,091	185,666,952	207,652,458	212,827,845	210,113,723
Steam (MMBtu)	844,972	894,828	938,135	1,005,500	1,022,150	1,075,650
Natural gas (MMBtu)	153,091	162,123	155,331	244,009	238,879	197,750
Carbon Dioxide Equivalent (metric tons)	~165,000	167,647	259,801	275,973	205,090	207,215
Water Purchased (millions of gallons)	504.2	507.3	491.0	453.0	502.0	475.3
Wastewater Generated (millions of gallons)	382.2	346.0	328.5	317.1	359.6	332.1
Landfill Waste (short tons)	6,973	7,187	6,637	6,532	6,364	6,689
Diversion Rate	nda	21%	33%	34%	34%	57%
Percentage of faculty and staff that drive alone ³	60.0%	49.1% (in 1996)	51.3%	51.3%	47.1%	47.1%
Percentage of students that drive alone	10.7% (in 1992)	12.8% (in 1997)	10.7%	8.0%	8.0%	8.0%
Population ¹	44,120	43,509	45,565	47,884	48,700	49,138
Square Footage ²	12,817,517	13,520,471	14,145,728	14,827,825	15,464,279	15,675,971

nda= No data available

¹ Includes students, faculty, and staff.

² Square footage for 1990 is assumed to be the same as square footage for 1991.

Source: Facilities & Spatial Data Integration at UC Berkeley, <http://fasdi.berkeley.edu/>

³ Campus transportation surveys conducted every few years and data is assumed to be unchanged from prior survey

Energy & Climate

The [Intergovernmental Panel on Climate Change \(IPCC\)](#), which includes many Berkeley faculty, has concluded that the planet is experiencing warming due to anthropogenic causes⁵, focusing attention on the need to reduce greenhouse gas (GHG) emissions. Consequently, climate change – and energy – have become a preeminent issue for many governments, organizations and institutions, including UC Berkeley. The international importance of the issue is demonstrated by the joint awarding of the Nobel Peace Prize to Al Gore and the IPCC for work related to addressing climate change.

The Cal Climate Action Partnership (CalCAP) Steering Committee was convened by Vice Provost Catherine Koshland in early 2006 in response to growing student advocacy for climate action and with support from CACS. As a result of the Steering Committee's recommendations, UC Berkeley has completed an inventory of its GHG emissions and an emissions reduction feasibility study, and joined the California Climate Action Registry, a voluntary greenhouse gas registry. These inventory results and the findings of the feasibility study led Chancellor Birgeneau to commit the UC Berkeley campus to reducing its GHG emissions to 1990 levels by the year 2014, the equivalent of reaching California's AB 32 goals (the state law setting climate change reduction and reporting requirements) six years early.¹ The campus also signed the [American College and University Presidents' Climate Commitment in 2007](#)⁶.



The majority of campus greenhouse gas emissions result from steam and electricity usage in buildings (see Figure 1). The University has taken steps to reduce building energy since the 1980s, but growth in usage has outpaced efficiency efforts. Since 1990, electricity use has increased three times as fast as population, likely due to the increases in air conditioning, computing, and other technology-driven energy demands. Electricity usage has grown by 37%



since 1990, but by just 1% since 2005. GHG emissions per capita have increased 16.2%, while the ratio of carbon to building square footage has only increased 5.8%, further implying that much of the increase in energy demand is due to increases in technology, instead of a growing student body or faculty and staff presence (see Figure 2). While the campus' purchased electricity is relatively low carbon, the only on-site renewable energy generation is the [59 kW PV system installed in 2003](#) on the roof of the Martin Luther King Jr. Student Union Building.

The University is currently finalizing a Strategic Energy Plan (SEP), which is expected to reduce emissions from energy usage by up to 40%. The campus is eligible for significant grants and rebates from Pacific Gas and Electric to do energy efficiency work through a [statewide UC/CSU/IOU partnership](#). Such rebates will be used to fund lighting retrofits, monitor-based commissioning of buildings, steam trap replacements, and other work.

Energy & Climate

Lighting retrofits are a key energy-saving strategy and include audits, replacements of bulbs and ballasts, the addition of better occupant controls and motion sensors, and the installation of LED exit signs. Recent retrofits have been completed in 30 buildings and resulted in a savings of 572,155 kWh per year.

It is very important that buildings function as designed, or significant energy may be wasted. To ensure that campus facilities are performing optimally, Facilities Service has expanded the number of buildings that are re-commissioned from four a year to ten a year. The majority of buildings (about 60%) are monitored as part of the centralized energy management system, allowing facilities to track energy use. Within the next six years, all major campus buildings will be commissioned and will have real-time metering installed to enable energy management. Other projects that are completed or in progress include HVAC retrofits, upgrades of high-energy use buildings, and the replacement of steam traps.

Figure 1: UC Berkeley Emissions by Source, 2007

Emissions Sources	CO ₂ equivalent (metric tons)	Percentage Contribution
Steam (co-generation)	85,436	41%
Purchased Electricity	61,443	30%
Air Travel	20,991	10%
Faculty & Staff Auto Commute	17,433	8%
Natural Gas	10,470	5%
Student Commute	3,736	2%
Fugitive Emissions – Refrigeration	3,517	2%
Water Consumption	1,955	1%
Solid Waste	981	<1%
Campus Fleet	1,253	<1%
TOTAL EMISSIONS	207,215	100%

Energy & Climate

Figure 2: Annual Energy Usage and Greenhouse Gas Emissions at UC Berkeley, 1990-2007

	1990	1995	2000	2005	2006	2007	Growth Rates, 1990 to 2007
Electricity (mWh)	153,681.8	171,709.1	185,666.9	207,652.5	212,827.9	210,113.7	36.7%
Steam (MMBtu)	844,972	894,828	938,135	1,005,500	1,022,150	1,075,650	27.3%
Natural gas (MMBtu)	153,091	162,123	155,331	244,009	238,879	197,750	29.2%
CO₂ equivalent³ (metric tons)	~165,000	167,647	259,801***	275,973***	205,090	207,215	25.6%
Population⁴	44,120	43,509	45,565	47,884	48,700	49,138	11.4%
CO₂ per capita (metric tons)	3.648	3.853	5.702	5.763	4.231	4.237	16.2%
Square footage⁵	12,817,517	13,520,471	14,145,728	14,827,825	15,464,279	15,675,971	22.3%
CO₂ / sq. ft (lbs)⁶	25.11	24.80	36.73	37.22	26.65	26.56	5.8%

³ The significant increase in CO₂ emissions in the years 2000 through 2005 is due to the use of electricity from Arizona Public Services (APS), which uses more coal in their power mix than the current provider, Pacific Gas and Electric.

⁴ Includes students, faculty, and staff.

⁵ Square footage for 1990 is assumed to be the same as square footage for 1991. Source: [Facilities & Spatial Data Integration at UC Berkeley](#).

Energy & Climate

Current University Goals

- Reduce greenhouse gas emissions to 1990 levels by 2014 (CalCAP)
- Reduce growth-adjusted energy consumption by 10% by 2014 (UCOP)
- Procure 20% of electricity from renewable sources by 2010 (UCOP)
- 10 Megawatts of local renewable power by 2014 system-wide (UCOP)

Assessment Milestone: Opportunities Achieved Since 2005

(See appendix A for more information)

Completed	4
Partial (late stage)	2
Partial (early stage)	4
Not Completed	0

The early stage is defined as roughly less than 50% completed, whereas late stage is greater than 50% (but less than 100%) completed.



Related Academic Courses

ER 299 CalCAP Action Course: Brings together interested students to study the projects currently being considered for implementation under CalCAP, identify new projects the campus might undertake, and to move them forward through action-oriented research.

ER 100/200 Energy and Society: An introduction to the technology, politics, economics, and environmental effects of energy in contemporary society.

ER 199 Applications of Energy Efficiency and Conservation: Students perform energy audits and analyze energy consumption in campus buildings to create and implement an energy plan for that building.

ER 98/198 Energy 101 Decal: Focused on energy conservation, climate change, alternative energy and fuels, and sustainable living.

Energy & Climate

Dashboard

Two UC Berkeley graduate students recently were awarded \$76,750 from the [Green Initiative Fund \(TGIF\)](#) to develop a campus dashboard. A dashboard is a centralized database and website that aggregates a common and consistent set of resource consumption data (electricity, water, steam, etc.) for the campus. The information can be easily accessed by a diverse set of data consumers (students, researchers, building managers, and analysts) to support tracking of individual project impacts and to inform and motivate building residents. The dashboard will be accessible to the campus community online, as well as at kiosks on the campus (possibly in Wurster Hall and at the Free Speech Movement Café). A dashboard may also be installed at the Clark Kerr Campus Residence Halls, as part of a renovation.

Green Campus

The [Berkeley Green Campus program](#) strives to educate students, staff, faculty, and the local community about the importance of energy conservation and achieve substantial energy savings by implementing projects on the main campus and in the residence halls. Recent efforts include several student classes, Shut the Sash campaign, Vending Miser Expansion, Haas Energy Challenge, lightbulb and CRT monitor exchanges, “Blackout Battles” energy competitions in dorms, and Residence Hall Staff Outreach. Since it began in 2004 Green Campus programs have saved \$191,000 in avoided energy costs. Green Campus is a program run by the Alliance to Save Energy funded by PG&E and a grant from the Chancellors Advisory Committee on Sustainability (CACS).

Benchmarking

Figure 3 compares greenhouse gas emissions at other universities, using data reported in the [California Climate Action Registry](#) (i.e., only the direct emissions from stationary and mobile combustion and the indirect emissions from electricity and heating). UC Berkeley’s emissions are relatively low compared to some other institutions, in part due to our mild climate and the low-emissions electricity from our utility. UC Santa Cruz, however, is dramatically lower because of renewable energy credits purchased via student fees⁷. Another institution – Oberlin College in Ohio – gets 50% of its electricity from renewable sources purchased from their local utility⁸.

Figure 3: Annual Greenhouse Gas Emissions at Other Universities, 2006

University	Emissions (metric tons carbon equivalent)	Number of Students	Campus area (million sq. ft)
UC Berkeley	158,287	34,953	15.68
UC Santa Cruz	39,560	15,820	4.83
UCLA	235,248	38,218	n/a
Stanford	165,453	19,782	13.1

Source: California Climate Action Registry for 2007. Accessed 9/19/08

<https://www.climateregistry.org/CARROT/public/reports.aspx>

Water is an increasingly scarce resource in California, due to population growth and drought. After two consecutive dry years, the [East Bay Municipal Utility District \(EBMUD\)](#) has declared a drought and is implementing a drought management plan⁸ that seeks a 15 percent overall reduction in water use. Water conservation is even more important when the energy associated with transportation and treatment of water is analyzed: the energy used to transport and treat water in California exceeds 15,000 GWh per year, or at least 6.5 percent of the total electricity used in the State per year⁹.

The University has succeeded in reducing water consumption by 6 percent since 1990 (see Figure 4), although usage tends to vary by year. Since the 2005 Assessment, the campus has continued to make progress, especially in irrigation (currently 10% of total water use). Facilities Services staff have continued to research new technologies that make irrigation “smarter” and have expanded the Supervisory Control and Data Acquisition (SCADA) system, which automates irrigation management, to 90% of campus. Irrigation management will be further improved by a [“weatherstation”](#) that will provide the SCADA system real-time or predicted weather information so that grounds are not over watered. [Physical Plant and Campus Services \(PP-CS\)](#) has begun using numerous technologies to ensure that water is not wasted in irrigation. These include simple measures like replacing plastic valves, which tend to crack and leak, with brass, as well as introducing more efficient sprinklers and testing the efficacy of drip irrigation.



Reclaimed water is not yet a viable alternative to potable water since the EBMUD reclaimed water line does not extend all the way to campus, however, non-potable well water is being used for some applications. At University Village in Albany, the site is “double plumbed,” meaning that it has adequate piping to use grey water for irrigation, however reclaimed water is not being used at the site. The most feasible option for the central campus to use reclaimed water for irrigation or other purposes might require on-site waste water treatment. At the time of the 2005 assessment such a project was under consideration, but due to funding and logistical issues was not implemented. Efforts are currently underway by faculty in the College of Environmental Design and the College of Engineering to resuscitate this effort.

The majority (approximately 65%) of water used serves campus buildings, including laboratories and restroom facilities. UC Berkeley has many higher flow toilets and urinals – up to 69% of toilets and 81% of urinals were not low flow according to a [2005 audit](#)¹⁰. There are few records of how many toilets have been replaced with new models since that time, but in general toilets are only replaced during full bathroom renovations. Most retrofits have involved standard low flow fixtures (1.6 gpf toilets and 1 gpf urinals), but not more efficient appliances such as dual flush toilets, waterless urinals, and super low flow fixtures (like 1/8 gpf urinals and 1.2 gpf toilets).

Water

The remainder of campus water usage is in the steam cogeneration plant, cooling towers, and swimming pools. There are leaks in the physical plant steam condensate system due to the combination of an aging infrastructure and insufficient maintenance resources that adds a small amount to campus water consumption.

Figure 4: Annual Water Usage at UC Berkeley, 1990-2007

	1990	1995*	2000	2005	2006	2007
Water (millions of gallons)	504.2	507.3	491.0	453.0	502.0	475.3
Wastewater (millions of gallons)	382.2	346.0	328.5	317.1	359.6	332.1

* Estimated

Current University Goals

- Minimize water consumption of buildings (LRDP)

Assessment Milestones: Opportunities Achieved Since 2005

(See appendix A for more information.)

Completed	4
Partial	3
Not Completed	3



Related Academic Courses

CP290D/ER291-02 Sustainable Water Recycling: This course explores the feasibility of water recycling and beneficial nutrient reuse for the campus, using Wurster Hall as a pilot.

EEP 162 Economics of Water Resources: The course covers the economics of water resources, with special emphasis on areas such as California where water is a scarce resource. The aim is to teach both about economic tools – how economists go about analyzing key aspects of water policy – and also about the specifics of water in the US West – what has been learned by applying these tools to water issues in the region.

Benchmarking

Figure 5 compares water usage at several comparably-sized universities. While Berkeley's water consumption has dropped over the last two decades, there are still numerous opportunities for further reduction. Examples employed by other universities include [Oberlin's "living machine"](#) water treatment plant. The Living Machine is an ecologically engineered system that combines elements of conventional wastewater technology with the purification processes of wetland ecosystems to treat and recycle the building's wastewater. The treated water is reused in toilets and irrigation¹¹, however the machine also has a significant energy impact. Closer to home, Stanford has implemented a comprehensive ["Water Conservation, Reuse and Recycling Master Plan"](#)¹² and reduced daily water consumption to 0.5 MGD (millions of gallons daily). This plan is based on new water saving technologies, including plumbing retrofits, replacement of once-through cooling systems in laboratories with re-circulating systems that reuse the cold water to maximize cooling capacity, and water reclamation for irrigation and flushing toilets.

Figure 5: 2006 Water Use at Other Universities, in Millions of Gallons per Year

University	Water Usage	Usage per student
UC Berkeley	502.0	0.0136136
Cal Poly SLO	158.7	0.0080036
Stanford	802.9	0.0537064
UW Oshkosh	60.9	0.0047872

Sources:

Sustainable Stanford site <http://sustainablestanford.stanford.edu/water>;
[University of Wisconsin Oshkosh Sustainability Plan](#), February 2008;
[Second Biennial Progress Report 2008-Sustainability at Cal Poly Facilities and Operations](#)

Built Environment

In the United States, buildings account for 36% of total energy use, 65% of electricity consumption, 30% of greenhouse gas emissions, 30% of raw material use, 30% of waste output (136 million tons annually), and 12% of potable water consumption.¹³ Constructing greener buildings is a complex undertaking and can require that decision makers consider the life cycle costs of materials, integration of green features in the early design phase, and holistic design of systems.

The Berkeley campus contains a diverse set of buildings including offices, classrooms, libraries, residences, and laboratories. Laboratories in particular have high energy and water loads relative to office buildings, and may produce significant toxic and non-toxic waste. The planned expansion of new research facilities on campus will make it challenging to reduce the university's



environmental impacts. In spite of these challenges, UC Berkeley is committed to constructing buildings that are certified LEED or equivalent, and the campus Strategic Energy Plan will continue to make existing buildings more efficient. The campus has completed its first LEED Silver (New Construction) certified building (the Haste Street Child Development Center) and has plans to certify 10 more new buildings projects and four existing buildings (under the LEED-EBOM program).

Holistic, integrated design is crucial to the creation of sustainable buildings. A “green building” cannot be built by simply adding sustainable components to a prior design. Instead it is important to involve the entire design team early in the process. The architectural design should be integrated with the design of the mechanical, electrical, and plumbing systems. Early planning sessions, called eco-charrettes or Integrated Design Workshops, have become a key part of a project's design process and seek to address many of these challenges. These exercises bring together all relevant parties – from future occupants to staff stakeholders – with the design team to discuss the building program and how best to integrate sustainability features. In addition to choosing which LEED credits to pursue, some projects also develop sustainability goals that support and integrate the project program. The Graduate Assembly and ASUC recently received a grant from the Green Initiative Fund (TGIF) to support an expanded eco-charrette for the Lower Sproul Plan that will involve students extensively in the planning process.

Capital Projects has made many achievements in mitigating the end phase impacts of buildings. The concrete, rebar, and metal generated during a demolition represents a tremendous amount of waste if not diverted, so campus requires that a minimum of 50% construction waste be diverted. Recent projects have actually achieved diversion rates of over 90%, so that requirement is being raised. Berkeley has also recently instituted a condition that all contractors should strive to achieve both possible LEED credits in this area. The campus design standards have also been updated to reflect green building requirements for paints, finishes and carpeting. These are all important steps toward institutionalizing sustainability at all stages in the lifecycle of buildings.

Built Environment

Building projects at UC Berkeley have also received several awards and recognitions of exemplary performance in several green building areas. In 2006, the new Early Childhood Education center received a [Best Practice Award for its Integrated Design Process](#). In 2007, [LeConte Hall Renovation](#) received a [Best Practices Award](#) for their exemplary reuse of building materials, and the University Housing Redevelopment project was given an Honorable Mention for its overall Sustainable Design. And in 2008, the design of the new Li Ka Shing Biomedical building was acknowledged with a [Best Practice Awards for HVAC Design](#).

Current University Goals

- All new buildings must be at least 20% more efficient than [Title 24](#) (California's building energy efficiency requirements) (UCOP)
- UC will design and build all new buildings except lab and acute care facilities to the minimum standard of LEED 2.1 certified equivalent (UCOP)
- Design and build all new labs to minimum LEED 2.1 certified equivalent and Labs 21 EPC (UCOP)
- Renovation projects with cost of \$5 million or more should at minimum comply with UC equivalent to LEED commercial interiors certified rating and register with Savings by Design program (UCOP)
- Minimize energy consumption of buildings through commissioning, efficiency upgrades, and the installation of renewable energy components (LRDP)

Assessment Milestones: Opportunities Achieved Since 2005

(See appendix A for more information.)

Completed	5
Partial	5
Not Completed	0



Built Environment

Related Academic Courses

Building ES 84 Building Sustainability at Cal: Student perform water and waste audits in campus buildings, creating a Sustainability Plan of Action that considers both long-term and short-term projects and can help building inhabitants reduce their impacts.

ARCH 245 Daylighting Analysis Using Physical Models: Daylighting analysis using physical models as a vehicle for the investigation of daylight in architectural space, including issues of photometric measurement, qualitative assessment, temporal variability, and presentation technique.

ARCH 243 Natural Cooling and Ventilation: Course focuses on a wide range of passive cooling strategies, including solar control, natural ventilation, radiation, evaporation and earth-contact cooling and their treatment in architectural design.

Center for the Built Environment

[CBE](#) is a collaboration between researchers and industry whose mission is to improve the design, operation, and environmental quality of buildings. This group of UC Berkeley researchers has been able to directly apply their research to work on campus. For example, a system of wireless lighting controls was piloted in an open space office building and resulted in a 65% reduction in associated energy use. The technology has now been commercialized, and the campus is planning installations in two libraries.

Haste St Child Development Center LEED Silver

The Child Development Center is UC Berkeley's first LEED certified building. The building is very energy efficient, exceeding Title 24 energy requirements by 40%; is constructed of materials that are healthful and ecologically sound, free of harmful chemicals, VOCs, pesticides or other undesirable agents; and is designed to provide good indoor air quality, thermal comfort, and reduce maintenance and replacement costs.

Benchmarking

The use of the LEED certification system as a measure of the sustainability of buildings is increasingly popular. Harvard has built or is in the process of building 19 LEED certified buildings, of which one is platinum and 11 are gold. Harvard also has 17 LEED-Commercial Interior buildings (one Platinum, six Gold) either finished or under construction. Since LEED was started as a new construction standard, some universities have focused on making existing buildings more sustainable. In three years, the University of British Columbia (UBC) upgraded and retrofitted nearly 300 of its core buildings. UBC has exceeded its goal of reducing energy use by 20% and water use by 30%. This increased efficiency will save UBC at least \$2.6 million each year in electricity, steam, and water costs. It will also have reduced its greenhouse gas emissions by 15%. (Sources: UBC Sustainability Report 2006-2007; Harvard Green Building Resource <http://www.greencampus.harvard.edu/theresource/guidelines/> accessed 9/19/08)

Waste

Solid waste is a growing problem in this country and has multiple environmental impacts. Waste that is not recycled or composted must be transported to landfills for disposal, and there is also an associated carbon footprint—from the methane generated when waste degrades and the emissions produced through transport. The campus has steadily increased the amount of waste that is diverted from landfills through recycling and composting (see Figure 6), but still has room for improvement.

UC Berkeley has made significant progress in increasing the amount of organic waste that is composted, increasing the tonnage composted by nearly 50% since 2005 and 100% since 2000. The campus continues to increase the amount of material recycled, although a significant amount of mixed paper is still not being recycled. The campus has made huge strides in salvaging demolition and construction wastes and has been able to salvage upwards of 80%-90% of such waste. Capital projects contractors have not always tracked precise metrics associated with waste in the past, but new project contracts include a requirement that waste must be tracked and that there be a 50% minimum diversion rate. It is expected, however, that contractors will divert at least 75% of waste in order to achieve LEED points. Including construction waste in the UC Berkeley diversion rate means that the campus has achieved a 57% diversion rate, exceeding the 2008 goal of 50%.

Although progress in waste management is generally measured by diversion rates, the most sustainable action is to avoid the creation of waste. [Campus Recycling and Refuse Services](#) has implemented numerous programs designed to reduce or reuse materials. These include promoting double sided printing, the creation of [green catering guidelines](#) that minimize waste, packaging material reuse programs, and programs that subsidize or provide reusable mugs and water bottles.

Figure 6: Annual Solid Waste at UC Berkeley, 1990-2007

	1990	1995	2000	2005	2006	2007
Landfill Waste (short tons)	6,973	7,187	6,637	6,532	6,364	6,689
Diverted: Recycled + Composted (short tons)	nda	1,704.82	3157.19	3209.65	3219.47	8,866.81
Recycled Waste* (short tons)	nda	1,704.82	2,374.02	2,141.34	1999.95	7,266.88
Composted Waste (short tons)	nda	nda	783.17	1068.31	1127.47	1599.93
Diversion rate	nda	21%	33%	34.%	34%	57%
Population**	44,120	43,509	45,565	47,884	48,700	49,138
Landfill waste per capita (tons)	0.158	0.165	0.146	0.136	0.131	0.136

Source: Personal Communication with Lisa Bauer, July 8, 2008

*This value reflects all non organic composting (i.e., paper, bottles, and cans and demolition waste in 2007).

** Equal to students, faculty, and staff.

Waste

Figure 7: Annual Hazardous Waste at UC Berkeley, 1998-2006

	1998	2002	2006
Hazardous Waste	125,776	61,042* (131,175)	63,042
Extremely Hazardous Waste	1,214	3,526	244

Source: Hazardous Waste Source Reduction and Management Review SB 14 for UC Berkeley produced by UC Berkeley Environmental Health and Safety Division

*There was a significant change in methodology for tracking hazardous waste in 2002. The number in parentheses is the value that was calculated using the previous methodology.

Current University Goals

- 50% diversion rate by June 2008 (UCOP)
- 75% diversion rate by June 2012 (UCOP)
- Zero waste by 2020 (UCOP)

Assessment Milestones: Opportunities Achieved Since 2005

(See appendix A for more information.)

Completed	3
Partial	3
Not Completed	1

Wurster Hall Energy and Waste

This student initiated project was funded through the Chancellor's Green Fund Grant. The small grant award was used to recycle usable architectural supplies, instead of being discarded at the end of the semester by students under pressure to vacate studios. Collected supplies can now be given to next semester's incoming architectural students free of charge. This program included significant outreach to building occupants, including the creation of art from used coffee cups to demonstrate the magnitude of the waste.

LeConte Hall Renovation Award

The LeConte Hall project was awarded a "Best Practices in Sustainability Award" from the California Energy Efficiency Partnership Program 2007 for its achievements in materials reuse. The renovation was designed with reuse as a priority. The construction diagrams specifically listed materials and building components to be reused. Architects then designed a database of parts for reuse. Components were retained whenever possible but otherwise were reserved for use elsewhere on campus, salvaged and recycled, or donated.

Benchmarking

Figure 8 shows the diversion rates that are possible in higher education. Hampshire College is an example of how purchasing policies can impact waste streams. Starting in July 2003, Hampshire College began purchasing 100% post consumer content, 100% processed chlorine free recycled paper to "[be used campus wide on all convenience copiers and office printers whenever possible](#)".¹⁵ The [Zero Waste Program](#) at UC Davis implements strict guidelines to ensure that virtually all materials from an event are recycled, composted, or reused. Since its inception in March 2004, there have been about 70 zero waste events held on campus, some of which include Picnic Day and Relay for Life. One interesting feature of the program is the availability of Zero Waste kits, 100% recyclable or compostable materials for events including disposable dishes, cutlery, cups and bags for disposal. This program is one of many that have enabled Davis to maintain a diversion rate above 50% for the past 8 years¹⁶.



Figure 8: Annual Diversion Rates at Other Universities

University	Diversion Rate	Year
UC Berkeley	57%	2007
British Columbia	42%	2006
UC Santa Cruz	32.3%	2006
Stanford	61%	2007
Harvard	52%	2007

Sources: [UCSC Sustainability Site](#), accessed 9/19/08; Stanford Recycling Site [recycling.stanford.edu](#), accessed 9/19/06; Personal Communication with Robert Gogan at Harvard 9/25/08; [AASHE Campus Profile for University of British Columbia](#), accessed 9/19/08.

Purchasing

Environmental preferable purchasing (EPP) involves buying products that have a smaller environmental impact than comparable products. They may have a reduced manufacturing footprint such as recycled products, lower operating impact such as [Energy Star®](#) appliances, or a smaller disposal impact because of reduced packaging. The practice of computing the production, operation, and disposal costs and impacts – or life cycle assessment – is an important tool when making purchasing decisions so that the total cost of ownership is included.

UCOP has taken leadership on EPP and has included a rigorous set of guidelines concerning campus purchasing. UCOP is also striving to use the combined purchasing power of all ten UC campuses to achieve economies of scale. The UCOP standards obligate Berkeley to consider the lifecycle cost of purchases and prioritize the purchase of products which are reusable or recyclable, which have minimal packaging, and products that will be “taken back” by manufacturers at the product end of life. At Berkeley, efforts are underway to operationalize the goals, and have included the introduction of [Sustainable Copy Paper Guidelines](#). Even before these guidelines had been released, the campus had already reduced its use of non-recycled content copy paper by half (from 70% to 35% of total). In 2007, almost half of the total purchases of janitorial supplies from main suppliers were classified as green.

Current University Goals

- Multiple Environmentally Preferable Purchasing Practices (UCOP), including:
 - Standard of 30% post consumer waste (PCW) recycled content paper
 - Uncut paper, including janitorial supplies, will be 100% PCW recycled content
 - Preferential purchase of Energy Star appliances
 - Purchasing decisions should be made that minimize packaging waste and consider lifecycle analysis
 - Work to phase in Green Seal Products

Assessment Milestones: Opportunities Achieved Since 2005

(See appendix A for more information.)

Completed	3
Partial	4
Not Completed	0

Benchmarking

Quantifying and consolidating purchasing metrics and goals is difficult. Most organizations instead focus on a few areas for improvement, such as office supplies or electrical equipment. Princeton has committed to purchasing 100% [Green Seal](#) or equivalent cleaning products and 100% recycled disposable paper products by 2009. They have also committed to require the purchase of energy star appliances when available and develop a Life Cycle Assessment program to evaluate the footprint of the product supply chain. Yale has proposed the use of the following indicators to evaluate their operations: Appliance Energy Efficiency, Recycled Paper Purchasing, and Chlorine free paper purchasing. (Sources: [Princeton University Sustainability Plan](#), [Yale Sustainability Metrics](#))

Transportation

Transportation is major issue in the Bay Area. The prevalence of single occupant vehicles creates congestion, increases land demand for parking, is responsible for 50.6% of the Bay Area's greenhouse gas emissions¹⁷, and contributes to the compromised air quality in the region. Most transportation in the Bay Area is powered through the combustion of fossil fuels. The pollutants from this combustion reduce visibility and have negative health effects upon humans and other organisms. The Bay Area suffers from poor air quality and failed to attain California air quality standards for ozone and particulate matter in 2007¹⁸.

Transportation is the second largest greenhouse gas emission source on campus after buildings (about 22%). The campus fleet has made significant progress in increasing the amount of partial zero emissions vehicles (PZEVs) and other alternative fuels vehicles (AFVs). The University now has 46 vehicles that are AFV or PZEV – a 229% increase since 2005 (see Figure 9). Campus Refuse and Recycling Services also has one biodiesel fueled garbage truck and has plans to expand the use of biodiesel to others in the near future.

Figure 9: Composition of UC Berkeley Campus Fleet 2005 versus 2008

	2005	2008
Total vehicles	608	595
Gasoline	516	527
Diesel	31	20
Total AFV	14	46
Compressed Natural Gas	1	2
E85 flex-fuel	0	13
Electric	12	19
Hybrid/at-pzev	0	7
Gas/pzev	0	5
Solar Vehicle	1	0
Bicycle	0	3

Sources: UC Berkeley 2005 Campus Sustainability Assessment; Personal Communication, Eric Robinson, 7/11/08.

Transportation

Another source of carbon emissions on campus are faculty, staff, and student commutes. Any changes in the modal split – specifically the reduction in commuters driving alone – may help reduce the emissions from this source. Since 2005, there have been numerous program enhancements to promote bicycling, transit, and ridesharing as alternatives to single occupant vehicle (SOV) trips. In August 2006, UC Berkeley released its first Campus Bicycle Plan to integrate planning efforts for making the campus more bike friendly and promoting bicycling as a healthy and sustainable commute mode. The campus has also improved public transit options and ride-sharing incentives.

The most notable trend from the modal split is a decrease in drive-alone rates and an increased use of transit by students, faculty, and staff. It is likely that the unlimited ride passes on AC Transit are a major factor in increasing transit use.

Figure 10: Modal Splits at UC Berkeley, 1990-2006

Faculty and Staff	1990 LRDP	1996	2001	2006
Walk	12.0%	13.5%	8.4%	7.7%
Transit	12.0%	16.7%	17.8%	24.3%
Bicycle	5.0%	8.5%	9.5%	7.5%
<i>Drive Alone</i>	<i>60.0%</i>	<i>49.1%</i>	<i>51.3%</i>	<i>47.1%</i>
Rideshare	10.0%	10.3%	9.1%	11.5%
Other	1.0%	1.9%	4.0%	1.9%
Total	100.0%	100.0%	100.0%	100.0%

Student	1992	1997	2000	2005
Walk	45.5%	55.1%	53.5%	46.8
Transit	18.8%	13.8%	23.0%	31.9
Bicycle	16.7%	14.0%	8.7%	9.4
<i>Drive Alone</i>	<i>10.7%</i>	<i>12.8%</i>	<i>10.7%</i>	<i>8.0%</i>
Rideshare	4.4%	1.6%	1.8%	2.7%
Motorcycle	2.7%	1.0%	0.7%	0.8%
Other	1.2%	1.7%	1.6%	0.4%
Total	100.0%	100.0%	100.0%	100.0%

Source: Personal Communication Kira Stoll, July 2, 2008 (based on campus surveys).

Transportation

Air travel is the largest component of Cal's transportation emissions (10% of total) and has continued to grow since 2005. Long distance travel is vital to much of the mission and the research of the University, and there are few alternatives besides video and teleconferencing.

Figure 11: Air Travel at UC Berkeley, 2005-2007

	2005	2006	2007
Distance traveled (km)	56,372,081	80,322,335	81,924,710
Total campus trips	24,074	27,824	28,535
Total CO ₂ emissions (metric tons)	17,715	20,475	20,998

Assessment Milestones: Opportunities Achieved Since 2005

(See appendix A for more information.)

Completed	5
Partial	1
Not Completed	3

Related Academic Courses

CE 155 Transportation Systems Engineering: Focuses on operation, management, control, design, and evaluation of passenger and freight transportation systems.

CY Plan C114 Introduction to Urban and Regional Transportation Planning: This course is designed to introduce students to the characteristics of urban transportation systems, the methods through which they are planned and analyzed, and the dimensions of key policy issues confronting decision makers.

CY Plan C216 Transportation Finance: This course will explore the economic and financial dimensions of urban transportation systems, including highway finance and user fees, toll financing and congestion pricing, transit finance, and fare and subsidy policies.

Transportation

UC Berkeley Green Bike Share

Two Berkeley students received funds from the “Bears Breaking Boundaries” contest to start a bikesharing program on campus. The pilot program began Fall of 2008 with 20 bikes. The [Green Bike Share](#) seeks to make the quality of student life better by giving students affordable, environmentally sustainable, and increased access to bicycles; a healthy alternative form of transportation. The project also includes bike advocacy work, a two unit course on Bike Sharing, maintenance teach-ins, and other bike-related services (maps, tours, etc.).

Benchmarking

Many other campuses are also working to reduce the impact of transportation. At Michigan State University, all farm equipment and diesel trucks are powered exclusively by biodiesel. They also run a bike service center that rents “green bikes” and provides bike services like maintenance, repair, and information. The Transportation Demand Management program at Stanford includes incentives and services for employees who agree not to



drive alone to work. Benefits include cash payments for not driving (Clean Air Cash), guaranteed rides home in case of illness or other emergencies, rideshare matching services, vanpool subsidies, pretax payroll deduction for transit passes and commuter checks, complimentary daily parking passes for those who carpool, and reserved parking spaces for all carpools and vanpool. The TDM program further supports a transportation alternative to single-occupant vehicles via passes for free use of local transit and Caltrain by university employees. (Sources: [Michigan State University 2007 Campus Sustainability Report](#); Michigan State University Bikes Website, accessed 9/25/08; [Stanford Parking and Transportation Website](#), accessed 9/25/08.)

Food & Dining

Food and dining – like purchasing – is an area where there are few metrics yet many different paths to sustainability. On campus, Cal Dining has made tremendous progress towards greening their food supply, operations, and disposal. They have made a commitment to sourcing local and organic food when possible and have formed an alliance with Buy Fresh Buy Local to purchase at least 10% and strive for 25% local produce. Cal Dining is already preferentially purchasing local and super local foods, up to 60% of local in-season produce is produced within a 16 mile radius. In fact, 18.9% of Cal Dining’s total purchases were sustainable – either local, organic, fair trade, or humane. Cal Dining received the nation's first organic certification on a college campus in March 2006. The first organic salad bar was launched in Crossroads dining commons in April 2006 and now all four dining halls (including Clark Kerr, Foothill, and Café 3) are certified and have 100% organic salad bars as well. Cal Dining offers abundant vegetarian and vegan options and was named the third most vegetarian friendly campus in the nation.¹⁹

Cal Dining has mitigated the footprint of its operations by improving the efficiency of water and energy use, limiting the use of toxics, and increasing the diversion of waste. They have tracked and documented these improvements in order to become certified as an Alameda County Green Businesses for all four dining commons. Much of the waste produced by Cal Dining is organic and is composted. All waste oil is turned into biodiesel. Cal Dining even provides composting services to students outside of the dining halls for pizza boxes and to-go containers (which are made of bagasse and compostable).

Assessment Milestones: Opportunities Achieved Since 2005

(See appendix A for more information.)

Completed	9
Partial	0
Not Completed	1



Related Academic Courses

IAS 171 Internship in Agroecology and Sustainable Development: Students work in selected internships in non-profit, government agencies, or farmer networks associated with the Brazilian Consortium on Agroecology and Sustainable Development.

EEP 141 Agricultural and Environmental Policy: This course considers the formation, implementation, and impact of public policies affecting agriculture and the environment.

ESPM 117 Urban Garden Ecosystems: An ecosystem approach to the study of urban gardens with an organic perspective. Topics include fundamentals of horticulture, soil properties and fertility, pest and disease management, and food preservation.

Food & Dining

The Society for Agriculture and Food Ecology (SAFE)

[SAFE](#) is a student group dedicated to creating a dialogue about truly sustainable food systems. The group's activities include the organization of films and lectures regarding food systems and also the publication of a zine and a website dedicated to the issue.

The Local

The ASUC Sustainability Team created and currently runs [The Local](#), the first ever UC Berkeley student cooperative selling organic vegetables and fruit on campus. The stand offers affordable produce once a week and will possibly expand to twice a week in the fall of 2008. The Local offers convenient sustainable food choices, but is also a launching point for educational efforts about sustainable food systems.



Benchmarking

Given the relative lack of common metrics for sustainable dining, providing useful benchmarks is difficult. UC Santa Cruz purchases 13% of its food locally, with 23.8% organic. Stanford composts at all facilities and has one green business certification. Princeton University purchases 20% food is from "sustainable" sources, and Oberlin estimates that around one-third of its food is local. (Sources: 2007 UCSC Campus Sustainability Assessment, [Stanford Dining Website](#), accessed 9/19/08; [Sustainability at Princeton Website](#), accessed 9/19/08; [Oberlin Sustainability Site](#), accessed 9/19/08)

Land Use Impacts

UC Berkeley operations have direct impacts on local air quality, water quality, and ecosystems. In order to mitigate these effects, the University strives to limit its use of toxics, dispose of such toxics in a responsible manner, limit airborne emissions, improve the quality of stormwater runoff, and restore native species and ecosystems on campus in the Strawberry Creek Riparian Corridor and off-site at the Richmond Field Station prairie and marsh.



The University continues to make progress in implementing non-toxic methods to control pests in and around structures by using Integrated Pest Management (IPM). IPM relies upon understanding the biology of pests in order to inhibit pest inhabitation and breeding and also using natural compounds to deter pests. Since the 2005 Assessment, pest management personnel have explored methods such as the use of low concentration boric acid to control ants, working with landscape architects to limit plants habitable by rodents, using sprays of peanut oil and cloves

to control insects, and exploring heat instead of chemical fumigation.

Stormwater runoff from paved surfaces and grounds may contain heavy metals, hydrocarbons, and pesticides that could impact the riparian ecosystem in Strawberry Creek and pollute the runoff that flows through storm drains to the San Francisco Bay. If surfaces are paved with permeable materials or runoff is diverted from a catch basin into a vegetated area, the water can be purified of contaminants as it percolates through the ground, reducing both the amount and toxicity of runoff. Two main campus parking lots, Wellman and Dwinelle, were re-designed to use permeable pavement and vegetated catchment areas to mitigate the runoff to Strawberry Creek. In addition, the Botanical Gardens entrance is serving as a demonstration project of permeable concrete.

[Grinnell Glade](#) is an example of well-integrated sustainable design. The redeveloped glade includes a weather sensitive irrigation system that conserves water, and systems to compare underground irrigation with overhead spray. The new lawn and storm water retention basin capture and treat runoff from nearby impermeable surfaces to water pollutant loading and flows to Strawberry Creek.

The UC Berkeley central campus is located in the greater Strawberry Creek ecosystem and the creek is the central landscape feature of the campus park. The campus is committed to protection and enhancement of this ecosystem through repairing historical impacts of urban development and through implementation of LEED recommended design of new buildings. Regular monitoring of Strawberry Creek water quality and flow was enhanced by the installation of three hydrological monitoring stations in 2007. The data collected from these stations is available in real time on the [Strawberry Creek website](#) and will be used to alert staff of deviations in quality so that actions can be taken to address causes.

Land Use Impacts

Beginning in the winter of 2005-06 the campus commenced its most ambitious habitat restoration project to date: the [Grinnell Natural Area Native Biodiversity Restoration Project](#). This multiyear project of weed removal and native plant re-vegetation along the banks of Strawberry Creek will provide improved habitat for other flora and fauna and contribute to improved aesthetic conditions, water quality, and educational opportunities. Over five hundred UC Berkeley, Berkeley High School, and local elementary school students have participated in this project.

Since the 2005 Assessment, the campus has restored approximately one acre of rare upland coastal prairie at the Richmond Field Station (RFS) and continues to implement a marsh restoration program that has led to restoration of five acres of tidal salt marsh.

Current University Goals

- Improve the health of Strawberry Creek (SCMP)
- Improve the quality and reduce amount of runoff (LRDP)
- Increase the number of natural spaces and native plants (LRDP)
- Reduce the number of pesticides, herbicides and fungicides used (LRDP)
- No increase in impervious surfaces (LRDP)

Assessment Milestones: Opportunities Achieved Since 2005

(See Appendix A for more information.)

Completed	4
Partial	0
Not Completed	6

Related Academic Courses

CE 212 Water Quality Engineering: Addresses principles and engineering applications of technical processes for water and wastewater treatment, and water reclamation.

ESPM 135 Biological Control of Pests: Study of various host-parasite, prey-predator systems, especially those of significance to agriculture, forestry, urban, and recreational environments. Implementation of biological control methods involving importation, augmentation, and conservation of natural enemies.

Benchmarking

The University of British Columbia has a pesticide-free policy for all of the grounds on campus, meaning that no artificial herbicides, pesticides or other chemicals can be used until all other options have been exhausted. The policy has only been broken to protect rare, heirloom varieties as a last resort measure. (Source: [UBC Sustainability Report 2006-2007](#))

Academics & Learning By

The campus seeks to educate students about sustainability in addition to reducing its environmental impacts. Assessing the ‘student outcome’ – what has been learned both inside and outside a classroom – is a difficult but important aspect of the UC Berkeley sustainability program. There are over 20 student groups actively working on sustainability-related issues, and a large number of sustainability courses and majors. Some sustainability classes and projects are highlighted in other sections and show the breadth of campus involvement and engagement.

More broadly, there are two constituent groups for campus sustainability. The first and obvious group is the advocates of sustainability. The members of this group are the students, faculty and staff that are actively engaged with the issue and may study the issue, belong to a student group, or simply be proactively pursuing related initiatives. This group continues to grow at Cal: students are engaged in various advocacy groups, staff continue to incorporate sustainable practices, and faculty receive Nobel prizes for their participation with the IPCC. It is important that the University continue to expand its support for such individuals.

Yet, it is impossible to assume that the campus will ever be comprised solely of sustainability advocates. The campus has historically been characterized by its plurality, and members of the campus community will continue to pursue political reform, social justice, labor advocacy, and innumerable other important issues. Outreach to the broader campus – to achieve a threshold level of environmental literacy – is also an important part of campus sustainability. The aim would be to engage the wider campus on recycling, energy and water conservation, and other sustainability initiatives. The interest level from this group is growing and is evidenced by the fact that 69% of the campus voted for TGIF, a student fee initiative that is used to fund on campus sustainability grants.

Assessment Milestones: Opportunities Achieved Since 2005

(See Appendix A for more information.)

Completed	4
Partial	2
Not Completed	2

CACS Internships

The Chancellor's Advisory Committee on Sustainability sponsors several sustainability internships each year to work on a variety of projects to accomplish sustainable development and environmental management goals. Through a competitive process, 10-15 internships are awarded campus groups to support student labor for a variety of projects. Preference is given to initiatives that address opportunities identified by the 2005 Campus Sustainability Assessment or the goals of the Cal Climate Action Partnership (CalCAP).

Academics & Learning By

TGIF Initiative

The Green Initiative Fund (TGIF) passed in the 2007 Associated Students of the University of California (ASUC) Election at UC Berkeley with 69% of the vote. TGIF was a student-led initiative that will generate roughly \$200,000 per year for 10 years through a \$5/semester student fee increase. The Fund will be used to further UC Berkeley's environmental sustainability and expects to support projects that increase the energy efficiency of campus operations, lower greenhouse gas emissions, and contribute in other ways to improving environmental quality. The first grants were awarded in April 2008.

UC Berkeley Environment and Sustainability Portal

With over 400 environmental courses, some 300 faculty, 86 academic degree programs, and dozens of research centers and campus groups working in the fields of environment and sustainability, UC Berkeley is among the world's largest environmental research and teaching centers in the world. Organizing the breadth and depth of this work is a challenge that requires collaboration among these multiple campus units. The [UC Berkeley Environment and Sustainability Portal](#), is a content management system that allows faculty, staff and student organizations to easily share information about their respective programs, providing up-to-date one-stop-shopping for environmental resources at UC Berkeley. Previous versions of this website, dating back to 2006, were maintained by the Berkeley Institute of the Environment, with initial financial support from CACS. Sustainability course information is available at this site.

Related Academic Courses

CE 292A Technologies for Sustainable Societies: The goal of this course is to investigate important technologies that serve major societal needs. The presentations will be framed from the perspective of how technologies do or do not contribute to a move towards sustainability. Elements in the following systems may be considered: buildings, manufacturing, water, food, energy, and transportation.

Engineering and Business for Sustainability (EBS) Certificate: This certificate program is a new initiative to train UC Berkeley graduate students to understand the complexity and urgency of their role in engineering, business, and environmental management, and to work across boundaries to achieve sustainable solutions to pressing societal problems. EBS courses will allow graduate students to tap into the university's vast multidisciplinary educational resources. The goal of the EBS Certificate Program is to produce a cadre of influential problem solvers who can have a lasting beneficial impact on the global environment. The EBS Certificate Program is the first certificate program approved at the highest campus level under formal campus guidelines established in 2006. It has also been approved by the College of Engineering.

Benchmarking

There are several universities who have also started to include sustainability more explicitly in their curricula. At Arizona State University, the Global Institute of Sustainability offers bachelor's degrees in sustainability. The University of California at Irvine also offers a Minor in Global Sustainability. A long list of campuses have also begun the efforts needed to add sustainability courses and majors. (Source: [AASHE Academic Programs in Sustainability Site](#), accessed 9/19/08)

Potential Future Research

General

What is the campus definition of sustainability?

Investigate sources and amounts of financial resources available for sustainability.

Energy & Climate Change

How many staff have attended training addressing energy efficiency and conservation?

What is the relative energy intensity of building uses (e.g., lighting, HVAC, plug loads, computers)?

What are the wind (or other renewable) resources on or around campus and how should the campus decide which to install?

Are there additional efficiency or other upgrades that would decrease greenhouse gas emissions from the steam plant and distribution system?

Water

How much water is used by once-through cooling and how much is lost through leaks in the steam loop?

How many bathrooms have higher flow fixtures?

What EBMUD rebates still exist? What is the financial feasibility of various water projects (like fixture replacements)?

What advanced technologies (e.g., dual flush toilet, waterless urinals, etc.) have been successful at other institutions?

Built Environment

How many staff members have been LEED certified?

What approach to green buildings is most effective for the UC Berkeley campus? Should a mandatory LEED water credit be part of this approach?

Which LEED points have been achieved by individual buildings?

Waste

Are there additional waste streams that should be added to the calculation of the recycling rate?

How can composting be expanded on campus?

Are there standard metrics or guidelines for calculating recycling rates?

Purchasing

How are other organizations tracking overall progress on environmentally preferable purchasing? What additional purchasing indicators or metrics should be tracked?

Dining & Food

What are appropriate metrics and measures of success for sustainable food?

Land Use Impacts

What pesticides do we use? How much? Are there significant levels of pesticides in runoff?

What is the water quality of Strawberry Creek?

How many acres of different habitat types are managed by UC Berkeley?

Academics and Learning by Doing

Develop additional metrics:

- number of staff receiving sustainability training
- number of students that signed sustainability pledge
- number of students in sustainability related major
- number of students that pursue a sustainability related career
- number of students that have taken at least one class related to sustainability
- number of students that are involved in a sustainability group

Footnotes

1. [UC Berkeley Climate Action Partnership, Feasibility 2006-2007 Final Report](#)
2. [UCOP Annual Report on Sustainability Policy 2007](#)
3. [2020 UC Berkeley Long Range Development Plan](#)
4. [Strawberry Creek Management Plan](#)
5. [Climate Change 2007 Synthesis Report, IPCC, Geneva, Switzerland](#)
6. [American College and University Presidents Climate Commitment, 2007](#)
7. [AASHE Mandatory Student Fees for Renewable Energy and Energy Efficiency](#), accessed 9/19/08 http://www.aashe.org/resources/mandatory_energy_fees.php
8. [Oberlin Environmental Sustainability Site accessed 9/19/08](#)
<http://www.oberlin.edu/sustainability/portfolio/energy.html>
9. [“EBMUD Adopts Drought Management Plan”, EBMUD Press Release](#) May 13, 2008.
10. [Sustainable Water Report for UC Berkeley, 2005 Jubilee Daniels](#)
11. [Oberlin College Environmental Studies Website](#) accessed 9/25/08
http://www.oberlin.edu/ajlc/systems_lm_1.html
12. [Stanford Water Conservation, Recycling, and Reuse Master Plan](#), 2003
13. [University of California Berkeley 2005 Campus Sustainability Assessment](#)
14. [U.S. Department of Energy](#). <http://www.eere.energy.gov/industry/financial/feddoe1.html>
15. [Hampshire College Purchasing Manual](#) July 1, 2003
16. [UC Davis Recycling Website](#) accessed 9/25/08
<http://r4.ucdavis.edu/about/diversion.html>
17. [Source Inventory of Bay Area of Green House Gas Emissions](#), Bay Area Air Quality Management District, November 2006
18. [Ambient Air Quality Standards and Attainment Status](#) (BAAQMD site) accessed 8/11/08 from http://www.baaqmd.gov/pln/air_quality/ambient_air_quality.htm
19. [“Winners for PETA2’s Most Vegetarian Friendly Campuses 2007”](#)
<http://www.peta2.com/college/c-vegschools-winners07.asp>
20. [University of California Berkeley Water Protection Policy](#), issued October 1, 2004

Cover photo BAP photos

Appendix A

Details of 2005 Assessment Milestones

Energy and Climate

Completed

1. Create strategic energy plan [SEP]
2. Initiate Energy Star Purchasing Standards [UCOP policy]
3. Conduct GHG inventory
4. Report Emissions

Partial

1. Conduct lighting audit and retrofits [About 30 buildings will have been completed by the end of the fiscal year – 50%]
2. Increase monitor based commissioning [10 buildings are now realtime metered should be 20 by the end of the year – 25%]
3. Improve energy management systems [About 60% of buildings are on the EMS system – 75%]
4. Create a revolving financing mechanism
5. Develop a clean energy strategic implementation plan [UCOP 10 MW goal]
6. Real time energy feedback [10 buildings have realtime metering]

Water

Completed

1. Test waterless urinals
2. Plant drought tolerant plants
3. Perform campus wide water audit
4. Expand SCADA to all irrigation facilities [90% completed]

Partial

1. Install water efficient fixtures in existing buildings and establish toilet maintenance system [Toilets are replaced as bathrooms are renovated]
2. Pilot greywater project in a new or substantially renovated building [Albany village is dual plumbed but the EBMUD greywater line doesn't extend to main campus.]
3. Pursue LEED credits for water

No

1. Provide building occupants with monthly water use data
2. Eliminate once through cooling operations and water aspirators
3. Install EBMUD recycler plant [Funding fell through]

Built Environment

Completed

1. Achieve LEED silver for new buildings
2. Develop system of accountability for LEED equivalency
3. Eco-charrettes
4. Metering
5. Incorporate life cycle analysis into analysis of buildings/create LCA assessment tool [Taken into account when buying building materials, no explicit tool]

Appendix A

Partial

1. Existing building improvement (LEED EB) [6 planned]
2. Commissioning [8 completed, 9 planned]
3. Post occupancy studies [One done for Haste CDC, planned for classroom retrofits]
4. More integrated design teams better than most in industry
5. Zero waste buildings [Policy to divert 50% of waste, but regularly achieving over 75%]

Waste

Completed

1. Recycled paper standard
2. Set a goal for the campus diversion rate [UCOP]
3. Increase campus diversion rate above 50% [Only if construction waste is counted]

Partial

1. Transition to paperless and electronic procedures [10% Highly dispersed]
2. Expand composting [50% -- Recharge units have robust composting, funds needed to expand on campus]
3. Establish organized recycling standards for major events [25% -- Most recharge units have set diversion procedures]

No

1. Explore waste reducing technologies like high performance air dryers

Purchasing

Completed

1. Create comprehensive EPP policy [UCOP]
2. Establish a recycled paper quota for purchase
3. Track paper purchasing

Partial

1. UC will consider the total cost of ownership including purchase, operating, maintenance and disposal in purchasing
2. Prioritize the purchase of reusable and recyclable materials
3. Cradle to cradle is the preferred purchasing standard (UCOP purchasing policy)
4. Prioritize the purchase of materials which minimize packaging

Transportation

Completed

1. Create incentives to promote public transit or cleaner fuel consumption. [BearPass and Classpass, parking is cheaper for people who carpool]
2. Purchase alternative fuel vehicles in compliance with Energy Policy Act [Have 2 CNG, 19 Electric, and 13 E85 flexible fuel]
3. Pursue introduction of rideshare projects.
4. Measure average vehicle ridership
5. Increase the percentage of PZEV and ZEV vehicles by 50% by 09-10 [Have 12 PZEV now]

Partial

1. Conversion of campus vehicles to run on biodiesel [One garbage truck and plans for more]

Appendix A

No

1. Negotiate cleaner fuel contracts with AC transit (UC rents busses from AC Transit)
2. Expand housing assistance programs for staff
3. Discount passes on Bart for students

Dining and Food

Completed

1. Include support for organic agriculture in Cal Dining Mission Statement
2. Provide local produce in one dining common
3. Become a certified organic processor/retailer
4. Provide and promote at least one organic option in dining commons
5. Develop one campus restaurant and/or DC with sustainable food theme
6. Formalize consideration of local and organic criteria
7. Improve compost collection
8. Increase the use for biodegradable packaging
9. Reduce waste sources

No

1. Establish a Cal farmer cooperative

Land Use

Completed

1. Use sustainable methods in exotic weeds abatement
2. Reduce the impervious area
3. Increase the area planted with native vegetation
4. Metering of Strawberry Creek flow and water quality

No

1. Organic lawns and playing fields
2. Electronically track pest control data
3. Create and adopt policy concerning pesticide use and purchase
4. Adopt Building and Grounds design standards to control pests and prevent breeding
5. Form network with other UC pest management programs
6. Adopt onsite wastewater treatment standards

Academics and Culture

Completed

1. List of sustainability courses
2. Encourage student learning courses
3. Increase institutional support for CACS [Office of Sustainability]
4. Collective Policy between regional institutions [East Bay Green Corridor]

Partial

1. Sustainable Development or Environmental Literacy Requirement [Grant to pursue college wide requirement]
2. Create a Sustainability Academic Advisory Committee [BIE]

No

1. Organize regular meetings between City of Berkeley and UC Berkeley
2. Better media coverage for Sustainability Week