DESIGN PHASE BUSINESS CASE: ENERGY MANAGEMENT (2/22/11) V9

University of California, Berkeley

SPONSORSHIP

Initiative

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EXECUTIVE SUMMARY

Energy use and management at UC Berkeley: The current state

- UC Berkeley currently spends $17 million per year to supply electricity to the central campus.
- Due to insufficient state funding for utilities, $6-9 million has been diverted annually from campus discretionary spending to pay for power.
- UC Berkeley does not use energy as efficiently or as wisely as we could. Energy services – like heating or lighting – are too often managed as if energy is "free," a scenario that encourages waste.
- We rarely know how much energy we use or how much it costs.
- Campus energy usage has increased by almost 2% per year or nearly 33% since 1990.
- Energy intensity (usage per square foot) in campus buildings has been increasing.

Some of the opportunities and challenges related to energy use on our campus:

- UC Berkeley wants to be a leader in energy efficiency and management.
- We have an aggressive greenhouse emissions reduction target: the campus has committed to reduce our greenhouse gas (GHG) emissions to 1990 levels by 2014. Roughly 80% of campus emissions are from energy usage.
- Our buildings have generally been built such that they can provide efficient heating and cooling.
- UC Berkeley has a temperate climate, requiring less heating and no cooling (except for research and other specialized environments).
- We have old buildings: 70% are more than 75 years old.
- We often have inefficient and old energy systems.
- The number of staff who repair and maintain the buildings has dropped by 40% since 1990 – from 135 to 81.
- Most people on campus do not know how much energy is used in their buildings.
- There are numerous initiatives to reduce energy in individual buildings led by faculty, staff, and students.

The Energy Management Initiative is one of seven initiatives that make up Operational Excellence, a campuswide program designed to reduce the cost and complexity of administrative operations at UC Berkeley.
The initiative planning team was given the task of designing an incentive program for the campus. As we investigated the current state of campus energy funding and use, identified opportunities and looked at best practices, our team realized that to truly create a sustainable energy savings plan, we needed to:

- better monitor buildings and energy usage and fix problems quicker
- provide support to campus units and individuals so that they could save energy
- share some of the incentives to save with campus units
- craft new policy that supports this effort.

The Energy Management Initiative Summary of Recommendations

UC Berkeley should be smart and lean with our energy consumption – it is better for the environment, and the funds saved will be put to better use. We will decouple growth in research and teaching from growth in resource use, as a way to lower costs and reduce waste. The university's mission is education and research – managing energy better will help ensure success and help make the campus a living laboratory and a model for a more sustainable future.
The Energy Management Initiative (EMI) will improve energy and energy services management in campus facilities by:

1. Instituting a central **Energy Office** and ensuring **On-going commissioning** in buildings
2. Providing **incentives** for reducing consumption
3. Emphasizing **individual actions** through campus outreach
4. Strengthening **campus energy policy**
5. Investigating the feasibility of new **major projects**

Expected Total Savings

The Energy Management Initiative will deliver $3-4 million in annual energy savings. These savings represent at least a 10% reduction from business as usual.

The savings that we estimate will accrue from implementing these recommendations should be just the start. These changes will build a foundation of people, incentives, and services that can continue to yield additional energy reductions and savings and increase our ability to innovate and adapt.

More details about the initiative, including campus examples, best practice cases, assumptions, calculations and recommendations for implementation are available in the full report.

SUMMARY OF RECOMMENDATIONS

The recommendations of the Energy Management Initiative (EMI) represent a dramatic shift in the way that energy and energy services (like lighting or heat) will be managed on campus. By instituting a central office to oversee campus-wide efforts, providing incentives, and emphasizing the importance of individual actions (from dimming monitors to quick responses to hot and cold calls), *the campus will achieve $3-4 million in annual energy savings and a 10,000 ton reduction in annual greenhouse gas emissions*.

When combined with current commitments to fund energy efficiency projects, UC Berkeley will have undertaken a $33-42[1] million energy management effort that will yield cost savings of $8-9 million annually. This investment in our campus should also result in more comfortable buildings, greater collaboration among researchers, students and staff, and new renewable energy generation.

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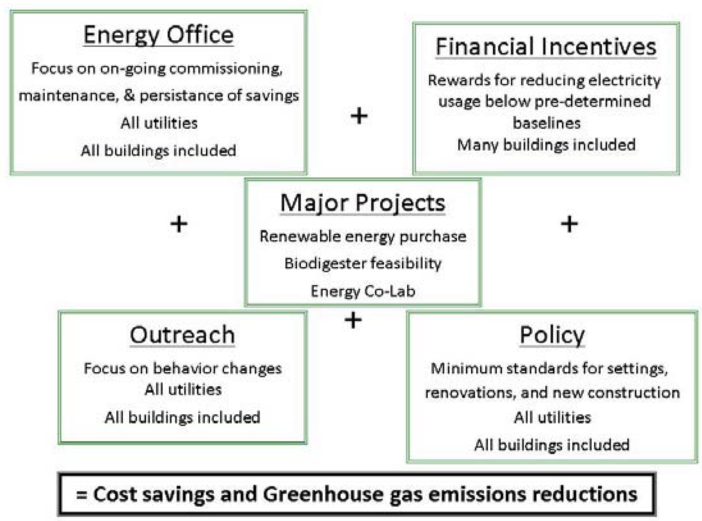


FINANCIAL ANALYSIS

The Energy Management Initiative will deliver up to $3-4 million in annual energy savings. These savings represent at least a 10% reduction from business as usual. The up-front investments required to implement the EMI vary across several scenarios. Investments to cover the on-going costs of this initiative could come from sources other than OE, including SEP financing, central campus funds, or additional energy savings from completed SEP projects (that are not needed to repay the SEP loan).

The annual savings are a mix of:

- Savings that accrue to Operating Units (~45%, in the form of direct incentive payments and PP-CS credits to cover energy-related work orders)
- Savings that accrue to central campus (~55% through the acceleration of Strategic Energy Partnership projects and some of the outreach work, including about 10% that are avoided costs[2])

These savings are relative to a business-as-usual baseline that assumes a 1-2% growth in energy consumption, but do not include any of the savings from the projects currently being implemented by the Strategic Energy Partnership. The savings are a combination of one-time costs (1/4) for equipment, software, and consultants and on-going costs (3/4) for staffing. See attached copy of Excel spreadsheet for more details.

PROBLEM STATEMENT/NEEDS ASSESSMENT

UC Berkeley does not use energy as efficiently or as wisely as we could. *Energy services – like heating or lighting – are too often managed as if energy is "free," a scenario that encourages waste.* We rarely know how much energy we use or how much it costs. Unlike many peer campuses, there is no campus energy manager, a person whose primary role is to facilitate reduction in energy use and associated expenditures while maintaining a high level of energy services campus-wide. Moreover, we lack the technical staff necessary to maintain building performance and ensure that energy efficiency projects continue to deliver their promised benefits.

New and better energy management tools and systems are needed to improve conditions in our buildings, support behavior change, reduce greenhouse gas emissions, and attract faculty, staff, and students who desire a green campus. *Improved energy efficiency can deliver costs savings, more comfortable buildings, environmental improvements, and an enhanced reputation.* Better energy management can also engage students, empower staff, and align with campus research.

UC Berkeley should be *smart and lean with our energy consumption* – it is better for the environment, and the funds saved will be put to better use. We will decouple growth in research and teaching from growth in resource use, as a way to *lower costs and reduce waste*. The university's mission is education and research – *managing energy better* will help ensure success and help make the campus a living laboratory and a model for a more sustainable future.

Current Situation – The Numbers

There are key opportunities and challenges on campus related to energy usage, which have guided the OE Energy Management team's discussions and deliberations. UC Berkeley has a temperate climate, requiring less heating and no cooling (outside of research and other specialized environments). We have old buildings (70% are more than 75 years old), but with excellent thermal mass for efficient heating and cooling. We often have inefficient and old systems, but want to be a leader on energy efficiency and management.

First, **campus energy usage has historically increased by almost 2% per year** or almost 33% since 1990 (see Figure 1). Recent efforts to reduce usage can be seen both in the total usage and usage by square foot, with decreases in 2009 of 0.5% and 2.4%, respectively. Electricity usage has grown faster than total energy (almost 40% since 1990 – see Figure 2) and, unlike natural gas or steam, did not decrease in 2009.

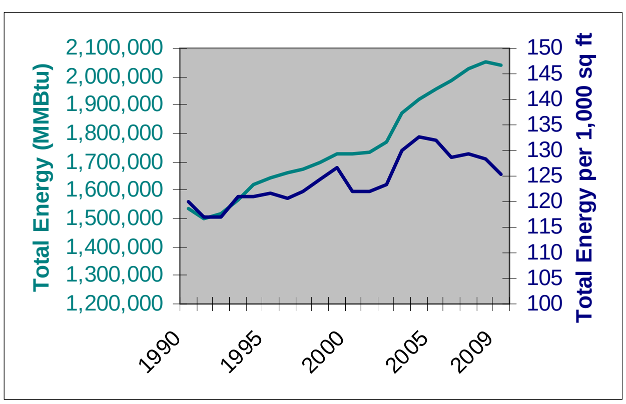


Figure 1. Campus Energy Usage (electricity, natural gas, and steam combined, "site" energy conversion) by Year. Source: CalCAP inventory

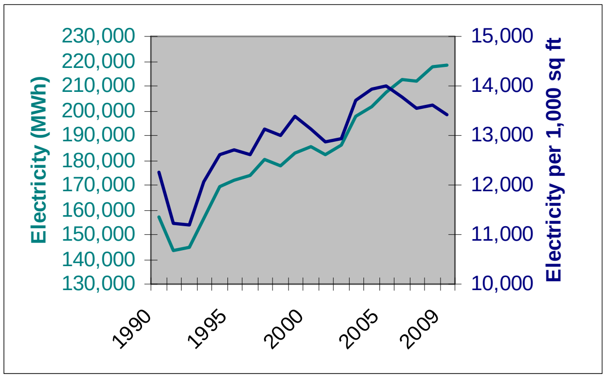


Figure 2. Campus Electricity Usage by Year. Source: CalCAP inventory

At the same time, **energy intensity (usage per square foot) in campus buildings has been increasing…** Over one quarter of state-funded campus buildings contain laboratory or other complex space, and these lab buildings on average use energy costing over $5 per gross square foot per year, as compared to around $1-2 per square foot per year for non-laboratory buildings. Self-funded units also have a significant number of buildings with energy-intensive space types including food service and health care[3]. In addition, new buildings and major renovations tend to increase the overall energy intensity. For example, after the LeConte Hall renovation electricity usage per thousand square feet rose from 7,800 to 12,100 kWh/kgsf – or more than 50%. The new Stanley Hall was three times bigger than the building it replaced, but uses seven times more electricity. As more sophisticated energy services are included in renovations (especially in laboratories), energy use in these spaces increases unless highly skilled design resources are employed and most efficient technology is used.

…while our total square footage also continues to grow. The 2020 Long Range Development Plan outlines future growth in campus buildings – square footage may increase by 18% by 2020 (relative to 2004), one-third of which may be laboratory space[4].

One of the possible causes of the continuing increases in electricity consumption is information technology (IT) energy usage and the associated cooling requirements. According to the OE Final Diagnostic Report, there are currently at least 900 servers on campus, spread across over 50 different locations[5]. The majority – 95% – of these servers (by number) are outside of the central data center, resulting in sub-optimal, distributed HVAC systems[6]. It is estimated that the digital storage utilization rate for these servers is approximately 52%[7], which is below what can be achieved by consolidating and virtualizing servers. Power savings from virtualization of servers is estimated to be 80%[8]. Reducing the number of servers can yield energy savings of over $2,300 per year per server eliminated[9], through direct savings and through reduced cooling needs.

Perhaps more importantly, the campus operates with a utility deficit. We currently spend approximately $35 million on utilities for central campus, auxiliaries, and other state-funded buildings; while auxiliaries are recharged for energy use, insufficient state funding for other facilities requires $6-9 million to be diverted annually from discretionary spending. Of these totals, the central campus currently spends $17 million on electricity.

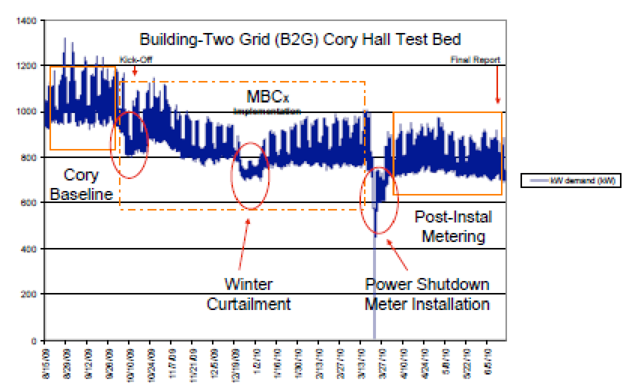
The continued rise in energy prices risks making this deficit worse. Estimated energy price increases vary depending on multiple factors, but can average 3-5% annually[10]. This estimate does not include the impact on prices (positive or negative) that may occur as a result of California's climate mitigation legislation (AB32) that begins in 2012.

UC Berkeley's **funding of maintenance has regularly been at the bottom of the ranking among our California research university peers**. Measured by dollars spent per gross square foot, the campus spends only $2.99. We were 44% below the average of the 13 schools who participate in a data-sharing partnership, even before last year's 21.7% cut in maintenance funding. At the same time, our backlog of deferred maintenance ($696 million) was the highest on the list and 2.4 times the average. The historic failure to invest in campus infrastructure has created a remedial situation that contributes to the poor performance of buildings – as measured by occupant comfort, outstanding repairs, or energy performance. Even with the additional investment proposed by this initiative, our maintenance funding per square foot will only rise $0.23 – still far below the average among our California peers.

One effect of this maintenance deficit is the **inadequate number of staff to operate and maintain buildings.** *The number of staff who repair and maintain the buildings has dropped by 40% since 1990 – from 135 to 81.* The predictable result is that urgent, reactive tasks swamp the day-to-day and preventative ones. Delaying preventative maintenance can increase overall maintenance and capital costs, as equipment breaks more easily and operates less efficiently (resulting in energy costs that creep up). During the same time period, the average time for resolution of comfort calls (work orders related to temperature problems and noise) increased from 6 days to 26, while the number of such calls dropped from 1,400 to 800 as building occupants gave up in the face of such long response times.

While there are numerous initiatives in individual buildings led by faculty, staff, and students, there is **currently no comprehensive campaign to motivate individual behavior change to reduce energy**. The impact of these individual campaigns can be large. For example, the Green Campus program holds Blackout Battles each semester in the residence halls where the winning building has reduced electricity usage by as much as 16%. However, these savings have been difficult to sustain when the campaign is over and are not being replicated campus-wide. *Motivating individual behavior change is also complicated by the fact that most people on campus do not know how much energy is used in their buildings.*

Centralized implementation of large infrastructure projects has worked to reduce energy consumption. Since 2006, the campus has funded multiple projects to reduce energy usage in new and existing campus buildings. As part of a systemwide partnership with PG&E and the other investor-owned utilities serving other campuses, the projects to date are expected to have yielded annual cost savings of almost $1.4 million. Additional projects are planned through the Strategic Energy Plan (SEP), which identifies potential energy efficiency retrofit projects at all campus buildings over 50,000 square feet, or about 70-80% of campus square footage[11]. Moving forward, the SEP projects will be implemented over four years (2009-2012) and invest a total of $24 million in campus projects. *Annual cost savings (after loan payments) are expected to be $3 million, with expected emission reductions of 17-19,000 metric tons CO_2 equivalent per year (or about a 15% reduction in overall energy usage).* More staff have recently been hired to ensure successful completion of scheduled work, and these staff should be able to also implement additional projects in the future.



In particular, the campus has implemented several successful monitoring-based commissioning projects. Commissioning is essentially a building tune-up, where systems and equipment are checked for operating efficiency[12]. The recent monitoring-based commissioning of *Cory Hall* included 32 individual upgrades or retrofits, reducing electricity usage by almost 1.4 million kWh and saving the campus $144,000 a year. The commissioning of *LeConte Hall* expects a reduction of 350,000 kWh in electricity use. The monitoring-based commissioning of the *Tang Student Health Center* yielded estimated savings of 32% reduction in electricity use and a 28% reduction in natural gas use.

Persistence may be an issue for some project savings… In fact, of ten recent commissioning projects, over half have seen an increase of 3-13% in electricity usage since the project was completed. In one example, eight of the 32 upgrades at Cory Hall have failed to maintain the expected level of performance, resulting in a 3% increase in usage.

…highlighting the need to regularly monitor and manage energy usage in buildings and to ensure that there are adequate and skilled staff responsible for energy management, who understand the complex systems being installed.

The impact on energy usage of delays in repairing or identifying broken equipment can be large. In one case at *Wurster Hall*, multiple work orders were required over a nine month period to repair a supply fan – even after a new variable speed drive had been installed. The estimate of the additional cost due to the drive operating at a higher than needed speed during the delay: $6,500.

Campus Resources and Benefits – Not Starting at Zero

One opportunity for the EMI is the **aggressive greenhouse emissions reduction target** set in 2007. Through the *Cal Climate Action Partnership*, the campus has committed to reduce our greenhouse gas (GHG) emissions to 1990 levels by 2014, which will entail reducing emissions by about one-third from business-as-usual levels. Since roughly 80% of campus emissions are from energy usage, meeting this target will correspond to a decrease in energy consumption. In 2009, emissions decreased by 5.3% or about 10,800 metric tons CO_2 equivalent relative to the 2008 inventory. While GHG emissions have grown by 18% since 1990, emissions per square foot are down by 7%.

Even with our commitment to carbon neutrality, the campus **has only installed 100kW of renewable energy capacity** (solar panels on the roof of MLK).

Active building specialists are important. There are currently a number of Facility Specialists/Managers on campus who function as advocates in their buildings for energy savings and maintenance. Concentrated in the more complex, high-energy-using buildings, these managers are key to occupant comfort and satisfaction, but cannot be expected to handle all or even most service calls.

Even a few years ago, the campus had a 5-person energy office. This office reviewed project plans for energy efficiency features/opportunities, maintained meter books and signed off on utility invoices, identified energy saving opportunities for campus systems, and provided short term loans of approved model fans and heaters for building occupants' comfort while they were waiting for system repairs (to avoid people bringing in dangerous heaters).

Energy management can also be an avenue to harness academic resources. Cory Hall is part of a research project involving the extensive installation of wireless electricity monitoring devices. Using new technology developed by Professor David Culler, the Cory Hall team can pinpoint opportunities to reduce energy usage, including identifying unused equipment[13].

Best Practices for Reducing Energy Usage and Costs

Having centralized energy management services can play a vital role in energy savings. The University of British Columbia achieved significant savings – more than $7 million annually and a 25% reduction in energy intensity – through a comprehensive energy management program. Components include monitoring and data analysis, establishing accountability, an energy policy for classrooms and offices, energy retrofits, and a utility partnership to optimize building performance and on-going maintenance[14]. UC Santa Barbara achieved a 30% increase in energy efficiency from 1997 to 2006 (and $1.8 million in cost savings) by enabling a proactive an energy manager, metering all buildings, and investing in energy information systems[15].

On-going building tune-ups (or commissioning) can ensure that initial savings persist and consumption continues to decline. Much like tune-ups for automobiles, regular attention is needed. **In the absence of re-commissioning, building energy usage can actually regress at a rate of up to 3% per year[16].** Cornell and University of Michigan are two prime examples. Michigan targets over ¼ of their buildings with a six-year cycle of building recommissioning; many of these buildings are recommissioned on a three-year cycle, saving 6-35%. Cornell "targets spikes in building energy utilization" coupled with a less-detailed annual building review. On average, Cornell has reduced energy usage by 8%[17]. Some institutions have reported more significant savings during second and third passes than in the original commissioning[18].

Better support for existing building managers can lead to greater occupant productivity and satisfaction. UC Berkeley research shows that both occupant satisfaction and worker productivity are correlated to the response time to address complaints of discomfort. More specifically, occupants give a building manager "the benefit of the doubt for…up to three days, then get upset or give up.[19]"

New design practices can insure renovations and new construction projects add as little as possible to the campus energy footprint. UC Merced employs bench-mark-based design targets to deliver buildings with much lower than typical energy use, without the advantage of building orientation, with a plant still in need of extensive commissioning, and with normal University building budgets[20].

Providing even modest financial incentives can induce behavior change and enduring energy savings. Several universities have added billing systems that require campus units to pay for all or part of their energy usage. Stanford's program has reduced consumption by 3% below established baselines, while 14 participating units at Iowa State reduced usage by an average of 7%[21].

Funding alone is not sufficient – education, outreach, social marketing, and individualized support for building occupants can further increase potential energy savings. UC San Diego is one of several universities to use dashboards to display energy consumption visually – the installation of dashboards in 60 buildings is expected to save $900,000 in electricity costs[22]. The University of Albany also has an electricity dashboard and an educational campaign that has attained a 7-8% reduction from behavior change, sustained over two years[23]. As part of an effort to increase occupant awareness of building systems and energy consumption, the University of Michigan's Planet Blue program conducted engineer-led building tours, hosted small group meetings with building occupants and open house sessions, and distributed fact sheets and quizzes. While it was difficult to separate the savings from other projects implemented at the same time,[24] the total energy savings were 8%[25]. Stanford provided consulting services and audits by their energy manager to support their incentive program[26] and have also added an outreach campaign. Our own Wurster Hall saw a 3-5% reduction in energy from occupants being asked to turn off lights when not in use.

These same feedback tools also help ensure persistent savings. In part because savings as a result of feedback are due to changes in day-to-day practices or other infrequent, low/no cost changes, research shows that savings are more persistent when the feedback is persistent or provided "in a supportive social environment."[27]

Clear campus energy policies can support broader energy management efforts. Successful energy management programs at other research universities are backed up by clear campus-wide energy policies, which outline specific energy-related guidelines, such as limits on reasonable thermostat settings. With active promotion by the leadership, these policies help to reinforce the priorities of the university to save energy while providing a framework of priorities for tackling energy waste over time. The new energy policy at UNC Chapel Hill is already having a significant impact on the energy budget of their university. In one example, simply enacting the part of the policy that called for adjusting cooling thermostats during unoccupied periods resulted in a savings of $100,000 in a 10-week period[28]. In another success story from the University of Tennessee, the campus estimated a savings of 7-8% in electricity expenditures per square foot due to an energy policy targeting thermostat setpoints[29].

Campuses that are strongly committed to carbon reduction have begun on-campus installations of renewable or alternative energy. The Association for the Advancement of Sustainability in Higher Education maintains a database of such installations: at least 118 institutions of higher education have installed solar panels, ranging in size from 1 to

4,000kW (average is just under 300kW). In addition, at least 45 institutions have wind power (with two universities having over 100,000kW installed) and 15 have fuel cells[30].

Many campuses also encourage collaboration between researchers and energy management staff. For example, UC Davis has installed LED lighting developed by the California Lighting Technology Center and is also investigating the feasibility of installing biodigester technology developed by a campus professor. Nine of the ten UC campuses, including Berkeley, have hosted demonstrations of a variety new energy-efficient technology in conjunction with the California Energy Commission (CEC) Public Interest Energy Research (PIER) Program's State Partnership for Energy Efficient Demonstrations, coordinated by UC's California Institute for Energy and Environment (CIEE). More widespread adoption of the successfully demonstrated technologies would accelerate reductions in energy use[31].

Other best practices and lessons learned:[32] A 2010 UC Berkeley Leadership Development Team studied how to reduce occupant-controlled electricity usage and offers the following additional observations of successful practices:

- successful initiatives need high-level support or mandates, coupled with grassroots involvement by faculty, staff, and students; they are backed by on-going funding and full-time staff and are part of campus strategic plans
- reductions are best achieved by an integrated program of incentives, marketing, and infrastructure improvements
- visible rollouts are particularly helpful, in the form of open houses, kick-off parties, pledges, or other
- maximum effectiveness of incentive programs likely requires that information on energy usage is shared with all building occupants.
- communication is viewed as the key to success by many universities who have an established energy management program

- ## OVERALL ENERGY MANAGEMENT RECOMMENDATIONS

1. **Improve management of energy usage and services by establishing a central campus Energy Office** – A high-profile Energy Office will be tasked with overseeing many of the new initiatives and services being proposed. We ask the campus to make a commitment to a new approach to operating our buildings – one that strengthens and enhances the existing system of facility managers and maintenance staff. Combined with the infrastructure improvements being funded through the Strategic Energy Plan, we can make a difference in the consistency of building operations and put the campus on a road toward excellence in energy management. This commitment and trust-building for our maintenance program will be important when we also ask the campus join us in making energy reductions through behavior change.

   Energy Office
Focus on on-going commissioning, maintenance, & persistance of savings
All utilities
All buildings included

   The Energy Office will continuously monitor the operations and maintenance of the campus facilities, will be in contact with Building Managers regarding their facilities' operation and utility consumption, and will provide the high level of service and maintenance required by these complex facilities.

   - Establish visible leadership and on-campus presence for the EMI: The work of a new Energy Manager will maximize short-term and long-term energy savings, through planning, regulating, and monitoring energy use in campus buildings. The Manager would oversee much of work of the Energy Management Initiative.
   - Work directly with engineers, occupants, building management, and PP-CS to develop and implement ongoing energy conservation and efficiency programs to support facilities and occupants. A team of stationary engineers will be hired to direct and manage maintenance needs of campus buildings, with each assigned a regular zone of buildings.
   - Ensure ongoing commissioning of buildings and work closely with Facility Managers to speed energy-related repairs and identify conservation measures and reduction projects to expand the current Strategic Energy Program (SEP). This commissioning work is expected to yield savings of 3% of total main campus utility usage.
   - Enable central operators to minimize energy consumption by monitoring and controlling heating, ventilating, and air-conditioning equipment and settings. Additional staff in the Energy Management System Unit will also provide support for maintenance and operation of the campus installed electronic meters (electric, steam and water).
   - The additional engineers will provide support for an average of 15 buildings each, while the additional EMS technicians would ensure an average of one per 12 buildings. This is comparable to other institutions which have Energy Offices: Stanford commits more staff per square foot, while UC Santa Barbara's office (which has increased its energy efficiency by 30%) is roughly the same per square foot.
   - Provide building utility information to the Operating Units, facility managers, Budget Office, Office of Sustainability, and others. A new Energy Analyst will also calculate the baseline of electrical consumption for each facility and address questions or concerns.
   - Assist Operating Units in their efforts to reduce energy usage.
   - Coordinate with SEP to ensure energy use reduction projects are implemented in a timely manner.
   - Install and maintain building meters, software, and kiosks necessary to visualize consumption.
   - Review renovation and construction projects to assure best energy design.
   - Assist auxiliaries as needed to maximize total energy reductions.

Estimated Savings: By FY15-16, the savings directly associated with the Energy Office are expected to be around $2.3 million per year. A majority of the other savings ($1.4 million) associated with the EMI also depend on the establishment of this Office.

Estimated Costs: Creating the Energy Office will require an on-going investment of approximately $1.95 million/year.

The Energy Office will also implement and support the following elements of the EMI:

Through collaboration between Energy Office and Strategic Energy Plan, implement additional energy-saving infrastructure projects

Identify and implement at least 10-15 additional projects for years FY13-14 and FY 14-15 for savings that could total $1,000,000. Projects may come from the existing list of potential SEP projects or they may be identified by the Energy Office, facility managers, or others.

Provide funding options (such as revolving fund loans or matching grants for equipment, lighting and appliances) for energy-saving projects funded by Operating Units (OUs) and/or other sources

Energy Office will work with Units to fund energy efficiency projects with a short payback period (<1 year) out of the discretionary utility budget.

Energy Office will also explore additional funding models, like an Energy Re-Investment Fund, a Q-Brace-style cost-sharing model, or a "cash for clunkers" approach; funding might come from future energy savings, Unit cost-sharing, grants, central funds, and/or other.

Explore ways to offset energy costs associated with new research initiatives and projects

Encourage collaboration on ways to reduce energy consumption in advance of installations, renovations, and purchases of large equipment.

Investigate the possibility of assigning some indirect cost funds to offset research-related increases in energy costs.

Set up a program to work with Principal Investigators and GSRs to help identify equipment that can be decommissioned or shared. Existing equipment inventories will also be used.

Explore extending the use of Laboratories for the 21st Century (Labs21) Environmental Performance Criteria (EPC) from new construction (per UC Policy) to major renovations.

Consider the use of benchmark-based design targets for new construction and major renovation projects.

Provide training and support to facility managers to enable and empower action

Hold regular meetings of managers and develop a standard job description and training schedule.

Create opportunities for managers to gain industry certifications associated with building energy efficiency.

Develop a system of Energy Stewards, comparable to the current Building Coordinator program

Volunteer stewards will be appointed by each Operating Unit, but stewards and or teams of stewards for each building will be encouraged.

The Energy Office and the Office of Sustainability will work with OUs to designate a contact for the program and to assist in setting goals for how Energy Stewards plan to help their OU reduce its electricity usage.

Energy Stewards will be familiar with energy utilization patterns and programmatic uses of space, will help track energy use and space occupancy changes, and will identify potential energy-saving projects.

2. **Offer financial incentives to Operating Units to reduce energy consumption** – This program will provide financial incentives and related tools to reduce user-controlled electrical consumption. The incentives will transfer partial accountability for energy savings to OUs, to assist in a campus-wide reduction of energy consumption. By engaging OUs as active partners with the Energy Office and the Office of Sustainability, they should be able to achieve persistent 3-5% reductions in electricity usage through simple, low costs measures such as turning out hallway lights or unplugging equipment. There is ample evidence – including from residence hall competitions on our campus – that individual buildings or OUs can achieve savings as high as 10-20% through more aggressive measures. Key elements of the Incentive Program include:

> Financial Incentives
> Rewards for reducing electricity usage below pre-determined baselines
> Many buildings included

- Electricity consumption baselines (measured in kilowatt-hours of electricity) will be set for each OU, generally based on one year of data of historical data (FY9-10).
- OUs that use less electricity than is allocated will receive an incentive payment. For the first 3-6 months of the program, OUs will be sent data on their usage for informational purposes only (no incentives will be paid).

Financial incentive payments will be paid annually, although information on usage relative to baselines will be distributed monthly.

- In the second year of the program, OUs that use more electricity than is allocated to their baseline will be expected to reimburse the campus utility budget. OUs will be held harmless for electricity price increases.
- Savings will be shared – part going directly to the Operating Units and the remainder allocated as credits for the OU to cover work orders or other PPCS expenses related to achieving or maintaining electricity reductions.
- Baselines can be adjusted through a rigorous appeal process, for enrollment or major programmatic changes only, although major equipment failure may also trigger a baseline change.
- OUs can partner with each other to reduce energy usage or can trade reductions with another OU as way to reduce costs.
- Most large campus buildings will be eligible to participate in the program and will be connected to state-of-the-art meters, providing real-time information to occupants on energy usage through dashboards and/or websites.
- Where more than one Operating Unit occupies the same building, space assignment data will be used to allocate baseline consumption between OUs based on assignable square footage and on occupancy type.
- There will be coordination with the OE IT, Procurement, and Finance teams to ensure maximum collaboration between projects; one preliminary shared goal is to reduce the number of servers by at least 100. The Energy Office will work with budget and finance staff to ensure that the incentives are correctly credited to OUs.
- The Energy Office will provide annual reports to OUs that highlight the energy-savings steps that were taken and recommend additional measures.

Estimated Savings: By FY15-16, the savings directly associated with the Incentive Program are expected to be $740,000 per year, based on achieving a 3% reduction in main campus electricity usage plus additional IT energy savings.

Estimated Costs: The Incentive Program will require an upfront investment of around $550,000 for meters, dashboards, and software, plus approximately $330,000 in annual on-going costs. These on-going costs are based on preliminary estimates of the annual cost of the software that will convert the energy data into a more user-friendly format; it is hoped that the costs can be lower.

3. **Initiate campus 'save energy' outreach campaign** – Individual behavior change is at the heart of the Incentive Program. Our success will be related to how well we communicate with the campus and convince people to make needed and permanent changes. Research tells us that there are predictable ways to ensure successful environmental communication – like attracting attention and keeping it and making sure you use persuasive messages and strategies to foster change. The goals of the outreach campaign are to make energy usage more visible; create tools and share ideas on ways to reduce energy; create interesting, compelling, and consistent messages; establish social norms around using less energy; and, maintain the messaging over time. Key elements include:

> Outreach
> Focus on behavior changes
> All utilities
> All buildings included

- Install software, facility dashboards, kiosks to provide access to building performance info, and a website.
- Include competitions, energy audits, resources on how to reduce energy usage, and other information to help OUs participate in the program.
- Ensure adequate and on-going resources and staff to support the campaign.
- Introduce concept that "energy is not free."
- Coordinate with the OE Procurement and IT teams to make energy efficient equipment easier to purchase. Power management software – that can power down equipment after hours – may be better supported by the distributed desktop support under consideration by the IT team.
- Provide a clearinghouse and resource for all outreach efforts and service learning opportunities, including those currently underway by students and other campus groups.

Estimated Savings: By FY15-16, the savings directly associated with the Outreach Program are expected to be $700,000 per year, based on achieving an additional 2.5% reduction in total campus utility usage.

Estimated Costs: The Outreach Program will require an upfront investment of around $85,000 for a consultant and other expenses, plus approximately $80,000 in annual on-going costs.

4. **Establish campus energy policy to provide administrative context for conservation** – The campus is committed to promoting energy efficiency and conservation to benefit students, faculty, staff and the campus community. Beyond reducing utility bills, careful energy management helps protect the environment and extends the life of equipment while also maintaining a comfortable setting in which to learn, teach and work. The goal of the energy policy is to:

Policy
Minimum standards for settings, renovations, and new construction
All utilities
All buildings included

- Establish expectations for energy load management in and for campus buildings, as MBTUs/sf and based on energy profile of existing spaces to assure effective operations and minimize waste.
- Set ambitious standards – beyond the UC Policy on Sustainable Practices – for energy efficient performance for new construction and renovation, equipment and procurement. Determine and implement practices that can decouple growth in research activities from increases in energy consumption.
    a. Design new buildings to meet campus energy load and energy intensity standards and to exceed California energy code by a minimum of 30%, aiming to achieve conformance with the AIA Building Challenge: Zero Net Energy (ZNE) by 2030.
    b. Building renovation projects should attempt to be ZNE increase.
    c. Purchase only Energy Star equipment where available, and assure energy consumption criteria are included and assessed in equipment procurement, consistent with UCOP policy[33].
- Set a standard for energy intensity for campus buildings, by building type (MBTU and kW/sf).
    a. Commit to continuous building commissioning, to minimize waste in building operations due to over/under heating and cooling.
    b. Operate building systems only when buildings are occupied.
    c. Establish and publicize regular building operation hours for each campus building by type and dependent on the occupant program needs.
- Establish/confirm a goal for renewable power generation and/or procurement.

Estimated Savings: The policy will support the other elements of the EMI, and no direct savings have been estimated.

Estimated Costs: No investment is being requested.

5. **Three additional projects are proposed to expand the campus renewable energy generation, to evaluate a partnership to install a biodigester, and for a campus Energy Co-Lab.**

Major Projects
Renewable energy purchase
Biodigester feasibility
Energy Co-Lab

Triple the campus renewable energy capacity – Install 200 kW of solar power on the roof of the Recreational Sports Facility through a power purchase agreement. The photovoltaic panels would create almost 300,000 kWh of electricity each year.

Investigate the feasibility of installing a bio-digester at the Richmond Field Station – The biodigester could be sized to handle all campus municipal solid waste and would generate biogas that could be used either for conventional purposes or in a fuel cell. Partners would be identified and might include UC Davis, StopWaste, and interested participants in the East Bay Green Corridor Partnership.

Tap into the campus as a living laboratory for collaborative research – create a Campus Energy Co-Lab that

would serve as a focus for faculty-student-staff research:

By playing an integrative function, the Co-Lab would provide assistance and be a point of entry and a connector for on-campus applied energy research projects (rather than basic energy research)

The Co-Lab would work with student groups and projects as well as academic courses to improve the service learning opportunities on campus.

Offer campus internship opportunities for industry and other institutions, as well as training for Facility Managers.

Create scaled deployments of technologies demonstrated on UC campuses by the CEC /CIEE PIER SPEED Program.

Possible projects to be jointly funded by the Co-Lab and outside donors or sponsors might include: a thermal energy flow efficiency experiment on Corey or Wurster (the two most studied buildings), a smart building planning and analysis effort for all of campus, and a comfort science project designed to test new small scale heating/cooling devices designed to increase occupant control and reduce HVAC energy utilization.

Estimated Savings: No direct savings are estimated at this time.

Estimated Costs: The Energy Co-Lab requests a $500,000 investment, and the renewable energy installation will require an annual net cost of around $21,000.

Expected Longer Term Savings – The savings that we estimate will accrue from implementing these recommendations should be just the start. These changes will build a foundation of people, incentives, and services that can continue to yield additional energy reductions and savings and increase our ability to innovate and adapt. In addition, the program could expand to include exploring systems that allow better sub-metering of energy usage to give individual users increased awareness of their personal consumption, including expanded use of the wireless sensors already in place in Cory Hall.

ALTERNATIVES CONSIDERED

Base Scenario – This scenario assumes that all recommendations are fully implemented. An investment of $5-11 million would be required, and additional funding would be needed to cover on-going costs. As is described in more detail below, it will be possible to cover future costs through a combination of SEP financing, central campus funds, or additional energy savings from completed SEP projects (that are not needed to repay the SEP loan).

FY10-11 (in $M)	FY11-12 (in $M)	FY12-13 (in $M)	FY13-14 (in $M)	FY14-15 (in $M)	FY15-16 (in $M)	Cumulative Total, 2010-2016 (in $M)	FY15-16 Run Rate (in $M)
Financials: Savings projections							
$0	$860,000	$1,900,000	$2,610,000	$3,660,000	$3,700,000	$12,730,000	$3,700,000
Financials: Investment required (includes both one-time and on-going)							
$320,000	$1,690,000	$2,140,000	$2,530,000	$2,530,000	$2,430,000	$11,640,000	$2,380,000
Financials: Net Benefit (cost): Total Savings							
-$320,000	-$820,000	-$240,000	$80,000	$1,130,000	$1,270,000	$1,090,000	$1,320,000
Financials: Net Benefit (cost): Centrally-captured Savings Only							
-$320,000	-$1,320,000	-$1,370,000	-$1,310,000	-$320,000	-$180,000	-$4,810,000	-$130,000

No Major Projects – The campus could choose to eliminate the three major projects proposed by the EMI. In this scenario, the Co-Lab would still exist but without campus funding for a technology project. The campus would still see $3-4 million in annual energy savings, but the total investment would drop by $800,000.

Energy Management: No Major Projects Scenario							
FY10-11 (in $M)	FY11-12 (in $M)	FY12-13 (in $M)	FY13-14 (in $M)	FY14-15 (in $M)	FY15-16 (in $M)	Cumulative Total, 2010-2016 (in $M)	FY15-16 Run Rate (in $M)
Financials: Savings projections							
$0	$860,000	$1,900,000	$2,610,000	$3,660,000	$3,700,000	$12,730,000	$3,700,000
Financials: Investment required (includes both one-time and on-going)							
$320,000	$1,490,000	$1,970,000	$2,360,000	$2,360,000	$2,360,000	$10,850,000	$2,360,000
Financials: Net Benefit (cost)							
-$320,000	-$620,000	-$70,000	$250,000	$1,300,000	$1,340,000	$1,880,000	$1,340,000
Financials: Net Benefit (cost): Centrally-captured Savings Only							
-$320,000	-$1,120,000	-$1,200,000	-$1,130,000	-$150,000	-$110,000	-$4,030,000	-$110,000

Phased Energy Office – This is the first of two approaches (see Contracted Energy Office) to lowering the cost and the risk of establishing a new Energy Office, while still preserving the option of establishing a fully functional Office in the longer term. Under this alternative, the Energy Office would not be fully staffed in the first 2-4 years. Instead of providing energy management services campus-wide, the Energy Office would only add enough staff to cover 2 of 8 proposed zones, focusing on the largest energy users first. ***This first phase would require an investment of $2.6-3.7 million.***

Annual gross savings would initially be ~20% less under this scenario, but would eventually increase to the same level as predicted under the base scenario. Besides the loss of re-commissioning savings for the buildings in the remaining 6 campus zones for the first 3 years, the savings from the outreach program are expected to be lower. This would occur because the lack of Energy Office support would reduce response time to nuisance calls risks and could lower the participation rate. Savings achieved under the Strategic Energy Plan may also not persist in buildings in the remaining zones (at a loss of up to 3% annually in savings). One concern of this scenario is whether this approach ensures sufficient capacity to have an impact on savings sufficient to maintain interest in the initiative across campus.

The second phase of this scenario is expected to be mostly self-sufficient, covering on-going costs through centrally captured savings. In order for these savings to be sufficient, it would have to be the case that half of the PPCS credits earned by the OUs end up supporting the Energy Office through recharged costs (e.g., a work order credit used for custom adjustments to building operating schedules). This analysis excludes the proposed funding for Major Projects. In the event that these centrally captured savings are not sufficient, there are expected to be close to $3 million in central savings from the current SEP projects (net of the existing loan commitments) that might also be considered a source of support. It is also possible that some costs could be covered through recharge to the SEP financing mechanism.

Energy Management: Phased Energy Office Scenario (also excludes Major Projects)							
FY10-11 (in $M)	FY11-12 (in $M)	FY12-13 (in $M)	FY13-14 (in $M)	FY14-15 (in $M)	FY15-16 (in $M)	Cumulative Total, 2010-2016 (in $M)	FY15-16 Run Rate (in $M)
Financials: Savings projections							
$0	$660,000	$1,490,000	$2,100,000	$3,380,000	$3,700,000	$11,320,000	$3,700,000
Financials: Investment required (includes both one-time and on-going)							
$320,000	$1,070,000	$1,090,000	$1,260,000	$1,580,000	$2,360,000	$7,670,000	$2,360,000
Financials: Net Benefit (cost)							
-$320,000	-$410,000	$400,000	$840,000	$1,800,000	$1,340,000	$3,650,000	$1,340,000
Financials: Net Benefit (cost): Centrally-captured Savings Only							
-$320,000	-$810,000	-$540,000	-$310,000	$460,000	-$110,000	-$1,630,000	-$110,000

Contracted Energy Office – This is the second of two alternate approaches (see Phased Energy Office above) to lowering the cost and the risk of establishing a new Energy Office, while still preserving the option of establishing a fully functional Office in the longer term. Under this alternative, the Energy Office would commit to hiring a majority of its staff on limited contracts (2-4 years). A concern is whether the same caliber of applicants would be drawn to a limited contract position, especially since the positions being added are in relatively high demand even in this economy. The effort to convert positions from limited contract to permanent may also be disruptive to the program.

At annual reviews of the initiative, modifications in the number and type of employees could be made in response to the project outcomes and achievement of projected energy savings. ***The EMI would initially request the first 3 ½ years of funding ($3.7-6.1 million, which includes FY10-11). The next phase of this scenario is again expected to be mostly self-sufficient, covering on-going costs through centrally captured savings (with the same assumptions as listed for the second phase above).***

Minimal Energy Office staffing – Under this scenario, fewer staff and services are included in the Energy Office, which would focus on developing and implementing the incentive program only. Annual gross savings would be ~60% less under this scenario, and very few of the savings would be captured by central campus. Besides the loss of re-commissioning savings, the savings from the incentive program and the outreach program are expected to be lower and potentially decrease over time. This would occur because the lack of support from the Energy Office would erode savings and because achieving lower savings in the initial years and not having a system to reduce response time to nuisance calls risks could lower the participation rate. Savings achieved under the Strategic Energy Plan may also not persist (at a loss of up to 3% annually in savings).

Energy Management: Minimal Energy Office Staffing Scenario (also excludes Major Projects)							
FY10-11 (in $M)	FY11-12 (in $M)	FY12-13 (in $M)	FY13-14 (in $M)	FY14-15 (in $M)	FY15-16 (in $M)	Cumulative Total, 2010-2016 (in $M)	FY15-16 Run Rate (in $M)
Financials: Savings projections							
$0	$390,000	$890,000	$1,180,000	$1,440,000	$1,440,000	$5,330,000	$1,440,000
Financials: Investment required (includes both one-time and on-going)							
$320,000	$890,000	$740,000	$740,000	$740,000	$740,000	$4,170,000	$740,000
Financials: Net Benefit (cost)							
-$320,000	-$500,000	$150,000	$440,000	$700,000	$700,000	$1,160,000	$700,000
Financials: Net Benefit (cost): Centrally-captured Savings Only							
-$320,000	-$780,000	-$500,000	-$320,000	$70,000	$70,000	-$1,770,000	$70,000

Cap on "Free" Energy Usage – Without the recommended measures, energy cost deficits may no longer be fully absorbable by campus discretionary funds and recharge to state-funded units may become necessary. Under this scenario, baselines for Operating Units would never be adjusted for programmatic or enrollment changes, forcing units that need to expand to find offsetting reductions in energy consumption. This scenario was rejected because of the possible impact on research, and political challenges in implementing, even though it would assist in meeting our greenhouse gas emissions reduction goal.

Status Quo – It is estimated that energy consumption would continue to rise by an average of 1-2% per year under this scenario, and that prices will rise by 3-5% annually – which would result in approximately $1 million in extra expense just from main campus electricity. The campus would face increasing utility deficits, increased risks of future price increases, and the additional cost of purchasing credits or offsets to achieve our greenhouse gas emission reduction goal. Building maintenance would further deteriorate and would offset present gains afforded by SEP reductions.

IMPLEMENTATION PLAN

Implementation activities: Implementation will be spread over four work areas.

Energy Office	Marketing and Outreach	Major Projects	Energy Policy
Functional Lead: Chris Christofferson Staff Lead: Sara Shirazi	Functional/Staff Lead: Lisa McNeilly	Functional Lead: Staff Lead:	Functional/Staff Lead: Judy Chess
Areas of responsibility: Implementing Recommendations #1&2	Areas of responsibility: Implementing Recommendations #3	Areas of responsibility: Implementing Recommendations #4	Areas of responsibility: Implementing Recommendation #5

Deliverables will include:

- Hire new staff for Energy Office and an appropriate space identified for these new staff
- Develop energy "usage records" and baselines for Operating Units that clearly show monthly usage (in total and relative to established baseline)
- Purchase software that presents energy usage in a user-friendly way and that can show progress toward the campus-set baselines for each Operating Unit (OU)
- Install kiosks or video displays in select campus buildings (focus on largest buildings).
- Create website for overall program that can also provide users information on building and/or Operating Unit usage.
- Hire outside help to establish a visual identity for the incentive program (and possibly the Energy Office) and a staff Communications Coordinator; develop marketing and outreach materials.
- Establish a group of student interns and volunteers to assist in implementation.
- Complete feasibility studies and planning process for major projects; installation of solar panels.

APPENDIX A: Design Team Members and Contributors

Design Team

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Other Contributors

Sam Borgeson, Graduate student Lindsay Baker, Graduate student Raul Abesamis, Physical Plant - Campus Services Ben Palaima, Physical Plant - Campus Services

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[1] The exact total will depend on how the on-going costs of the Energy Office are included.
[2] For this analysis, avoided costs are defined as due to future price increases, avoided payments for renewable energy credits (RECs) under our commitment to reduce our greenhouse gas emissions, and from the maintenance of energy savings under the current Strategic Energy Partnership (SEP).
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[6] Bain & Company, April 2010.
[7] Bain & Company, April 2010.
[8] "Servers and Data Centers," Briefing paper prepared by the OE IT Design Team, October 4, 2010.
[9] "UC Strategic Energy Plan, University of California, Berkeley," Newcomb Anderson McCormick, July 18, 2008.
[10] Rate analysis and worksheet prepared by Navigant Consulting for UCOP, October 2010.
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[33] University of California Office of the President, "Policy on Sustainable Practices," September 1, 2009. http://www.universityofcalifornia.edu/sustainability/documents/policy_sustain_prac.pdf