SOLUTION OVERVIEW
Home to more than 27,000 undergraduates and more than 10,000 graduate students, Berkeley is internationally renowned for excellence and pioneering achievements across all disciplines. Berkeley’s research strength includes expertise in addressing pressing global challenges in the areas of health, energy, and the environment. In 2014, US News & World Report ranked six Berkeley graduate programs — chemistry, computer science, English, history, public policy, and sociology — No. 1 in the nation.

UC Berkeley is also a leader in sustainability: 75% of students commute carbon-free by walking or biking; $1.8 million in student-fee funding has been allocated for 131 sustainability projects in seven years; and 29% of undergraduates took at least one course focused on sustainability in 2013–14.

UC Berkeley benefits from a mild, year-round climate that requires minimal heating or cooling, which is generally provided by steam, and campus energy consumption is instead dominated by electrical demand for mechanical systems, research equipment, electronics, air circulation, and lighting.

ORGANIZATION TYPE
Public University

GOAL
To cost-effectively deliver a program that actively manages and engages the campus community in reducing energy use, and saves $2 million in annual energy costs

BARRIER
The school’s biggest energy consumers – 46,000 students, faculty, and most staff – had no framework to understand or be informed about the energy impacts of their behaviors, especially since utility costs were administered centrally

SOLUTION
The Energy Management Initiative (EMI) solves this issue by targeting building occupants through building surveys and energy dashboards, and allocating energy cost responsibility to individual campus operating units.

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OUTCOME
The EMI has achieved savings of $6.5 million, 58.7 million kWh and 893 thousand therms in just three years.

POLICIES
UC Berkeley identified energy efficiency as an important pathway to meeting the University of California’s system-wide goal of reducing GHG emissions to 2000 levels by 2014, 1990 levels by 2020, and carbon neutrality by 2025. These goals align with those established by AB 32, the California Global Warming Solutions Act.

To help meet both the UC system and State of California goals, CalCAP, or Cal Climate Action Partnership, was formed in 2006 with the goal of reducing UC Berkeley greenhouse gas emissions to 1990 levels by 2014. UC Berkeley met this goal two years ahead of schedule in 2012 thanks in large part to campus energy efficiency projects and cleaner grid electricity supplied by Pacific Gas & Electric. To fund its aggressive energy efficiency program, the University of California Office of the President (UCOP) formed a unique Strategic Energy Partnership with the California State University system and the state's Investor Owned Utilities (IOUs). Energy efficiency projects since the program began in 2004 allow the UC system to avoid over $28 million in additional energy costs annually; UC’s annual energy costs would be ten percent higher if these projects had not been implemented. This program’s cumulative avoided costs reached $140 million by the end of 2014. Projects completed in 2014 were projected to increase these cumulative savings to approximately $170 million at the end of 2015. The program also provides extensive training to UC staff and sponsors the UC-CSU Energy & Sustainability Best Practice Awards Program and resulting case studies on winning projects.

PROCESS
The UC Berkeley Energy Management Initiative (EMI) was established in 2010 as one of the original Operational Excellence (OE) initiatives. The Operational Excellence Program Office advances UC Berkeley’s financial sustainability by offering expertise, services, and tools to support ideas that generate new revenue, reduce costs, or improve administrative operations. Thus, the EMI was designed to complement existing campus operations and goals, and broadly consists of four components: the Energy Incentive Program (EIP), Energy Office, Energy Dashboards and Energy Policy. With annual energy costs typically around $27 million ($21 million in electricity and $6 million in steam), the school set an ambitious target of saving $2 million per year in electric costs.

The status quo of energy consumption at UC Berkeley was showing an average annual electricity usage growth rate of 2.5%. In ten years, that compounds to growth of 28%! It was determined that a major barrier to reducing energy consumption and costs was having management of energy usage and costs reside centrally.

The campus just needed a scalable method to implement the EMI and change the status quo. Connecting building occupants, operators and the larger campus community required careful
planning and steadfast program execution, both of which were achieved with the Energy Incentive Program.

**Energy Incentive Program**

The Energy Incentive Program (EIP) restructures energy cost allocation by disaggregating electricity use at the campus level, and instead rolling it up under 29 individual campus operating units (OUs) – the highest level of reporting for any department or college within UC Berkeley. Program rules dictate that OUs are billed according to a square footage apportionment – energy use tied to a specific physical space.

A steering committee of administrators, researchers and other experts helped guide the development of the EIP. Each OU on campus was assigned an energy baseline according to historical energy use for their apportioned square footage. If certain spaces shared metering across OU’s, square footage was broken down by percentage and costs were billed proportionately. For shared spaces where there was uncertainty over percentage breakdown, the Energy Manager and steering committee considered input from OU’s and occupants, then issued final decisions. Equipment or space that was particularly energy intensive was submetered. The program focused solely on electricity use due to controllability by occupants and metering system reliability – steam use has few occupant-influenced controls and is notoriously difficult to meter.

The EIP was phased in over two years, with the first year being an “incentive-only” phase – any OU that saw savings in year one could claim those savings, while any OU that saw increases would have those covered by the university. First year incentive payments amounting to between $870,000 and $995,000 were factored into the utilities budget. OUs then assumed full cost responsibility in year two.

Prior to the first year, the EIP implemented a three month pilot phase which allowed it to educate deans and vice chancellors on energy basics and address unforeseen challenges in the program. The energy team met with, on average, three leadership staff members from each OU to bring them up to speed, and made themselves available for follow-up as needed to help establish a trusting relationship and good rapport. In the majority of OUs, at least one of these staff members were designated as an “Energy Liaison” that were tasked with EIP coordination. Each building also has a facility manager, whose background and training can vary widely and thus relies heavily on support from energy dashboards and the Energy Office. Within each unit, the deans and directors received monthly statements that showed energy performance trends in building. This method of communication was also augmented by a publicly-available real-time energy dashboard for many buildings on campus (more details below).

Challenges that arose during the pilot included the need to reconcile data integrity issues between smart meter readings and manual meter readings, which led to the installation of smart meters during the pilot period. Additionally, a process was refined for equipment failures during the pilot. Once OU staff identify an equipment failure, an Energy Adjustment Form asks them to submit their name, number and equipment problem, and the central plant team responds to the issue. During repairs, OUs are not responsible for energy costs generated by the equipment, which are covered by the existing facilities budget instead of emergency funds. This process has been found to identify

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issues more quickly than previously. Energy savings cited by EMI exclude costs of failed equipment since it is a central plant problem, not an energy problem.

In July, 2015, the EIP transition completed and the Energy Office capped EIP payments at $650,000.

**Energy Office**

The Energy Office was established over the course of two years to administrate technical support for the EMI. Seven mechanics and technicians were hired from outside the university to create a multi-disciplinary group of experts. Paired with two existing energy staff, the Energy Office had a total of nine employees at its peak in 2014.

The Energy Office used a blended approach of system diagnostics and energy trending to track system and equipment issues that may lead to energy use increases. A business process was put in place where the Energy Office became a stakeholder in processing work order requests related to setpoint and schedule changes to building lighting and HVAC systems. Through a separate business process, the Energy Office also provided guidance on practical energy efficiency for new construction and renovation projects through the review of select construction and design projects.

Instrumental in the early success of EMI, the Energy Office staff have been transferred into general maintenance positions to help alleviate campus-wide budget issues. In their new role, the staff serve as change agents throughout operations. The Energy Office now includes an Energy Manager and an Associate Director of Campus Facilities, as well as some part time staff. If the Energy Office does need assistance, they are able to pull in either external contractors or internal operations staff.

**Building Energy Dashboards**

Communication and outreach have been critical to the success of the EMI. The UC Berkeley Energy Office knew it would be necessary to provide individual OUs and their facility managers with energy data in order to educate and empower them to successfully manage their energy consumption.

UC Berkeley contracted Pulse Energy to develop MyPower – an intuitive energy dashboard. UC Berkeley’s Energy Office and the Office of Sustainability worked closely with Pulse on the technical aspects, as well as the graphic design and branding. The Energy Office had considered student help in MyPower development, but decided against it due to time constraints. Student work inherently takes time due to their class load and other commitments. Through Pulse, 60 dashboards were installed in nine months. Launched in 2012, the MyPower dashboard provides history of the building and the current occupants, as well as real-time energy and historical energy data.

The dashboards themselves provide energy data at 15-minute intervals, as well as historical energy use back to 2010. Reports are delivered to OU facility managers every morning showing actual energy use for the previous 24 hours, historical energy use for those 24 hours, and projected, “target” energy use based on proprietary algorithms developed by UC Berkeley. In a survey completed by recipients, 77% of respondents found the daily reports helpful, 77% reviewed them daily, and 56% had identified efficiency opportunities and tracked the result. Users are able to
compare the energy use of any two buildings by total square feet, number of occupants and total consumption. Each building dashboard also lists a building contact to increase transparency and allow users to engage.

To get full value out of the MyPower dashboard, UC Berkeley developed an outreach and marketing campaign to leverage the dashboard for influencing individual behavior change. A campus storefront, the “MyPower Resource Center”, was set up to provide free energy-saving tools and tips for students, faculty and staff. Resources were developed for specific energy-intensive space types, including laboratories. Walk-ins are able to view the energy dashboards, pick up materials like stickers, banners and posters, and borrow energy efficiency tools like power lagers and temperature sensors. These tools and resources helped put together energy saving competitions in academic buildings and residence halls, and maintained an Energy Office presence in main campus. In addition, four physical dashboard kiosks with 48” screens were installed across campus to assist with occupant engagement. However, there were generally not used very much and were running 24/7. This irony was recognized by both the Energy Office and students, and no future kiosks are planned.

In one instance, UC Berkeley targeted Wurster Hall, an academic building with studio, office and retail spaces, with an energy competition to influence behavior change. A student-funded grant paid for the installation of 24 submeters to track building systems and integrate with the UC Berkeley dashboard system. The building was split into seven teams and energy use tracked online, realizing an eight percent energy reduction. Wurster Hall also was selected for the EPA’s 2013 Battle of the Buildings competition against 3,200 other buildings nationally.

Publicly displaying building energy consumption has also led to enhanced energy data review, courtesy of faculty and students. In fact, eight building case studies illustrate energy saving successes resulting from use of MyPower. In one instance, an assistant professor noticed an energy anomaly where usage spike after graduation and did not come back down. He reported the observation to the Energy Office, who then identified and fixed a previously unidentified equipment problem. Without the dashboard and assuming this problem had gone unnoticed, the annual avoided cost could be as high as $45,000. In the future, a ‘wish list’ enhancement for MyPower is the development of heat maps for all buildings.

**Energy Policy**

A campus energy policy was published in January, 2014 to apply a broad set of behavioral and operational standards across the university. The University’s Director of Green Buildings worked with energy and facilities staff to write the 12-page policy, which applies to students, faculty, staff and visitors and covers the following areas:

1. Building Heating, Cooling and Ventilation
2. Lighting
3. Equipment Procurement
4. Building Design and Construction

The policy includes many common-sense provisions, such as shutting off lights in empty rooms and
requiring power-save settings. It also prohibits the use of certain energy-intensive equipment, like portable air conditioners and space heaters, without approval from the energy manager and requires facility managers to consult the energy manager before making any HVAC scheduling adjustments. Additionally, all new fume hoods must be equipped with VAV and reviewed by both Environment, Health & Safety and the energy manager, and projects should separately meter significant loads when appropriate to project scope. New construction and major renovations must exceed state energy code standards by 30%, and meet LEED Gold certification requirements.

Flyers and best practices documents were created and disseminated to help occupants and building managers become familiar with the policy, which is in effect until its next review in January, 2019.

**Partnerships with External Organizations**

While the EMI was developed in-house by UC Berkeley, the program also leveraged experts from campus research groups, national laboratories and other organizations for projects including re-tuning building HVAC and lighting systems and identifying and implementing energy efficiency opportunities in large research labs. A full list of EMI partnerships can be viewed below.

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<thead>
<tr>
<th>Organization</th>
<th>Research Interest</th>
<th>Application</th>
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<tbody>
<tr>
<td>Center for the Built Environment</td>
<td>• Occupant thermal comfort</td>
<td>• Personal comfort systems at Doe Library and Stanley Hall</td>
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<td></td>
<td>• HVAC controls sequences</td>
<td>• HVAC setpoint and deadband reset in Stanley Hall</td>
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<tr>
<td>LoCAL</td>
<td>• Occupant-controlled heating and cooling</td>
<td>• Application deployed in Sutardja Dai Hall</td>
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<td></td>
<td>• Energy dashboards</td>
<td>• sMAP viewer in over 50 buildings</td>
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<tr>
<td>College of Engineering / Architecture / PG&amp;E</td>
<td>• Building systems energy use and RCx</td>
<td>• Energy audit and analysis of HVAC, lighting and window shades in Energy Biosciences Building</td>
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<td></td>
<td>• Automated fault detection for HVAC</td>
<td>• Pilot application in pneumatic control system</td>
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<tr>
<td>CITRIS</td>
<td>• Best in class</td>
<td>• Pilot project in</td>
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<tr>
<td>Outreach</td>
<td>HVAC control sequences</td>
<td>Sutardja Dai Hall airside systems</td>
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<tr>
<td>TGIF</td>
<td>• Implement projects to help meet teaching and sustainability goals</td>
<td>• Smart plugs installation at Carleton and South Hall • LED retrofit for microscopes in Valley Life Addition</td>
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<tr>
<td>Lawrence Berkeley National Laboratory</td>
<td>• Rapid efficiency feedback for building managers • Whole building measurement and verification (various) • Backpack-mounted building energy modeling</td>
<td>• Deployed in over 60 campus buildings • Evaluate accuracy of forecast by whole building energy algorithm • Pilot data collection and verification in Mulford Hall</td>
</tr>
<tr>
<td>Pacific Northwest National Laboratory</td>
<td>• Re-tuning of building systems for efficiency using simple tool</td>
<td>• Re-tuning training and assessment of Soda Hall and Hertz Hall</td>
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**OUTREACH**

UC Berkeley’s Energy Office has performed outreach on the EMI both to UC Berkeley OUs, as well as to the general campus population.

Internally, the energy manager met with each of the 29 OUs on campus to brief them on the Energy Incentive Program, and generally about EMI. These meetings involved vice chancellors, CFOs, chiefs of staff, and building managers for each OU. These small, in-person meetings helped developed transparency and trust, and generally created a good communication link between OUs and the Energy Office. Starting with implementation of EIP, continuing through the cessation of EIP benefits in July, 2015, and up to today, the Energy Office has and continues to make itself available for questions and concerns of OU administrative, finance and operations staff, particularly building managers.

For outreach to the campus, the Energy Office employs one communications staff member with a graphic design background to produce flyers, pamphlets, stickers, web content and other outreach materials targeted towards the general campus population. A sustainability office staff member also works at orientation and campus events to distribute MyPower outreach materials.

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For more details on how MyPower engages students, faculty and staff, please see ‘Energy Dashboards’ above, under Process. For copies of outreach materials, see below, under Tools and Resources.

**TOOLS AND RESOURCES**
- Campus Energy Policy
- Sample Building Energy Assessment
- MyPower Building Energy Dashboard
- Energy Baseline Adjustment Form
- Energy Baseline Adjustment Process Memorandum
- Summary of Executed Energy Baseline Adjustments

**MEASURING SUCCESS**
UC Berkeley employs two key indicators for the Energy Management Initiative, total electric usage (kWh per year) and energy use intensity (kWh per square foot), in addition to complementary metrics. Data collection is completed through monthly utility bills that are summarized annually. This information is complemented by space planning data on the number of buildings on campus and their respective occupancy rates. An upgrade to the electricity monitoring system was required for more accurate data.

This assessment is being shared throughout campus as a barometer of success for the EMI. These indicators are conveyed to key staff throughout the organization to continuously reinforce a culture of energy efficiency.

**Total kWh** – capture total monthly and annual kilowatt hours consumed to track electric savings.

**kWh/sq. ft.** – capture annual kilowatt hours per square foot to track electric use intensity.

**Total Dollars** – quantify total monthly and annual utility costs to track energy cost savings.

**Total kBtu** – capture total monthly and annual British thermal units consumed to track steam savings.

**kBtu/sq. ft.** – capture annual British thermal units per square foot to track total energy use intensity (includes steam and electric).

**Work Orders** – complaints logged to facilities via call center, work order system or student social media sites (e.g. Facebook).

**OUTCOMES**
The Energy Management Initiative has saved 58.7 million kWh, 893 thousand therms and $6.5 million in the three years since its implementation, relative to the program’s fiscal year 2010/11 baseline. This is equivalent to a 22% drop in energy use intensity over the same period. The campus now has a method in place to help benchmark energy performance in its buildings and by operating unit, as well as a framework to enable individuals and OUs to contribute to energy efficiency.
Additionally, campus work orders carried out by the Energy Office have dropped significantly. In FY 14/15, between 400-500 work orders were logged by building occupants for what are most often occupant comfort issues stemming from energy-related problems. Through the first nine months of FY16, only 50 work orders have been logged. That equates to an approximate 85% reduction.

The understanding and buy-in of executive management on the topic of energy loads and costs was crucial to the success of the program. Additionally, MyPower provided the appropriate energy monitoring infrastructure to ensure transparency and reliability of the Energy Incentive Program, while also serving as a continuous commissioning tool for the Energy Office.