



Award Category

Monitoring-Based Commissioning

Opportunities Identified with MBCx

Replacement of failed variable speed drives

Revised HVAC schedules and control sequences

Occupancy-based lighting controls in structural lab

Modified hot water reset

Size

140,100 ft²

Annual Energy and Cost Savings

544,000 kWh (33%)

70,000 therms (64%)

\$110,000

Cost

In-house costs

\$28,500

Consultant fees

\$40,500

Contractor costs

\$126,000

Completion Date

2011

UC Berkeley Davis Hall Monitoring-Based Commissioning

Monitoring-based commissioning at Davis Hall replaced failed variable speed drives, reduced hours of operation for air handlers, and implemented occupant-based lighting controls. Generous utility rebates made the project highly cost effective, with a payback of less than five months.

Davis Hall at UC Berkeley houses a major portion of the Civil Engineering Department. Constructed in 1961, the building includes seven floors above grade with one below. A structural testing laboratory takes up a majority of the first floor; the remainder of the building contains other small lab spaces, classrooms and offices.

Davis Hall was long overdue for retro-commissioning and was selected for monitoring-based commissioning (MBCx) implementation as part of the Strategic Energy Plan (SEP), which is funded by the UC Office of the President. This program identifies potential energy efficiency retrofit projects among existing buildings, including lighting upgrades, HVAC modifications, as well as MBCx projects for buildings over 50,000 square feet. The MBCx implementations identify and correct operational problems associated with HVAC and lighting controls, and verify the energy savings using whole-building metered data. Both the SEP and the MBCx program are funded through the UC/CSU/IOU Partnership, a collaboration between the UC and CSU systems and California's investor-owned utilities (IOUs).

Generous utility rebates reduced the project payback to less than five months.

Measurement before and after retrofitting is a key aspect of any MBCx process. At UC Berkeley, controls specialist Venzi Nikiforov has worked to ensure that practically all campus building management systems (BMS) provide trending of numerous data points, something that facilitated the MBCx process at Davis Hall. Facilities Dynamics Engineering (FDE) was hired to identify energy saving opportunities in the building, to be implemented by UC Berkeley's Capital Projects.

The building had an outdated but effective Barrington BMS that provided the

commissioning agent with numerous data points and rich data early in the commissioning process. As one of the first steps in the MBCx process, new whole-building electrical and steam meters were installed to provide additional information that would be useful to document the energy baseline and verification of energy savings. Energy analysis performed by FDE revealed multiple opportunities for savings at Davis Hall. The three top energy measures were the replacement of failed variable speed drives, reduction of operating hours on the main air handling units (AHUs), and improved lighting control in the structural testing lab.



View of Davis Hall south elevation and courtyard. Image: UC Berkeley.

Most of the fan systems at Davis Hall are controlled by variable speed drives (VFDs). However, prior to the MBCx project many were broken or placed in a bypass or manual mode, causing fans to run continuously at full speed, even though many fans were scheduled by the BMS to be off at night and on weekends. As part of the MBCx project, the VFDs were replaced, so that now the fans slow down under low loads and turn off when scheduled.

Additional analysis of HVAC trend data revealed that many air handlers were running longer than necessary, a problem frequently found during BMCx projects. The project team reduced the average AHU operation by ten

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Project Team

Campus:
Capital Projects
MBCx Agent: Facility
Dynamics Engineering
Utility Partner: PG&E

More Information

<http://sustainability.berkeley.edu/pages/energy/overview.shtml>

<http://www.facilities.berkeley.edu/GreenBuildings/resources.html>

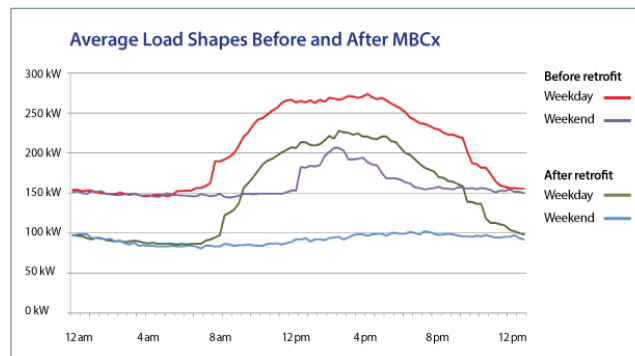
<http://cx.lbl.gov/MBCx.html>

<http://mypower.berkeley.edu/>

hours per week, with no complaints from occupants. In addition, a new BMS control sequence uses the return air temperature to control the fan speed.

A structural testing lab that was frequently unoccupied was a key opportunity for lighting energy conservation.

Another key energy saving opportunity was taking advantage of daylighting in the open bay area of the structural testing lab, and only using electric lighting as needed. Previously lighting was on continuously from approximately 6:30 a.m. until 8:00 p.m., regardless of occupancy. Based on recommendations from the commissioning agent and conversations with the research staff who use the space, the project team implemented



Electrical loads before and after monitoring-based commissioning. Image: Facility Dynamics Engineering.

occupancy-based lighting controls so that lights are off by default, used only as needed, and are on only in the specific areas that are in use, rather than the entire space. It is estimated that lighting consumption in the testing lab has been reduced by 70 to 80 percent. Engaging occupants to turn off lights in unoccupied spaces such as Davis Hall's structural testing lab is an example of UC Berkeley's myPower occupant engagement program, an effort to provide useful feedback about energy use to campus stakeholders.

The total annual savings from the combination of energy measures is 544,000 kWh of electricity and 70,000 therms of steam. This represents 33 percent of the building's annual electrical use, and 64 percent of the steam use. The total utility rebate for the project was \$156,000, which paid for consulting fees, UC Berkeley staff time, meters, and other rebate costs. After accounting for the rebate, the energy savings paid back the university's investment in less than five months.

LESSONS LEARNED

Mark Arney, Senior Engineer at FDE, points out that generous rebates from PG&E can make MBCx efforts such as the one at Davis Hall financially attractive. The UC and CSU systems negotiated preferential rates with the IOUs by arguing that the universities would perform

outreach to campus energy managers and decision makers, reducing the marketing costs for the utilities. With current budget challenges to institutions of higher education, these incentives provide opportunities for greatly needed equipment upgrades that can provide long term energy and operating cost savings. Arney says that many energy professionals are surprised when he mentions the rebates from PG&E, which are typically 25 cents per kWh, and one dollar per therm. Other utility rebate programs typically offer only 5 to 15 cents per kWh. Currently PG&E

rebates are capped at 80 percent of the total project cost.

Finally, Paul Oda, the project manager at UCB Capital Projects, reminds MBCx teams that when making changes to air handler operation it's important to consider life safety systems that monitor ventilation systems. Although life safety concerns don't need to compromise energy efficiency, project teams need to verify during commissioning that airflow is sufficient so that duct detectors can detect smoke.

Best Practices case studies are coordinated by the Green Building Research Center, at the University of California, Berkeley.

The Best Practices Competition showcases successful projects on UC and CSU campuses to assist campuses in achieving energy efficiency and sustainability goals. Funding for *Best Practices* is provided by the UC/CSU/IOU Energy Efficiency Partnership.



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