BEST PRACTICES 2013

MBCx at CSU Long Beach University Music Center

Representing the best success story from the monitoring-based commissioning (MBCx) of five buildings that in aggregate saved $57,000 annually, the University Music Center at CSU Long Beach reduced the electrical load by 6.5%, chilled water use by 66%, and hot use water by 72%.

Award Category
Monitoring-Based Commissioning

Opportunities Identified with MBCx
Recalibrated drifted sensors

Repaired and replaced non-operational actuators and valves

Optimized sequences of operations

Fault detection through advanced analysis of BMS data

Size
66,476 ft^2

Annual Energy and Cost Savings
Electricity 52,600 kWh

Chilled water 93,900 ton-hrs

Hot water 7790 therms

Cost savings $17,300

Cost
In-house fees $29,610

Consultant fees $60,428

Incentives $30,607

Completion Date
2012

Over the course of two years from 2010 to 2012, facilities and energy staff at CSU Long Beach (CSULB) tackled the daunting challenge of performing monitoring-based commissioning on five campus buildings simultaneously. Among the buildings completed, the University Music Center, home to the Bob Cole Conservatory of Music, surpassed expectations by achieving the most significant energy savings and improved building operation among the five MBCx projects. The building houses offices, classrooms, and performance spaces, and presented an unusually complex measurement and analysis situation as it consists of separate structures, each with its own air handler, connected by a common walkway.

University Music Center entry with Walter Pyramid sports complex beyond. Image: David Nelson, CSU Long Beach.

Paul Wingco, Energy and Sustainability Manager at CSULB, explains that while the campus already has high standards for building performance, the MBCx process has been highly effective at further improving their energy efficiency primarily through expert fine-tuning of building systems. Some of the symptoms CSULB staff noticed in the building prior to the MBCx project were simultaneous heating and cooling, zones not receiving adequate heating or cooling, and systems running when the building was unoccupied. In order to dig deeper to uncover additional energy saving opportunities, the campus hired EnerNOC to perform a multi-phase investigation including pre-functional testing, functional testing and verification. The most common problems EnerNOC found, through both site assessment and energy use analysis, were operational and maintenance issues including broken sensors, malfunctioning dampers, loose or broken fan belts, and problems with filter replacement scheduling. Also, many chilled water valves on the air handling units were found to be stuck, leaking, or unresponsive to energy management system (EMS) commands.

Although it was not known to be a particularly high energy user, the University Music Center underwent commissioning that achieved substantial savings in chilled and hot water usage.

The building's EMS, a Staefa TALON product installed in 1994, collects a range of operational data including information on air handlers and hot water systems. Though the EMS provides operators with large amounts of data, without sophisticated analytical tools it is difficult to make meaningful sense of it. EnerNOC fed the EMS data into its EfficiencySMART advanced diagnostic software tool, which continuously analyzes energy information to detect problems resulting from both controls and mechanical components. EnerNOC provided continuous feedback to the project team throughout the project via monthly scorecards and a "heat map" of system faults identified by the diagnostic tools.

The screen capture on the following page illustrates how an effective building operator can use such diagnostic tools to translate data analysis into actionable repairs and improve-

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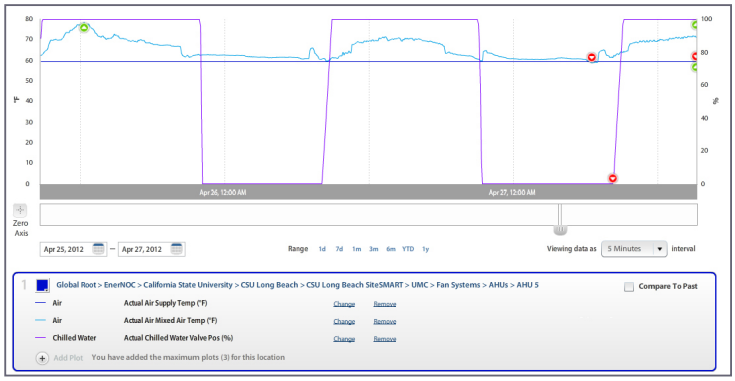
Controls Contractor: ControlWorks

More Information

http://daf.csulb.edu/offices/ppfm/facilitiesmanagement/sustainability/

http://www.aceee.org/files/proceedings/2012/data/papers/0193-000137.pdf

ments. The flat line (blue) indicates that the sensor is reading the same value regardless of the actual temperature, which is evidence of a poorly functioning supply air temperature sensor. When the sensor is performing properly, the trend line will fluctuate with the temperature of conditioned supply air, similar to the trend line in the mixed air temperature sensor (light blue line). The screen also shows the chilled water valve reading as a flat line either fully open or fully closed, another indication of a sensor malfunction. Since the system has an economizer, the chilled water valve should fluctuate based on the amount of free cooling from outside air being supplied. The example illustrates the value of good visualization tools, and the need to regularly verify sensor calibration and the status of key water valves.



Screen image from the University Music Center's diagnostic software. See text for explanation. Image: EnerNOC.

The campus had already captured the "low hanging fruit" of energy efficiency, yet through monitoring-based commissioning it continues to get additional savings on projects.

The University Music Center is unusual as it benefits from a significant amount of physical and network infrastructure that can be used to gather sub-metered data. The project's final report recommends that additional sub-metering be added, and suggested that tying new meters into the existing infrastructure would not be cost prohibitive and would provide the building operator with improved monitoring and diagnostic capability.

The project achieved total annual energy savings of 127,530 kWh, which is equivilent to estimated cost savings of $17,300 per year. These savings include an electrical reduction of 52,600 kWh, chilled water savings of 93,900 ton-hours, and 7790 therms of hot water savings.

To ensure these savings would persist and not deteriorate over time, CSULB opted to maintain EnerNOC's EfficiencySMART building performance monitoring service. This service will enable CSULB to visualize building performance over time and receive notification when energy performance or system components are operating out of usual limits.

LESSONS LEARNED

Unfortunately the project took longer than scheduled, in part to a chilled water meter that failed during the early stages of the project and delayed the establishment of the energy baseline. Without an accurate baseline the subsequent steps in the commissioning process could not be performed.

The project was also delayed by the need to perform functional testing off hours to avoid inconveniencing students and staff during the day. Other scheduling delays were the result of limited facility repair staff access. To avoid delays next time, the project team plans to start the baselining process as early as possible, and establish a protocol to monitor sub-meters and create alarms for malfunctions. This is expected to help eliminate data gaps and allow for robust energy analysis.

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.