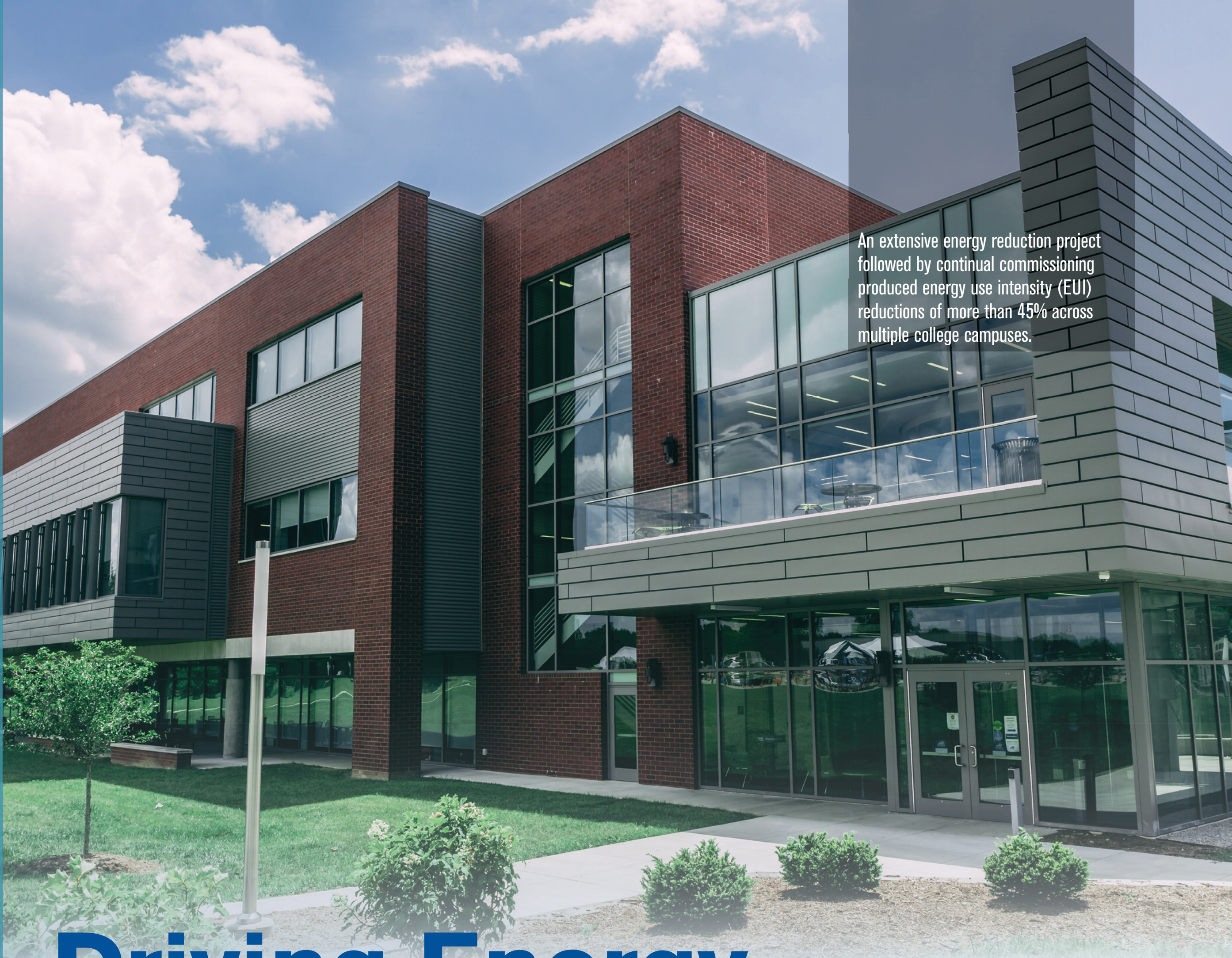

An extensive energy reduction project followed by continual commissioning produced energy use intensity (EUI) reductions of more than 45% across multiple college campuses.

Driving Energy Savings with Data

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A Kentucky college system turned its building data into results. The Kentucky Community and Technical College System now has more energy-efficient systems, better maintained facilities, and—most importantly—a better learning environment.

The Kentucky Community and Technical College System (KCTCS) encompasses 16 colleges located throughout the Commonwealth of Kentucky. In 2015, KCTCS released a request for proposal for a guaranteed energy savings contract (GESC). The goals were to reduce energy and water consumption, resolve ongoing mechanical system issues and replace obsolete equipment, enhance efficiency through the building automation system (BAS) and integrate the BAS into a state managed building data analytics platform. The Kentucky Finance and Administration Cabinet helped develop and manages their own platform called the Commonwealth Energy Management and Controls Systems (CEMCS).

CEMCS is a web-based energy tracking platform for building data analysis (http://kyenergydashboard.ky.gov/). The platform

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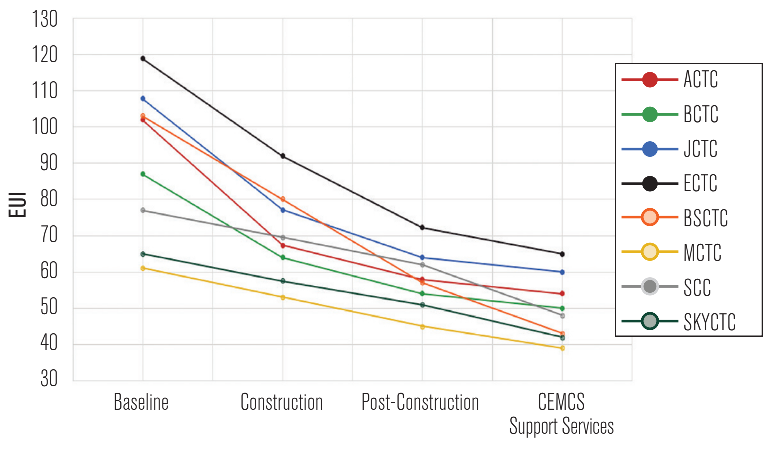
was created to document the progress of energy reduction goals within the Commonwealth of Kentucky. Additionally, CEMCS is a data acquisition tool that polls trend data from all of KCTCS's modern BAS systems.

By pairing this data with a third-party commissioning service, this data has been leveraged to capture additional energy savings, bridging the gap between data acquisition and action. Those energy savings are detailed in the campus energy use intensity reductions shown in *Figure 1*.

FIGURE 1 KCTCS energy use index by campus.



To effectively use the data available in the building analytics platform, the project lead offered a third-party continual commissioning service to KCTCS in the years following the GESC. This service includes: BAS data review of HVAC system performance and occupancy schedules; recommending a course of action for identified mechanical and BAS deficiencies; and, finally, implementing those actions. This process of turning data into action has been provided to eight colleges to date: Ashland (ACTC), Bluegrass (BCTC), Jefferson (JCTC), Elizabethtown (ECTC), Big Sandy (BSCTC), Maysville (MCTC), Somerset (SCC), and Southcentral (SKYCTC).

PHOTO 1 Jefferson Community and Technical College is one of eight Kentucky Community and Technical College System colleges to turn its building data into results.

Energy Efficiency

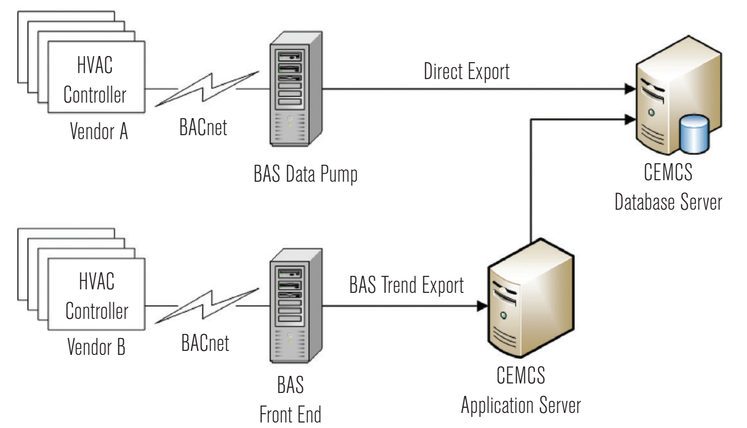
Each KCTCS college went through an extensive energy project before the continual commissioning program began. All facilities were upgraded with LED lighting, low-flow plumbing fixtures were installed, HVAC systems were replaced, new DDC controls systems were installed and, finally, each BAS was integrated into the CEMCS data platform.

Not only did each college energy use intensity numbers decrease after the energy project's implementation, these numbers continued to decrease in the years following. This is due to the continual commissioning provided in the CEMCS Support Services. The CEMCS data platform gave project engineers comprehensive access to trend data of the BAS points, occupancy sensors and utility meters.

This unique platform boosted the facility knowledge of the original project energy engineer with a data set not typically available. With this data, project engineers were able to identify additional energy savings opportunities and develop plans to implement these opportunities. The result was identification of a significant number of energy conservation measures (ECMs) that would tailor the facility's systems exactly to facility use. Program findings led to updates in control and demand limiting sequences, HVAC scheduling and facility comfort improvements. A select set of examples of findings, recommendations, actions and results are detailed here.

Example #1. The air handler night setback sequence at ECTC's Academic Technical Building had "requests required to run" set to two zones. These two zones—namely the entryway and lobby—were consistently out of range during setback times, forcing the AHU and chillers to run more than necessary during unoccupied times. The sequence was updated to require five zones to be out of range to enable setback operation, resulting in nearly $9,000 per year in savings.

FIGURE 2 CEMCS vendor neutral data collection infrastructure.



SOURCE: KEVIN FULLER, IDS

Indoor Air Quality and Thermal Comfort

Among the different measures identified, multiple measures improved the indoor air quality (IAQ) and thermal comfort of buildings. Two examples of the CEMCS Support Services findings that led to IAQ improvements follow.

Example #2. Four variable air volume air-handling units (AHUs) serve the Humanities Building at ECTC. Three relative humidity sensors are placed throughout the building in representative spaces. In the existing setup, each AHU was tied to a single sensor and controlled for relative humidity independently, even though all AHUs served overlapping common spaces. The fourth AHU had no associated humidity sensor in this orientation and was not set up for humidity control. The remaining AHUs were set to 55°F (13°C) supply air temperature (SAT) when their respective space humidity exceeded 60%. The sequence was updated to coordinate all four AHUs to respond to high humidity conditions. If any sensor rose above a 60% relative humidity threshold, all AHUs would respond by lowering the SAT to 55°F (13°C) until the space humidity levels were satisfied.

By addressing humidity control more effectively, this sequence update saved ECTC $3,300 in utility costs through reduced equipment run times and enhanced the occupant comfort.

Example #3. The outdoor air (OA) dampers on three rooftop units at MCTC's Montgomery Building were not functioning properly, and the zones they serve were not receiving adequate ventilation. The dampers were not following the minimum OA setpoint and were not opening to economize. The facility service contractors were alerted, and the damper actuators were repaired.

Innovation

Converting data into action would not be possible without a robust data collection system. CEMCS is completely BAS-vendor neutral system. Data acquisition for all of KCTCS's building automation data follows one of two fully automated paths (*Figure 2*).

Once the BAS information has landed in its respective staging table, CEMCS compiles the data and populates the database to be accessible to the user via the CEMCS front end. The front end includes automated fault detection, diagnostic trends and ad hoc reports. The data is kept permanently, in some cases going back a decade. In total, the KCTCS CEMCS system currently collects data from 125,000 points across 140 buildings.

Operation and Maintenance

Monthly meetings with the facility maintenance team were implemented to share findings of maintenance issues discovered from CEMCS data. These meetings gave the maintenance staff an opportunity to discuss existing facility issues with engineers that designed their facilities. The ongoing communication between the facility maintenance team and engineers who had a holistic understanding of their facilities was a highlight of the program for the college maintenance staff.

Example #4. The supply fan for an AHU-4 at JCTC's Chestnut Hall was running full-speed for months due to static pressure and temperature control issues. This dual-duct AHU was programmed to control to the worst-case static pressure sensor between the hot deck and cold deck. The hot deck supply duct static pressure sensor was blocked by a failed fire damper in the mechanical room, making it the worst-case sensor and forcing the supply fan to run at high speeds with little change in static pressure. This damper was repaired and the fan returned to normal operation. There were known issues with the fire dampers throughout this building, resulting in a review of the fire dampers. A report was provided bimonthly that identified zones with suspected fire damper issues.

Cost-Effectiveness

Since the CEMCS Support Services contract started, the combined total savings attributed to this program is $390,269, far surpassing the annual fee associated with the service contract. The savings for each measure are tracked for 12 months after implementation. The benefits (cost savings, comfort, maintenance, IAQ, etc.) will be realized by each college for years into the future.

Example #5. One of the most cost-effective measures reviewed in this program was the analysis of utility bills versus BAS real-time utility meters. The Occupational Technical Building's electrical contract capacity was originally set at 150 kW. The utility tariff set the minimum demand charge per month at 60% of contract capacity, or 90 kW. The average monthly demand over the previous two years was 66 kW. This resulted in the college paying the contract minimum instead of paying for their actual demand. Data from CEMCS was provided to the utility company and the contract capacity was lowered, resulting in $5,400 a year in demand savings. Similar billing error rectifications have been implemented at other locations. A full table of these measures is shown in *Table 1*.

TABLE 1 Utility rate savings identified through continuous commissioning.

COLLEGE	FACILITY	ECM	UTILITY SAVINGS
BCTC	Georgetown	Demand Correction	$74,857
BCTC	Building M	Billing Error	$1,636
BCTC	Leestown Main	Contract Capacity	$580
BCTC	Science Building	Contract Capacity	$11,000
ACTC	Main Building	Billing Error	$2,488
ACTC	LRC	Billing Error	$1,772
ECTC	OTB 300	Contract Capacity	$5,400
JCTC	Shelby Campus	Billing Error	$9,314
JCTC	Technical Building A	Contract Capacity	$12,000
MCTC	Main Campus	Contract Capacity	$3,754
MCTC	Main Campus	Sales Tax Removal	$1,165
SKYCTC	Glasgow	Sales Tax Removal	$557
		TOTAL	$124,523

Environmental Impact

The positive environmental impact from this commissioning service can be attributed to the continual reduction of electricity, natural gas and water consumption across KCTCS's facilities. From the incremental optimization of ASHRAE Guideline 36-2018 sequences to the resolution of economizer issues to the discovery of water leaks, the conservation measures implemented due to CEMCS findings are creating energy-efficient college facilities, with the added benefit of enhanced IAQ, improved learning environment and occupant comfort.

Example #6. The water bill entered for February 2021 at ECTC's ATB Building was the highest historic bill for the building. A review of the system revealed a broken float in a cooling tower was causing the fill valve to be 100% open for almost a week. This water was then immediately going down the storm water drain, therefore not visible to the maintenance staff. The float valve was replaced the same day the issue was identified, and a rebate was returned to the college for a total of $5,805.

Conclusion

In 2009, Lawrence Berkeley Labs identified continual commissioning, or monitoring-based commissioning (MBCx), as critical to achieving high-performance buildings. Without it, energy use increases over time for a building operating business-as-usual. KCTCS and the state of Kentucky decided to invest in a robust data analytics platform to provide the data. By pairing that data with a continual commissioning service, they ensured that data would be turned into action.

Since 2015, average EUI annual reduction across the colleges due to the continual commissioning services is 7.5 kBtu/ft^2·yr (85.2 MJ/m^2·yr). Energy use will continue to decrease as more building optimization opportunities are discovered. These results have confirmed Lawrence Berkeley Lab's prediction of the long-term impact on a building's energy use by implementing continual commissioning strategies. ■