Energy

EE.C3 Advanced Energy Management Systems and Submetering — 5 Points

Applicability	Verification Required		
All projects.	⊗ at Design Review	○ at Construction Review	○ at Performance Review

Intent: Provide control, accountability, and optimization of the building energy performance.

Energy Management Systems (EMS), lighting control and metering are important systems for controlling, monitoring, and understanding patterns of energy use in schools.

Requirement

1 point	EE.C3.1 Install an advanced energy management system (EMS) with the following additional features over those required in prerequisite EE.P5: • Temperature and ventilation control of spaces by the EMS. • Temperature and status monitoring and data storage for all HVAC equipment input and output points and outdoor air temperature and humidity points. • Capability of trend reporting of all points. • An alarm interface to notify operators when conditions are out of range. • A graphical user interface. • A web based operating interface for remote access to all data, graphics, operating schedules, and trend reporting.
1 point	EE.C3.2 Install a meter data acquisition and storage system for all electrical power used within the building. The system can use the main utility meter as a data source or an owner supplied sub-meter provided that all electrical power used in the building is recorded. Data from the system shall at a minimum record and store every 30 minutes and shall be available to the operator with 24 hours of the time the energy was consumed. The system shall include a user interface to trend and analyze stored data. Using the EMS, a separate stand alone system, or a system provided by the local utility company are all acceptable provided that the system meets the requirements above.

2 -3 points	EE.C3.3 Submeter three for two (2) points, and five for three (3) points of the following major electricity, water and gas equipment loads: • Domestic hot water systems • HVAC system (group metering is acceptable unless a load exceeds 100A, and then individual meters are needed) • Lighting (separate out the metering for interior and exterior lighting) • Significant plugloads such as kitchen systems (food service equipment and refrigeration) and computer labs • Cooling tower and irrigation systems if applicable • Potable water use For any type of submeter installation, provide a plan explaining how submetered data will be used to improve energy system management. The plan may be included as part of the documentation required for EE.C3.1 (EMS) above.

Implementation

Monitoring capabilities of the EMS should allow for comparison between various types of building loads throughout all spaces of the school. This information is valuable and can be used to manage and optimize energy use. By trending and monitoring the building operation, any deviation from the design operation can be identified and corrected before an impact on occupant comfort and energy performance of the building is created. Building performance can also be optimized by longer-term trending, observation of performance characteristics, and benchmarking performance against expected operation.

The EMS should comprise the following:

- Sensors should be provided as follows:
- Sensors to trend outdoor air temperature.
- Sensors to monitor and trend equipment status for all equipment with motors greater than ½ hp.
- Indication and trending of damper and valve commanded position
- Sensors to monitor building electrical, natural gas, and heating oil demand and consumption.
- Sensors to monitor indoor and outdoor CO_2.

Sensors to monitor and *trend* (create trend logs) controlled variables at the operator interface. Control variables may include air and/or water flow, temperature, pressure, CO_2, and pump or fan speed. Relevant multiplexed data from microprocessors located in chillers, boilers, humidifiers, VAV box controllers, variable speed drives, and other HVAC equipment with multiplexing capabilities may be used in lieu of specifying separate sensors.

Wells and other ports shall be specified for the installation of calibration devices to facilitate calibration of sensors.

Points Matrix: A points matrix including all hardwired input and output devices connected to the automation system, all set points, upper and lower control limits. The points matrix should include location of where all sensors are installed.

Trend Capabilities: Trend requirements including a trend point list and preprogrammed sample of point (performed by controls contractor), sample rate, storage interval, upload interval, custom trend abilities, alarms, and automated trend data review and notification (automated diagnostics).

System Architecture: A system architecture capable of allowing sampling of these points to facilitate building commissioning and diagnostics without significantly affecting system performance.

Data Storage: A data storage system with adequate capacity to record trend data for use by building operators. Data export requirements must facilitate user-friendly data access and manipulation.

Operator Interface: An operator interface designed for remote/web access, monitoring requirements, trend-log reporting and diagnosing building problems through a user-friendly interface. This includes providing a visual (non-text based) operations and reporting interface to facilitate rapid system assessment that utilizes color coding, diagrams of floor plans and graphing capabilities. Staff must be provided with a manual and training on how to operate the system and utilize the information.

Source: Advanced Buildings Benchmark Version 1.1, by the New Buildings Institute, Inc. pp. 38-39.

Natural gas and heating oil demand sensors are not required on buildings less than 50,000 ft2 as part of this credit.

Cross Category Considerations

Consider displaying the data in an occupant friendly way as part of II.P3 Educational Display, or as part of one of the demonstration areas under II.C2.

Verification

For projects seeking verification through the CHPS Verified Program (Pg 12), compliance documentation is required at only design review.

Design Review Requirements	
EE.C3.1 and EE.C3.2	Construction drawings must include the additional features in the specifications and plans for the Energy Management System noted in EE.P5.
EE.C3.3	Construction drawings must include a Riser Diagram highlighting metering of all systems.

Resources

New Buildings Institute, Advanced Buildings, E-Benchmark October 2003, Version 1.0

CHPS *Best Practices Manual*, Volume II: Guideline TC23: Adjustable Thermostats; Guideline TC24: EMS/DDC; Guideline EL4: Lighting Controls for Classrooms.

School Facilities Manual, Washington State Office of the Superintendent of Public Instruction, 4th Edition, March 2000, available online at:
http://www.eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED447673&ERICExtSearch_SearchType_0=no&accno=ED447673

Energy

EE.C4 Flex Energy – Solar Ready — 1 Point

Applicability	Verification Required		
All projects.	⊗ at Design Review	○ at Construction Review	○ at Performance Review

Intent: To design the school to be cost-effectively adaptable to the future use of renewable or alternative energy systems. Future installation should be readily accomplished with minimal cost and that alternative technologies are not inadvertently designed-out.

This credit is for developing a plan to address certain future energy scenarios. Create a school that can accommodate PV arrays to provide 100% of the school's annual electricity usage with minimal reconstruction or renovation costs.

Requirement

1 point	EE.C4.1 PV Ready. Provide a complete design of a PV system that will provide 100% of the annual electric energy needs and operate an average efficiency of at least 80% of the optimal for your location as determined by the US DOE's PVWatts program. The roof-top PV arrays must cover at least 65% (unless a smaller area is needed to provide full capacity) of the total roof area (the remainder of the PV can be located on parking covers or free-standing mounting structures). Other solutions may be considered on a case by case basis. The complete PV system can be installed with: • No structural modification to the roof to accommodate 5 lbs. per sq. ft. additional weight. • No additional roof or wall penetrations are need for electrical wiring. • No physical expansion of electrical or mechanical rooms to accommodate the inverter(s) and other electrical system components.

Implementation

The preparation necessary for this credit should be documented in the construction drawings on a separate sheet(s), so that they may be easily found and used in the future for an installation. A complete design will include: PV Watts calculations, one-line electrical diagrams, mechanical mounting diagrams, and proof that the roof can support the system as designed.

Verification

For projects seeking verification through the CHPS Verified Program (Pg 12), compliance documentation is required only at design review.

Design Review Requirements	
EE.C4	Construction drawings must include a separate sheet(s) describing the intent of making the

	school PV Ready. In addition, the sheets must include the PV Watts calculations, one-line electrical diagrams, mechanical mounting diagrams, planned PV location(s), and proof (structural load calculations) that the roof can support the system as designed.

Resources

FLEX Energy Workbook: http://www.chps.net

US DOE PVWatts Program: http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/

Energy

EE.C5 Control Building Envelope Openings — 2 Points

Applicability	Verification Required		
All projects. While this credit applies to modernization projects; the cost of installing interlocks on existing windows can be prohibitive. A good opportunity to install interlocks occurs when the windows are being replaced as part of the project. For new buildings and modernization projects, interlock switches may only be installed in the new building(s), or the building(s) being modernized to earn this credit.	⊗ at Design Review	⊗ at Construction Review	○ at Performance Review

Intent: Conserve energy loss through building openings with the use of interlocks connected to the HVAC system. Maximize natural ventilation (without mechanical cooling systems) by relying on outside air movement through classroom buildings.

Each year, significant amounts of energy are lost when teachers or staff members open exterior doors or windows while the HVAC heating and cooling equipment dedicated to that space continues operating. Interlocks installed on windows and doors can be used to shut off this equipment when windows and doors are opened for extended periods.

Requirement

1-2 points	EE.C5.1 For mechanically conditioned schools or hybrid systems: Provide a red and green light system that alerts staff when air conditioning or heating systems are active: red indicating that closed windows will provide the greatest comfort and energy efficiency. Provide permanent signage indicating how the system should be used and its benefits. (1 point) **OR** Install energy conservation interlocks, or an equivalent mechanism, to turn off zone specific heating and cooling equipment in conditioned buildings if operable exterior windows or doors are opened. (2 points)

Implementation

Specify and install interlock switches on all relevant classroom and non-classroom operable windows and doors. Consider including a strategy to notify staff when the air temperature outside is appropriate for opening windows and utilizing natural ventilation.

If the heating or cooling equipment provides conditioned air to multiple rooms, the equipment should only be shut down when all related rooms have a window or door open.

Interlocks must not turn off supply air fans that are used for ventilation, only equipment that is used to condition the air such as furnaces, heat-pumps, air-conditioner compressors and coil valves. Adequate amounts of ventilation must be supplied to the classroom at all occupied times.

Cross Category Considerations

If this credit is claimed, training on how the system works must be included under prerequisite EE.P3 Facility Staff and Occupant Training.

Verification

For projects seeking verification through the CHPS Verified Program (Pg 12), compliance documentation is required at design review and construction review.

Design Review Requirements	
EE.C5	Construction drawings, ideally the mechanical plans, must include system details.
Construction Review Requirements	
EE.C5	Provide proof of installation or pictures for required features.

Resources

ASHRAE Advanced Energy Design Guide for K-12 School Buildings:
http://www.ashrae.org/publications/page/1604

Energy

EE.C6 Enhanced Commissioning — 3 Points

Applicability	Verification Required		
All projects. For major modernizations and a new building on an existing campus this commissioning scope is required based on the scope of the project. The scope of commissioning services for major modernizations will depend on the whether HVAC and/or lighting systems are being upgraded, since these systems require most of the commissioning.	⊗ at Design Review	⊗ at Construction Review	○ at Performance Review

Intent: Verify that additional building energy systems are designed, installed, calibrated and operate as intended, and provide for the ongoing accountability and optimization of building energy performance over time.

This credit is intended to allow project managers to think beyond the typical scope of a commissioning authority, into other useful system testing.

Requirement

1 Point	EE.C6.1 In addition to the requirements listed under the commissioning prerequisite EE.P2, the Commissioning Agent (CA) shall: Review the design intent and basis of design documentation. Conduct a focused review of the construction documents consistent with the standard DOE submittals (prelim, prefinal and final) for public projects, and at 35%, 80% and final for private projects. Conduct a 10-month warranty, post-occupancy review.
1 Point	EE.C6.2 Commission the building(s) envelope using the National Institute of Building Sciences (NIBS) Guideline 3 or using an equivalent approach.
1 Point	EE.C6.3 Comply with WE.C5 for Irrigation System Commissioning, and commission at least two of the following: • Power distribution • Fire protection • Security system • Ensuring implementation of the IAQ management plan including but not limited to building flush out, ventilation rates and filter changes. • Other major system

Implementation

EE.C6.1

- *Review design intent and basis of design documentation.* The architect and the design engineer are the most appropriate people to create this document, which should list the owner's project requirements and design intent for each of the systems or features to be commissioned. The CA will review this document, and a copy of the review shall be provided to the owner.
- *Conduct a focused review of the design prior to the construction documents phase.* This review early in the design process should be focused on an assessment of how well the design meets the owner's design intent. Assessment should be made as to how the design meets the functionality, utility performance, maintainability, sustainability, cost, and indoor environmental quality requirements outlined in the design intent. Evidence of the review is to be documented in the commissioning report.
- *Ten month warranty, post-occupancy review.* The commissioning contract shall contain provisions for a 10-month warranty and post-occupancy review. The review is intended to bring the design, construction, commissioning, and facility staff together to solicit the facility staff's comments, suggestions, and areas of concern regarding the systems in their first year of operation. Warranties on any commissioned systems should be reviewed and deficient equipment should be identified and a plan for resolution developed.

EE.C6.2

When commissioning the envelope, follow the NIB Guideline 3 or an equivalent method that at minimum includes drawing review, field inspection (construction checklist) and prior to window installation perform a infrared (IR) mock up to test for thermal breaks.

EE.C6.3

Other major systems can include items such as pools or audio visual systems. Contact CHPS to see if your "major system" qualifies.

Cross Category Considerations

It is recommended that the owner consider using the commissioning process and provider for additional services including acoustic testing, irrigation commissioning and enforcement of indoor air quality measures during construction. Qualified commissioning authority's can provide quality control on a range of high performance school systems and strategies.

Verification

For projects seeking verification through the CHPS Verified Program (Pg 12), compliance documentation is required at design review and construction review.

Design Review Requirements	
EE.C6	Include requirements in the EE.P2 Commissioning Plan and Owners Project Requirements (OPR).
Construction Review Requirements	
EE.C6	Provide the final Commissioning Report.

Resources

CHPS Best Practices Manual, Commissioning Volume.

Portland Energy Conservation Building Commissioning Guidelines. Inc: http://www.peci.org/index.htm.

The Building Commissioning Association, Essential Attributes of Building Commissioning, 1999 Edition: http://www.bcxa.org/membership/attributes1999.htm

ASHRAE Guideline 1-1996: The HVAC Commissioning Process

ASHRAE Guideline 4-1993: Preparation of Operations & Maintenance Documentation for Building Systems