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Control Systems & LEED

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Typically, the largest energy consumers in commercial buildings are lighting and HVAC systems. Under the latest revision of LEED, 2009 v3, many of the points needed to obtain LEED certification can be acquired through LEED credits that require or suggest the implementation of control systems for lighting, HVAC, and/or the entire building.

The point thresholds for the different levels of LEED certification, based on LEED-NC 2009, are outlined in *Table 1*.³

The most recent revision of LEED-NC emphasizes energy efficiency and indoor environment quality. This is reflected in the significant increase in potential points in the Energy & Atmosphere credit category from 17 in v. 2.2 to 35 in v. 3.^{2,4} Other LEED systems have similarly high point allotments in the energy and atmosphere section.

This column outlines where and how the use of control systems has been integrated into qualifying for LEED points for certification. LEED-NC (New Construction and Major Renovations) is used as the reference rating system.

The need for using control systems is evident by their being mentioned specifically throughout the Energy and Atmosphere, Indoor Environment, and even Site Sustainability credit categories. Points can be attained by reducing light pollution, optimizing and monitoring the building's energy performance, controlling lighting, and providing a comfortable and safe indoor environment.

Table 2 summarizes some of the credits that can be gained with the help of control systems.³ *Table 2* totals a possible 29 points obtainable through strategies in which controls play an integral part. For example, the LEED-NC 2009 guidance suggests input power reductions for interior lighting after

hours with limited override determined by occupancy sensors, and suggests CO₂ and airflow sensors to trigger the HVAC system directly or to trigger the building automation system to alter the ventilation/outdoor air delivery as needed by the interior.

To accomplish the Measurement & Verification credit, energy consumption trend monitoring systems and control system diagnostic alerts are suggested. For the Lighting Controllability of Systems credits, occupant based control and task based controls are suggested.³ One company claims that the use of their lighting energy management system with occupancy and photo sensors and a variety of control strategies (time scheduling, occupancy control, task tuning, etc) can help to gain any of the 29 points listed.⁵

Overall, LEED 2009 encourages automated and manual controls as a means to reduce building energy consumption and to improve the building's indoor environment and outdoor environmental impact.³ It takes 40 points for a building to become LEED certified. Thus, it is feasible to obtain a large fraction of the points needed for LEED certification by choosing to meet credits that suggest or require an energy control system.

With current technologies and software, lighting and HVAC systems can be automatically controlled, scheduled, and monitored based on occupancy, space use, and time of day. This leads to energy savings and can be applied for LEED credits.

One company's building automation system monitored the HVAC system using CO₂, outdoor airflow, temperature, and relative humidity sensors. This system ensured 30% more outdoor air than required by ASHRAE Standard 62.1; this garnered 1 LEED-NC point. It also provided a 6% reduction in natural gas and 1% reduction in electricity consumption, again contributing to acquiring LEED points. The building's use of daylight set the baseline lighting energy consumption 15% below ASHRAE-compliant buildings and another 6% savings were gained with the controls used. In all, the building reduced its energy use by 25% compared to precommissioning levels.⁶

CBECs (Commercial Building Energy Consumption Survey) 2003* data shows that daylight sensors are used in only roughly 2% of lit commercial space, and lighting energy management and control systems are used in only a little more than 1% of lit commercial space.⁷ Energy management and control systems for HVAC are used in about 5.5% of surveyed commercial buildings.⁷ A great potential for energy savings exists in the 95% to 99% of buildings that have yet to adopt energy-saving control systems.

Commercial building lighting consumed 3.69 quads of energy in 2010, 20.2% of the total primary energy consumed by commercial buildings that year.⁸ In addition to fixtures that consume less energy, control strategies to reduce lighting use and energy consumption could save significant amounts of energy if widely implemented.

One company offers addressable dimming controls. This allows for control

* CBECs 2003 is the latest dataset as the CBECs 2007 dataset was deemed invalid for lack of statistical significance and other reasons. CBECs 2012 is currently in progress to be released in 2014.

down to the individual light fixture or sensor. Many lighting energy management strategies can be implemented with addressable dimming controls: time scheduling, occupancy based, daylight harvesting, and task tuning. On average, 30% of the electricity used for lighting can be saved.⁵

Another strategy is bilevel stairwell lighting. Stairwell floor space amounts to 2% of multistory commercial building floor space, is used at most 5% of the day, and is usually continuously lit. Dependent on a region's safety codes, occupancy sensors used to dim or even completely turn off stairwell lights when the stairs are not in use result in large savings.

Two buildings in New York City and four in California saved up to 60% of the energy previously used to light their stairwells.⁹

As lighting control systems help buildings gain LEED points, so do HVAC controls and building automation systems. Under LEED EB-O&M (Existing

Building Operation and Maintenance) a building must first meet minimum energy efficiency (ENERGY STAR minimum qualified rating†) and indoor air quality (Standard 62.1-2007) requirements.

Beyond these standards, buildings achieve points for improved energy efficiency, an ENERGY STAR rating above the minimum of 69, and indoor environmental quality beyond that required.

For LEED-NC 2009, ASHRAE Standard 90.1-2007 provides the energy baseline that new buildings must outperform by 10% and existing buildings by 5%. Above this level, a point is gained for every 2% of energy optimization with a point cap at 19 points. Similar point systems exist in other LEED categories.⁴ One company claims that their lighting energy management strategies in communication with the HVAC/building automation

† This represents one way to meet the minimum prerequisite energy savings; others are outlined in LEED-EB O&M documentation.

LEED Certification Level	Points
Certified	40–49
Silver	50–59
Gold	60–79
Platinum	80+

Table 1: LEED Building Rating System.³

system will contribute to the necessary energy savings to gain these points.⁵

Energy Savings Example

For most commercial buildings, lighting amounts to one-third of the electricity used; in lodging and retail buildings, lighting can account for half of the electricity used.⁵

Lighting control can be performed by using a variety of sensors and control strategies. Occupancy and daylight sensors integrated into a centralized control network, and time-based scheduling are two examples of ways to adjust lighting. As previously mentioned, addressable dimming controls can be used, allowing



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for centralized lighting control down to the individual fixture or sensor.

A survey of lighting control schemes found that the use of multiple control strategies provided the most savings. *Table 3* summarizes the results. Personal and institutional tuning allow for control through dimmers, preset selections based on a room's functionality, and on-off switches.¹⁰

The LEED guidelines specifically have points that can only be attained by using control systems. With a more integrated and centralized control system, the building can be managed more effectively as a unit, more energy savings can be achieved, and additional LEED points can be earned.

Market Potential

Under LEED 2009, it is difficult to acquire LEED certification without the use of a control system, and the potential advantages of a green building outweigh the costs. As of 2008, the energy cost of a green building was 30% lower on average than a conventional building. Additionally, the average rent for Class A office buildings was \$10 more per square foot (\$108 more per square meter) for LEED-certified buildings compared to all Class A office buildings in 2008. More recently, green Class A office space has an average lease rate 20% higher than the general Class A office space average.^{11,12}

Credit Category	Credit	Potential Points
Sustainable Sites	Light Pollution Reduction	1
	Optimize Energy Performance	19
Energy and Atmosphere	Measurement and Verification (M&V)	3
	Outdoor Air Delivery Monitoring	1
Indoor Environmental Quality	Controllability of Systems	1
	• Lighting	1
	• Thermal Comfort	1
	Thermal Comfort Verification	1
	Daylight and Views	1
	• Daylight	1
	• Views	1
Total		29

Table 2: Potential LEED credits through control system use.³

These savings and higher rental rates do not come at a significantly higher construction cost. A 2006 study of 221 buildings showed that although 83 of the buildings were striving

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for LEED certification, most of the buildings would have been able to achieve LEED certification with no additional funding. Otherwise, the cost premium for a LEED Silver building was only 1% to 2%.¹¹ For one case, an investment of 2% in green building design resulted in life cycle cost savings of 20% of total construction costs, and a sale price 10% higher per square foot than a conventional building. More specifically, this already energy efficient green building was saving \$647,747 per year. However, after acquiring LEED certification the building's annual savings increased by an additional \$534,398.¹²

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Control Strategy	Energy Savings
Occupancy Sensor	24%
Daylight Sensors	28%
Personal Tuning	31%
Institutional Tuning	36%
Multiple Approaches	38%

Table 3: Energy savings by lighting control strategy.¹⁰

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