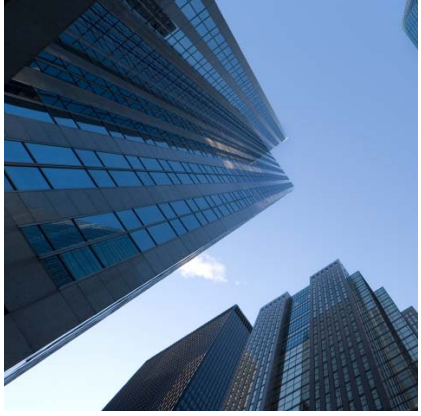
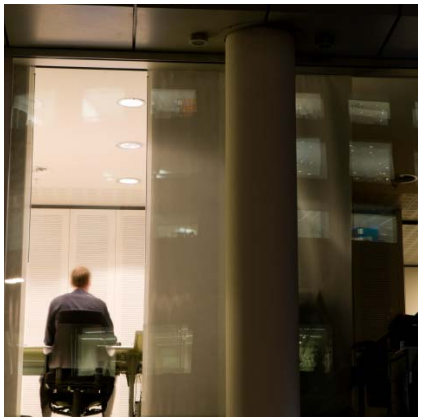


Obtaining LEED® Points with Addressable Dimming Controls

A White Paper for Building Owners, Managers, and Engineers



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Obtaining LEED® Points with Addressable Dimming Controls

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What is LEED®?

LEED, or Leadership in Energy and Environmental Design, is an internationally-recognized green building certification system. Developed by the U.S. Green Building Council (USGBC) in March 2000, LEED provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

LEED promotes sustainable building and development practices through a suite of rating systems that recognize projects that implement strategies for better environmental and health performance [1].

Levels of LEED Certification

LEED certification can be attained on four different levels, which are determined by a credit, or point system. The levels of LEED certification are Certified, Silver, Gold, and Platinum. A building or project can attain LEED certification by submitting an application that documents compliance with the requirements set forth in the LEED rating system and following an independent review.

Why LEED Certification?

Green buildings offer lower energy costs and better indoor environmental quality in addition to having lower life-cycle operating costs. According to statistics published on the USGBC website, LEED certified buildings offered the following benefits [1]:

1. Lower operating cost;
2. Increased building value;
3. Improved return on investment;

The LEED rating system is designed for rating new and existing commercial, institutional, and residential buildings, as well as entire neighborhood developments. They are based on accepted energy and environmental principles and strike a balance between known, established practices and emerging concepts. Each rating system is organized into 5 environmental categories:

1. Sustainable Sites;
2. Water Efficiency;
3. Energy and Atmosphere;
4. Materials and Resources;
5. Indoor Environmental Quality.

As of 2011, LEED certifications are awarded according to the following scale:

1. Certified 40–49 points;
2. Silver 50–59 points;
3. Gold 60–79 points;
4. Platinum 80 points and above.

The U.S. Green Building Council (USGBC) defines green design as “design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants.” In the context of lighting systems, green design means providing the right amount of light, when it’s needed, where it’s needed [13].

The objective of this white paper is to quantify the potential LEED points that can be realized through the use of addressable dimming lighting controls.

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LEED and Lighting

Buildings consume more than one-third of the total primary energy used in the US. About two-thirds of a building's primary energy use is attributed to electricity. On average, lighting accounts for 30% of energy use in office buildings, and thus often dominates the opportunity for energy savings among all electrical systems [2], [3].

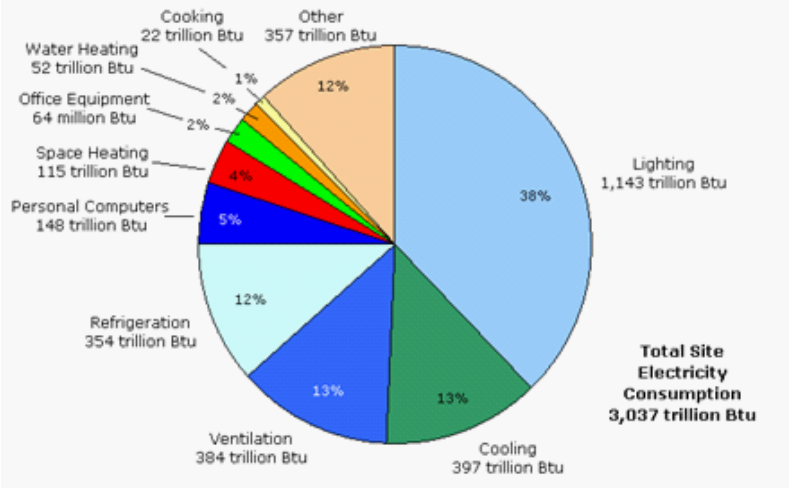


Figure 1: Electricity consumption in commercial buildings [Source: U. S. Energy Information Administration]

According to studies by Pacific Gas and Electric Company's lighting team and Lawrence Berkeley National Laboratory, advanced lighting controls in conjunction with various energy management strategies can typically yield a combined lighting energy savings of 40% – 80% in office buildings [4], [5].

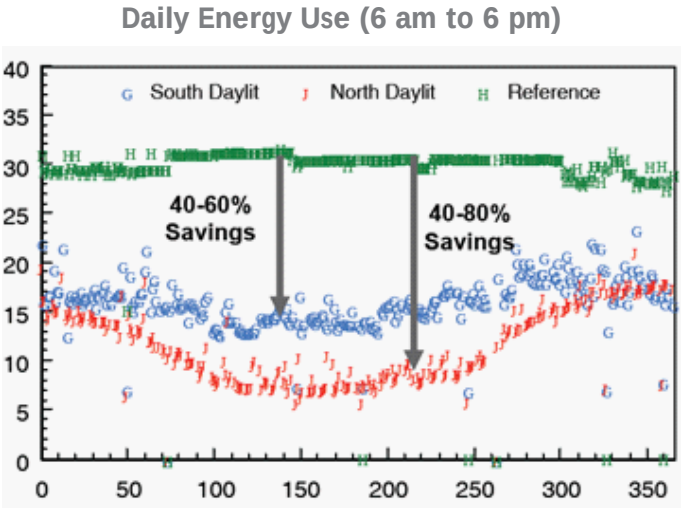


Figure 2: Energy savings realized by advanced lighting controls

Dorene Maniccia in her article published in LD+A (www.iesna.org) summarizes the importance of lighting control systems in green design for the following primary reasons [13]:

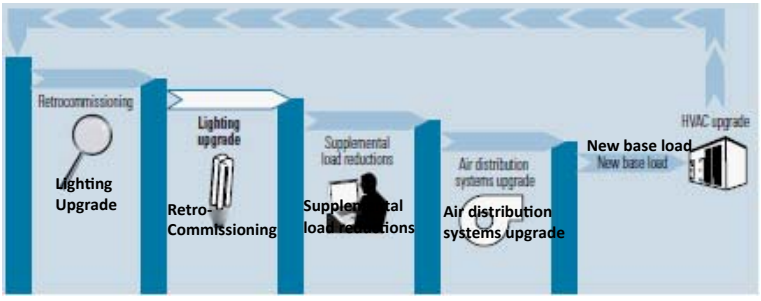
1. For enabling code compliance;
2. LEED strongly encourages designing buildings using daylight as a primary light source. Consequently, from an environmental perspective, the time and dollars spent designing and building a daylit building are wasted if lighting controls aren't utilized for dimming or turning off electric lights when they're not needed;
3. Lighting controls can be used for further reductions of lighting energy, and integrating the operation of lighting and mechanical systems, which are key strategies for optimizing building energy performance.

Planning for a Building Upgrade

Implementation of a proper control system for lighting is pivotal for a building to earn LEED certification as energy performance is the largest driver of LEED points.

It is also important to note that more accurate monitoring and control of energy-intensive systems like HVAC and lighting help keep energy costs in check [6].

According to the Energy Star Building Manual, during new construction or when planning full-building upgrades, a lighting upgrade should come early in the process, because it can also affect heating and cooling loads and power quality.



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Direct and indirect contributions from lighting energy savings can help a building or project maximize its potential to earn LEED points via the following LEED categories:

1. Sustainable Sites;
2. Energy and Atmosphere;
3. Indoor Environmental Quality

LEED Certification and Intelligent Buildings
There is a very strong synergy between an intelligent building design and a LEED-certified sustainable building design. Intelligent buildings demand reduced energy usage through optimization, system integration, and enterprise applications.

LEED certification requires energy efficiency, monitoring, validation, and control of all building systems. According to Paul Ehrlich, President & Founder, Building Intelligence Group, the goals and benefits of LEED and intelligent building design go together arm in arm. In fact, he strongly suggests that an intelligent building program should start with LEED certification and work to improve the building beyond that [7].

Addressable Dimming Controls

Addressable dimming controls when implemented, allow for individual addressing and controlling of each fixture or peripheral device (such as occupancy sensors, photo sensors and wall controllers) in a facility.

All control devices (each with unique address and connected to an individual light fixture) are networked and centrally controlled through a central software interface.

This allows for addressable dimming or switching of light fixtures independent of electrical circuiting for the purpose of energy management.

Once installed, commissioning and administration of the entire system can be performed via the front-end software interface.

Shown in Figure 4 is an example illustrating the Graphical User Interface (GUI) for an "Addressable

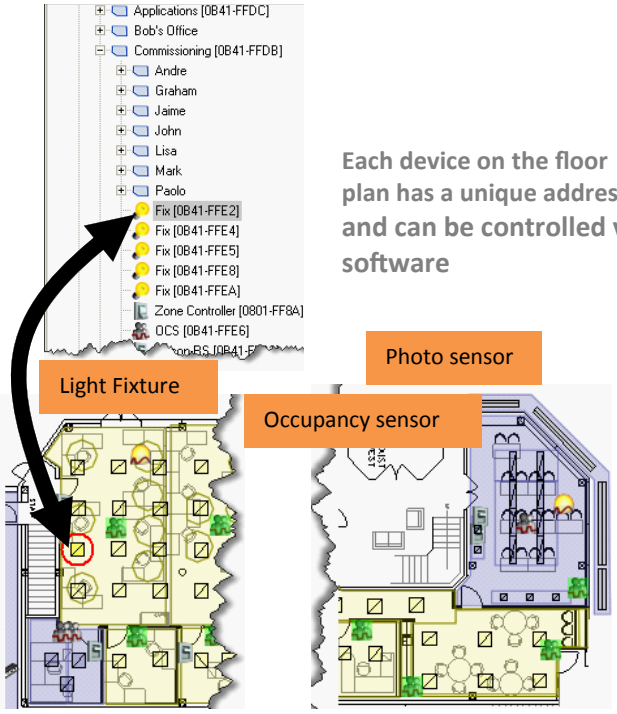

Figure 4: A node on the floor plan and its corresponding address

According to Stephen Selkowitz (Chairman, Building Technologies Department at Lawrence Berkeley National Laboratory), all lighting should be addressable and dimmable for optimum building performance.

Addressable lighting controls offer fixture level dimming capabilities and at the same time offer central management of a facility via software while enabling simultaneous application of multiple energy management strategies.

Addressable dimming controls can

1. Provide superior energy savings (greater than 50%);
2. Contribute significantly towards LEED certification in multiple categories;
3. Provide advanced load shedding capabilities by aggregating multiple building lighting loads to execute demand response;
4. Improve workplace ergonomics by providing personal lighting control from a PC or IP phone interface.


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Energy Management Strategies for Lighting

Once addressable dimming controls are implemented on a facility wide basis, a plethora of advanced lighting energy management strategies can be made available in order to optimize energy performance and improve lighting quality.

Smart Time Scheduling

With smart time scheduling, lights in a facility can be turned "ON", "OFF", or "DIMMED" according to day, night, holiday and other schedules.

Addressable dimming controls offer the ability to program time schedules from control zones as small as an individual workspace or office.

Smart time scheduling can net typical lighting energy savings in the range of 15% – 25% [8].

Daylight Harvesting

As daylight levels vary, individual fixtures or zones are dimmed up or down so that illumination is maintained evenly at the desired level throughout the space.

Dimming in response to daylight can be successfully used as a much more aggressive method of daily peak load management in buildings where daylight is available and peak load is considered problematic [9].

In the case of addressable dimming lighting controls, photo sensor to fixture associations are software based. In fact, just one photo sensor can be used for daylight harvesting an entire facade of a floor.

The amount of dimming for each individual fixture can be adjusted based on its proximity to a natural light source and is controlled digitally through software, thus significantly enhancing the energy saving potential.

Daylight harvesting can net typical lighting energy savings in the range of 20% – 40% [8].

Task Tuning

Commercial spaces are constantly re-configured or re-purposed for different uses or tasks. This requires changes in light levels to suit the particular use of a workspace or task. Use of addressable dimming individual fixture level through a control software application.

In fluorescent dimming systems, this reduction in light output or lumens translates directly into energy savings [10].

Task tuning can net typical lighting energy savings in the range of 20% – 50% [8].

Occupancy Control

Standalone occupancy sensors are well-suited for discrete rooms with intermittent occupancy and deliver reasonable energy savings. However, utilization of addressable lighting controls can yield even greater savings due to the granularity of the control and the ability to either turn "OFF" or "DIM" when no occupancy is detected.

Occupancy control can net typical lighting energy savings in the range of 20% – 43% [8].

Shown below in Figure 5 is the result from a study by the U.S. Dept. of Energy [11]. Here, stand-alone (i.e. non-networked) occupancy sensors were configured to turn lights "OFF" when occupancy has not been detected for 15-20 minutes resulting in approximately 30% energy savings.

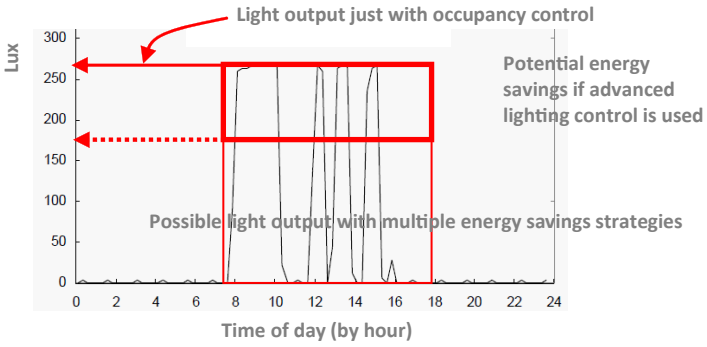

Figure 5: Occupancy sensor operation

In Figure 5, use of addressable dimming controls employing multiple energy management strategies would have yielded much higher energy savings. In other words, the office space where the study was conducted could have benefitted from additional energy management strategies such as Daylight harvesting, Task Tuning, Personal Control and Variable

networked system further optimizes system performance by sharing real-time occupancy data with other building systems.

Personal Control

Personal lighting control refers to the use of a PC, IP phone or hand-held wireless device for individuals to control lighting within their workspace.

Figure 6: PC based personal control application [ECSTM by Encelium Technologies]

Personal control not only offers greater occupant comfort and enviornmental control but also contributes to energy savings due to the inevitable dimming of lighting based on tasks or personal preferences.

Studies of personal lighting control suggest that it offers office occupants a more comfortable physical work environment while also delivering energy savings [12]. Readers should note that energy saving with a comfortable physical work environment is possible only with lighting that is individually addressable and dimmable as is the case with advanced lighting controls.

Personal control can net typical lighting energy savings in the range of 7% – 23% [8].

Variable Load Control

Most commercial and industrial facilities pay a considerable portion (as high as 40%) of their electric energy bill as demand charges for peak demand created by electrical loads.

Lighting is the second largest contributor to summer peak demand in commercial facilities, and rivals heating as the largest contributor to a commercial building's winter peak. As a result, lighting in commercial buildings should be considered as a critical sheddable load during periods of required energy curtailment.

It is cost effective for consumers to draw less power from the grid when electricity costs are highest. The use of addressable dimming controls ensures the ability to shed building lighting loads at peak demand either to reduce demand charges or to reduce consumption when time of use pricing is at its highest.

The use of addressable lighting controls the ability to shed as much as 50% of the building's total lighting load at peak demand and provide the means to integrate or share load shedding data with building automation or energy management systems.

Variable load control can net typical lighting energy savings in the range of 7% – 23% [1].

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Obtaining LEED Points with Addressable Dimming Controls

In the United States, buildings account for: 39 percent of total energy use, 12 percent of the total water consumption, 68 percent of total electricity consumption and 38 percent of the carbon dioxide emissions [14].

It is evident from these findings that savings from energy and electricity use can contribute towards significant LEED credits. It can also be seen from Figure 1 that lighting is the single largest energy consumer in commercial buildings.

The table below illustrates the potential contribution of LEED points by addressable dimming controls within the LEED framework:

LEED Category	Sub-Category	Max. Points
Sustainable Sites	Light Pollution Reduction	1
Energy & atmosphere	Optimize Energy Performance	19
	Enhanced Commissioning	2
	Measurement and Verification	2
Indoor Environmental Quality	Controllability of Systems – Lighting	1
	Daylight and Views – Daylight	1
Innovation in Design		5
LEED Accredited Professional		1

It is therefore clear that effective control of lighting energy consumption is critical in gaining LEED certification and addressable lighting controls can be an indispensable tool in achieving this goal.

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Appendix A: Application of Encelium ECS™ towards LEED Certification

The chart below lists the LEED categories that are applicable to Addressable Dimming Control and shows how Encelium's Energy Control System (ECS™) accomplishes this. USGBC's rating system document for "New Construction and Major Renovations" published in August 2011 is referenced for this exercise.

Sustainable Sites

Light Pollution Reduction

Intent	Maximum Credit Allowed	How ECS™ accomplishes the intent
To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact from lighting on nocturnal environments.	1 point	ECS™ can reduce interior lighting by employing "Smart Time Schedule", "Occupancy Control", "Task Tuning", "Personal Control" & "Daylight Harvesting" strategies. ECS™ can meet the exterior power density requirements by using exterior photo sensor and 24-relay control combinations in conjunction with "Smart Time Schedule" & "Daylight Harvesting" strategies.

Energy & Atmosphere

Fundamental Commissioning of Building Energy Systems

Intent	Maximum Credit Allowed	How ECS™ accomplishes the intent
To verify that the project's energy-related systems are installed, and calibrated to perform according to the owner's project requirements, basis of design and construction documents.	None. But this is a pre-requisite.	A "Daylight Harvesting" strategy is implemented in conjunction with other five energy management strategies (Smart Time Scheduling, Occupancy Sensing, Task Tuning, Personal Control & Load Shedding). ECS™ retro-commissioning & calibrations are performed and monitored through its Polaris™ software to ensure all lighting system parameters are functioning properly.


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Minimum Energy Performance

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To establish a minimum level of energy efficiency for the proposed building and systems to reduce environmental and economical impacts associated with excessive energy use.	None. But this is a pre-requisite.	Using Encelium's Advanced Energy Analysis application or by sub-metering lighting circuits, ECS™'s contribution towards this intent can be measured to ensure the lighting system achieves a minimum of: 10% improvement in the proposed building performance rating for new buildings, or a 5% improvement in the proposed building performance rating for major renovations to existing buildings, compared with the baseline building performance rating.

Optimize Energy Performance

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To achieve increasing levels of energy performance beyond the pre-requisite standard to reduce environmental and economic impacts associated with excessive energy use. (Requires comparison against a baseline building that complies with Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007)	1-19 points.	These energy credits are based on entire building energy use, not just lighting. That said, reductions in lighting energy can have profound impacts on building energy usage and may also result in associated reduction of HVAC loads. Encelium can achieve this intent via the following means: 1. Simultaneous use of Six Energy Management Strategies (Daylight Harvesting, Load Shedding, Smart Time Scheduling, Task Tuning, Occupancy Sensing & Personal Control); 2. Integration of lighting controls with building automation systems to optimize HVAC energy performance. 3. Use of Polaris™ software for the purpose of advanced energy modeling & analysis to optimize lighting control system's energy performance.


Enhanced Commissioning

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To begin the commissioning process early in the design process and execute additional activities after system performance verification is completed.	2 points.	Initial & retro-commissioning of ECS™ can be performed via its Polaris™ software application. 1. Central control over the entire facility; 2. Individually address fixtures and performs dimming or switching with the ability to verify the state of each lighting fixture in a facility; 3. Perform re-zoning and energy management strategy changes via remote accessing; 4. Monitor real-time energy saving via Energy Analysis (ECS™ package).

Measurement and Verification

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To provide for the ongoing accountability of building energy consumption over time.	2 points.	ECS™ can achieve this intent via its Energy Analysis (ECS™ package) application and its ability to retro-commission solely via its Polaris™ software's reporting capabilities.

Indoor Environmental Quality

Controllability of Systems - Lighting

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms and conference areas) and promote their productivity, comfort and well-being.	1 point.	ECS™ implements this intent via its Personal Control strategy as well as centralized control via its Polaris™ software.


Daylight and Views - Daylight

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.	1 point.	Use of ECS™'s daylight harvesting strategy combined with an automated shading solution allows for optimal daylight views without compromising occupant comfort.

Innovation In Design

Innovation In Design

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.	1-5 points.	ECS™ can accomplish this intent by contributing towards the following pilot credits: 1. Light Pollution Reduction (by using "Personal Control", "Daylight Harvesting" & "Task Tuning" strategies); 2. Demand Response (by using "Variable Load Shedding" strategy); 3. Quality Interior Lighting (greater than 50% efficiency, sources with more than 50 lumens / Watts, use of dimmable fixtures for 90% of the luminaire, minimum CRI of 80 for all lamps, automated shade controls & an electric schedule; 4. Advanced Energy Metering (by installing advanced energy metering for all whole-building energy sources consumed by the building) 5. Integrated Process (by performing energy modeling to analyze the effect of Daylight Modeling)


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LEED Accredited Professional

Intent	Maximum Points Allowed	How ECS™ accomplishes the intent
To support and encourage the design integration required by LEED to streamline the application and certification process.	1 point.	Encelium will work with the client to ensure that at least 1 principal participant of the project team shall be a LEED Accredited Professional (AP).

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