



EnOcean Technology and LEED
Enabling Sustainability

EnOcean Technology and LEED



Prepared by Building Intelligence Group LLC:

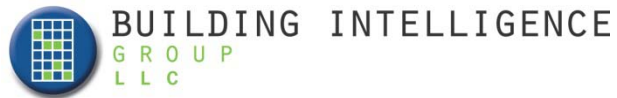
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Building Intelligence Group LLC is an independent engineering consulting firm retained by EnOcean Alliance to complete this work. Building Intelligence Group provides technical and strategic consulting services with a focus on intelligent and high performance buildings and the associated delivery of efficiency and sustainability.

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Executive Summary

Over the last decade, green buildings saw monumental growth. This trend is expected to continue as green building principles and practices becoming integrated in main-stream architecture and engineering communities, as well as in facility operations and maintenance. According to McGraw-Hill Construction, "green building will continue to grow over the next five years despite negative market conditions to be a \$96-\$140 billion market."¹ Much credit goes to the U.S. Green Building Council as its efforts have largely driven the charge to a more efficient and sustainable future for the built environment. USGBC's Leadership in Energy and Environmental Design Green Building Rating Systems are instrumental tools, providing roadmaps to sustainability for building project teams as well as operations and maintenance teams.

For building projects pursuing LEED certification, industry suppliers have an unprecedented opportunity and a unique role to play, bringing technology, products and systems to bear as part of solutions that achieve efficiency and sustainability. EnOcean technology offers unique features and advantages, and it is very relevant to many aspects of LEED. While technology, products and systems alone cannot achieve LEED credits, EnOcean technology may apply to many LEED credits in the following categories:

- ➔ Sustainable Sites: Measurement and tracking of light levels
- ➔ Energy and Atmosphere: Components of energy efficient HVAC and lighting systems
- ➔ Indoor Environmental Quality: Sensors and devices to support high quality indoor environments
- ➔ Innovation in Design or Operations: Innovative technologies and products to support innovative solutions, or to take solutions to exemplary levels of performance

This document is intended to serve as a roadmap to LEED for the EnOcean technology supplier, providing the following foundational elements:

- ➔ Overview of LEED, including recent developments and trends
- ➔ Application of EnOcean technology to LEED 2009
 - For New Construction and Major Renovations
 - For Existing Buildings: Operations and Maintenance
- ➔ Application concepts and considerations
- ➔ Project profiles highlighting EnOcean technology's contribution to sustainability and LEED certification

Finally, it is important to keep the broader picture in mind: EnOcean technology applied in the pursuit of LEED certification may also help to deliver on energy and operational efficiency, enhanced productivity and comfort, and sustainability in buildings over the long term.

¹ (McGraw-Hill Construction, 2008)

Introduction

The U.S. Green Building Council produced the first LEED, or Leadership in Energy and Environmental Design, Rating System in 1998. Since then, LEED experienced dramatic growth in terms of projects adopting the rating systems and seeking certification. Along the way, USGBC continues to expand and refine the LEED system with new and revised rating systems, documentation systems and supporting publications and training programs.

For any given building project pursuing LEED certification, there are perhaps many potential opportunities to bring technology to bear in solutions that support LEED certification and sustainability. This document is intended to provide an overview of how EnOcean technology may contribute to such building projects.

Overview of LEED

Some background on the LEED rating systems may prove helpful before looking at technology applications to support LEED. Four basic aspects of the USGBC LEED Green Building Rating Systems serve as a foundation:

- Levels of certification
- Rating systems
- Rating system structure and credit categories
- Process for LEED certification

Levels

There are four possible certification levels, and they are listed in Table 1. The more points a building project attains in the process of LEED certification, the higher the level of certification. Basically, points are achieved by proving that a building's design and/or operation meet the intent of a given credit.

Table 1: LEED certification levels

| Level | Points |
|------------------|--------|
| Certified | 40-49 |
| Silver | 50-59 |
| Gold | 60-79 |
| Platinum | 80+ |



Source: USGBC

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Structure

Each rating system is comprised of seven credit categories, as listed and described in Table 2. As will become evident in this document some categories present much greater potential for the application of technology than others.

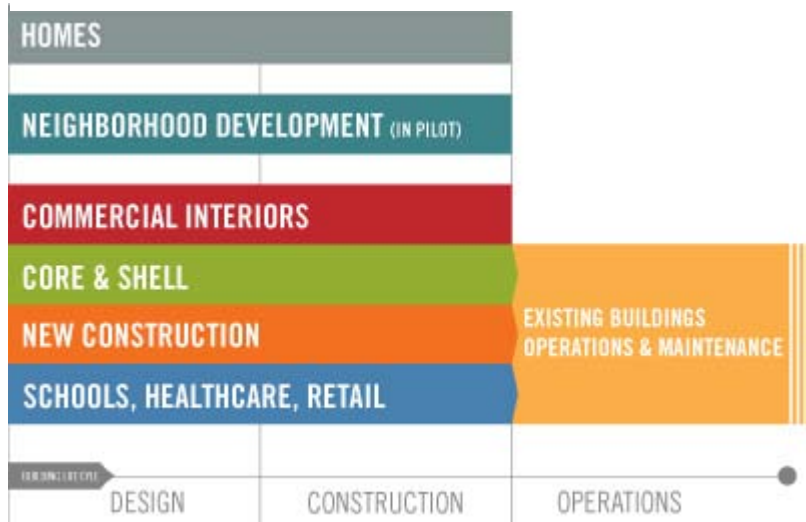
Table 2: Credit categories

| Category | | Content/Description |
|------------------------|--|--|
| SS | Sustainable Sites | Site selection, pollution prevention, alternative transportation, storm water design, heat island effect, and light pollution |
| WE | Water Efficiency | Water use reduction, water efficient landscaping, wastewater management |
| EA | Energy and Atmosphere | Commissioning, energy performance, refrigerant management, measurement and verification, and green power |
| MR | Materials and Resources | Recycling, building material reuse, regional and renewable materials, certified wood |
| IEQ | Indoor Environmental Quality | Indoor air quality, outdoor air delivery and ventilation, controllability of lighting and thermal comfort, thermal comfort design and verification, daylight and views |
| ID IO | Innovation and Design Process or Operations | Exemplary or innovative performance |
| RP | Regional Priority | Geographically-specific environmental priorities |

Systems

At the inception of LEED only one rating system existed: LEED-NC, for new construction. Over the last twelve years, USGBC has introduced additional rating systems that address specific building types or project scenarios. It is important to note that there is some variation among the rating systems in terms of credit content and points available per credit category or per credit. Figure 1 provides an illustration of the various rating systems.

Figure 1: Rating systems



Source: USGBC

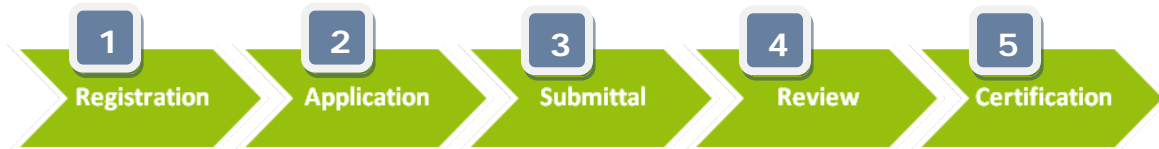
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Process

Finally, LEED certification is a process with the resulting certification applying to a building. It is important to note that only buildings can be LEED certified, and the certification does not apply to products, systems, or processes. The overall process is illustrated in Table 3 below.

Table 3: LEED certification process



| Stage | Activity |
|------------------------|--|
| 1 Registration | ➔ Project registration establishes intent to pursue LEED certification and provides access to tools and information. |
| 2 Application | ➔ Project design and documentation preparation, may be prepared in two phases: design and construction. |
| 3 Submittal | ➔ Submission of application, may be split into two phases: design and construction. |
| 4 Review | ➔ Application review. |
| 5 Certification | ➔ Award of certification. |

Building Design & Construction Process



Key aspects of the process to keep in mind are as follows:

- ➔ Typically, one or more LEED Accredited Professionals leads the team and guides the certification process for a given project.
- ➔ The best results for green building projects appear to be achieved through collaboration, where integrated teams of architects, engineers, various designers, construction managers, contractors, and suppliers, and other professionals work together to attain a common goal.
- ➔ There are substantial documentation requirements associated with the process, with an online system to facilitate documentation.
- ➔ Perhaps most importantly, note that products can help achieve credits by being part of a solution that earns LEED points, but that products alone do not earn points.

There are a few things that suppliers can do to assist the team's efforts:

- ➔ Become a part of the team. Work with the team to address challenges and identify solutions. The solutions lead to opportunities to apply technology, products and systems.

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- ➔ Educate the team on how products and systems contribute to specific credits and attainment of LEED points.
- ➔ Provide tools for the project team that facilitate design and documentation.

Recent Developments and Trends

Under USGBC the LEED green building certification system continues to evolve and to see broader application. LEED Version 3, launched in April of 2009, offers the latest advancements to the LEED Rating System (known as LEED 2009) in combination with improved online tools and a new certification model.

Continued Growth and Development

Data available from USGBC illustrates strong continued growth in LEED projects in both registrations and certifications, as illustrated by Figure 2.

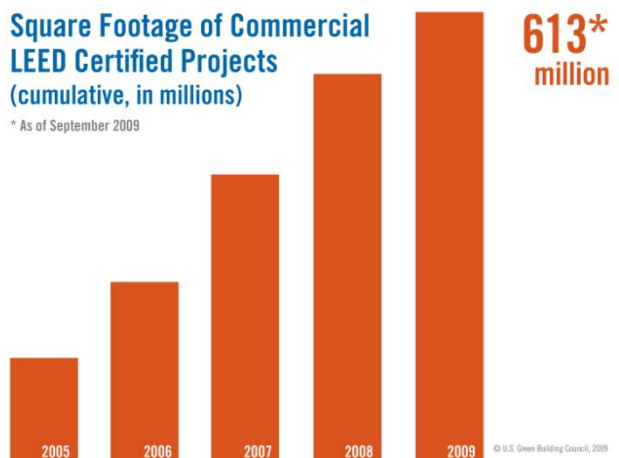
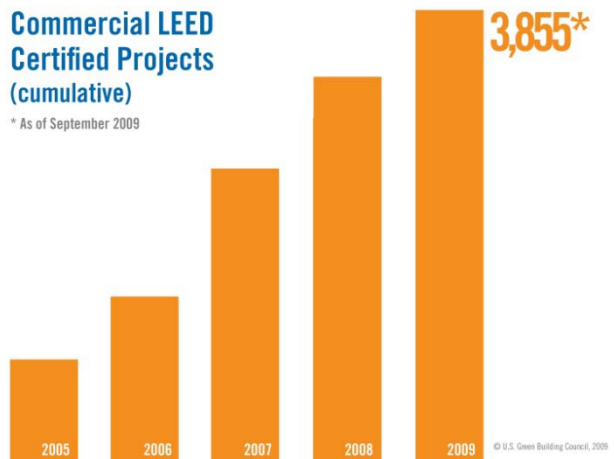
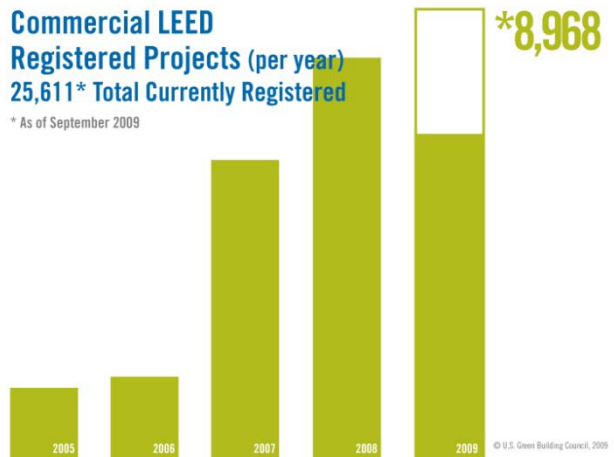
Early on, LEED offered a very strong focus on new construction. However, noteworthy evolutionary trends of particular interest for LEED and associated technology applications include a growing emphasis on the building lifecycle well beyond construction with much greater attention placed on two key aspects:

- ➔ Energy efficiency and carbon emissions impacts of buildings
- ➔ Operations and maintenance

Energy Efficiency

First, in addition to improved alignment of credits across rating systems and the introduction of regional priority credits to account for region-specific environmental issues, LEED 2009 offers revised credit ratings such that it “now awards more points for strategies that will have greater positive impacts on what matters most – energy efficiency and CO₂ reductions.” Earlier LEED Rating Systems did not offer this emphasis on energy efficiency, and as a result, LEED certified buildings vary in energy performance across a spectrum. A study completed by the New Buildings

Figure 2: LEED project registration and certification trends

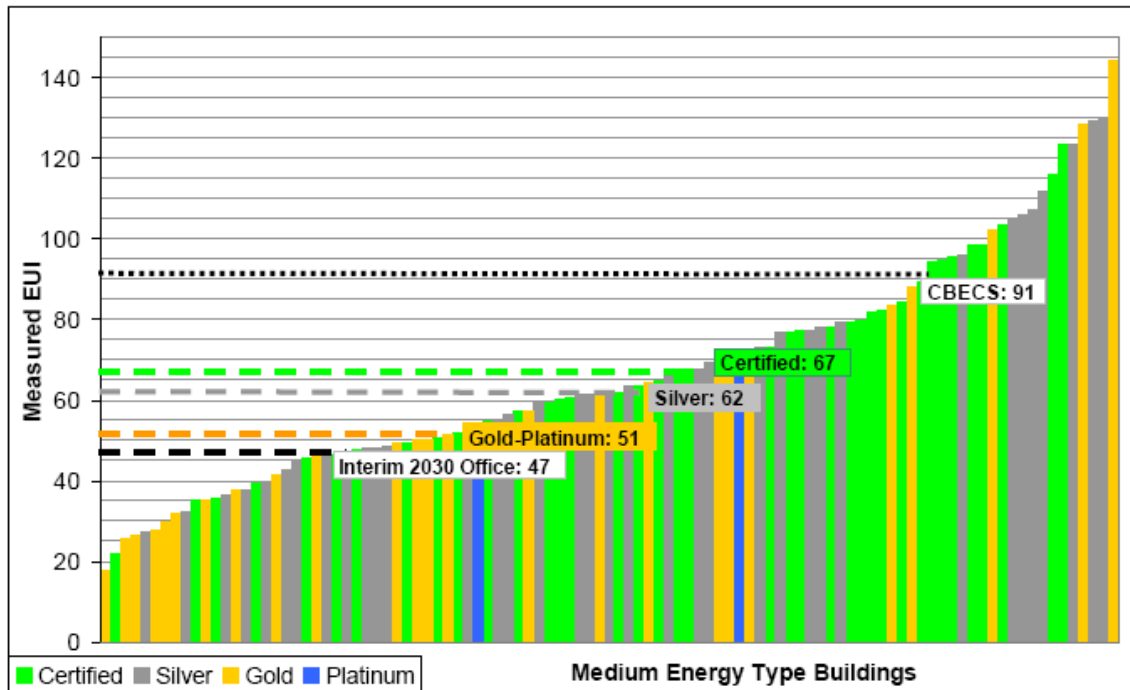


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Institute in March 2008 illustrated this phenomenon, and Figure 2 shows “median EUIs by certification level and the individual measured EUIs for each of 100 participating buildings, excluding those consisting of high energy activity types such as labs, data centers and supermarkets”.²

Figure 3: Energy Use Intensity (kBtu/square foot) for LEED Certified Buildings³



Source: New Buildings Institute

The revised credit weightings address this issue, and a comparison of LEED-NC (for New Construction) version 3 with its predecessor version 2.2 readily illustrates the increased emphasis on energy efficiency: While LEED-NC version 2.2 made 17 points available for Energy & Atmosphere credits out of a total of 69 points, LEED-NC 2009 (version 3) makes 35 points available for Energy & Atmosphere credits out of a total of 100 points, a 42% increase in points available for credits associated with Energy & Atmosphere.

It is also important to note that this increased emphasis on Energy & Atmosphere was addressed first for existing buildings with the introduction of *LEED for Existing Buildings: Operations and Maintenance*, issued in January 2008, with 30 out of 85 points available for Energy & Atmosphere. The proportion of points available under Energy & Atmosphere is unchanged in *LEED 2009 for Existing Buildings: Operations and Maintenance*, where 35 points are available out of 100 total points.

² (Turner & Frankel, 2008)

³ (Turner & Frankel, 2008)

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Another important aspect of *LEED for Existing Buildings: Operations and Maintenance* is its implied acknowledgement of the following:

- The opportunity for existing buildings to contribute to energy efficiency and sustainability far outweighs that of new construction.
- In order for a green building to remain green, proper and consistent operation and maintenance practices over time are vital.

Along the lines of the second point, recognizing the gap in LEED rating systems to ensure energy performance over time, USGBC announced the Building Performance Initiative in August 2009. This initiative's charter is to collect data from all LEED-certified buildings with the intent to conduct performance analysis and provide feedback to owners, and it complements the announcement earlier in 2009 that requires ongoing performance data from buildings as part of their certification under the latest version of LEED.⁴

These evolutions in LEED around energy efficiency, existing buildings, and operations and maintenance place greater emphasis on the performance of buildings over time, and also create and expand opportunities to apply technology to not only facilitate the achievement of LEED, but to deliver on sustainability in buildings over the long term.

Buildings and Opportunity

Existing Buildings

There is a broad base of existing commercial buildings, 4.9 million in the U.S. alone⁵, and a large volume of new facilities constructed annually. While most of the industry press appears to focus on the newest and greenest of buildings, the industry itself is slowly turning its attention to the existing building stock as a massive opportunity to cut energy consumption and greenhouse gas emissions.

In addition to representing such a massive opportunity to save energy and reduce greenhouse gas emissions, the existing building stock presents a corresponding massive opportunity to apply technology as a means to those ends. Wireless technology is of particular interest with its flexibility from both installation and operational perspectives.

Table 4: Existing building statistics

| Statistic | |
|----------------------------|---|
| Existing buildings (U.S.): | 4.9 million |
| Floor space: | 72 billion sq. ft. |
| Floor space per building: | Mean = 14,700 sq. ft. Median = 5,000 sq. ft. |
| Energy consumed: | 6.5 trillion Btus |

Source: U.S. EIA CBECS 2003

⁴ (USGBC, 2009)

⁵ (U.S. Energy Information Administration)

Application of EnOcean Technology to LEED

LEED 2009 For New Construction and Major Renovations

In the *LEED 2009 For New Construction and Major Renovations* rating system, there are a number of opportunities to apply EnOcean technology in pursuit of points. The credit categories that present the greatest potential are:

- ➔ Energy and Atmosphere
- ➔ Indoor Environmental Quality
- ➔ Innovation in Design

Considerations when seeking potential to apply EnOcean wireless technology to support the achievement of LEED in a new construction scenario converge on several central themes:

- ➔ Commissioning
- ➔ Monitoring, measurement and verification
- ➔ Energy performance
- ➔ Controllability

In addition, there is the opportunity to propose an innovative approach that may not fall under existing credits in pursuit of points available under the Innovation in Design credit.

It is also important to note that the information presented here for the *LEED 2009 For New Construction and Major Renovations* rating system also applies to credits within the following rating systems:

- ➔ Core & Shell
- ➔ Commercial Interiors
- ➔ Schools

The following three tables provide a set of tools to navigate the *LEED 2009 For New Construction and Major Renovations* rating system and to facilitate identification of opportunities to apply technology in support of LEED certification.

- ➔ Table 5 shows the relevant credit categories with their associated available points.
- ➔ For each credit that presents an opportunity with regard to EnOcean wireless technology, Table 6 indicates which applications are most appropriate. For example, for *EA Credit 1 Optimize Energy Performance*, EnOcean technology applies across the board to all of the applications; whereas, for *IEQ Credit 6.1 Controllability of Systems – Lighting*, *EnOcean technology only applies to half of the applications*.
- ➔ Table 7 indicates the number of possible points for each of the credits where EnOcean technology may apply, and it summarizes how the technology may impact and/or contribute to achievement of each credit's intent.

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For additional discussion of the credit categories and greater depth on potential ways to apply EnOcean technology, see the section *Application Concepts & Considerations*.

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Table 5: LEED for New Construction and Major Renovations credit categories

| EnOcean May Apply | Category | Available Points |
|-------------------|---|------------------|
| | SS Sustainable Sites | 26 |
| | WE Water Efficiency | 10 |
| ✓ | EA Energy and Atmosphere | 35 |
| | MR Materials and Resources | 14 |
| ✓ | IEQ Indoor Environmental Quality | 15 |
| ✓ | ID Innovation and Design Process | 6 |
| | Regional Priority | 4 |
| | Total | 110 |

Table 6: EnOcean technology applications in New Construction and Major Renovations

| Correlation of EnOcean Technology Applications with LEED Credits | | Application | | | | | |
|--|--|-------------|---------------------------------------|--------------------------------|-------------------|------------------------------|------------------------|
| | | Lighting | Shading | Presence Detection (Occupancy) | Window Monitoring | HVAC (Temperature, Humidity) | Data Acquisition |
| LEED 2009 For New Construction and Major Renovations | | | | | | | |
| Energy & Atmosphere | | | | | | | |
| EA Prereq 1 | Fundamental Commissioning of Building Energy Systems | ● | ● | ● | ● | ● | ● |
| EA Prereq 2 | Minimum Energy Performance | ● | ● | ● | ● | ● | ● |
| EA Credit 1 | Optimize Energy Performance | ● | ● | ● | ● | ● | ● |
| EA Credit 3 | Enhanced Commissioning | ● | ● | ● | ● | ● | ● |
| EA Credit 5 | Measurement and Verification | ● | ○ | ○ | ● | ● | ● |
| Indoor Environmental Quality | | | | | | | |
| IEQ Credit 1 | Outdoor Air Delivery Monitoring | ○ | ○ | ○ | ● | ● | ● |
| IEQ Credit 6.1 | Controllability of Systems-Lighting | ● | ● | ● | ○ | ○ | ○ |
| IEQ Credit 6.2 | Controllability of Systems-Thermal Comfort | ○ | ○ | ○ | ● | ● | ○ |
| IEQ Credit 7.2 | Thermal Comfort-Verification | ○ | ○ | ○ | ● | ○ | ○ |
| IEQ Credit 10 (Schools) | Mold Prevention | ○ | ○ | ○ | ● | ● | ● |
| Innovation in Design | | | | | | | |
| ID Credit 1 | Innovation in Design | ● | ● | ● | ● | ● | ● Plus, reduced waste. |
| Legend | | ● | Potentially applicable to credit | | | | |
| | | ○ | Minimally or not applicable to credit | | | | |

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Table 7: LEED 2009 For New Construction And Major Renovations

| Credit | Title | Points | EnOcean Technology Impact |
|-------------------------------------|--|--------|---|
| Energy & Atmosphere | | | <i>Up to 24 Points</i> |
| EA Prereq 1 | Fundamental Commissioning of Building Energy Systems | | Wireless connectivity and flexibility to locate and relocate wireless devices facilitates commissioning of building systems with simplified installation, calibration, and verification. |
| EA Credit 1 | Optimize Energy Performance | 1-19 | Apply technology to improve energy efficiency of HVAC, lighting, appliances, and other energy systems. Use wireless energy metering to monitor, control, and verify energy usage. |
| EA Credit 3 | Enhanced Commissioning | 2 | Wireless connectivity and flexibility to relocate wireless devices facilitates commissioning of building systems with simplified installation, calibration, and verification. |
| EA Credit 5 | Measurement and Verification | 3 | Wireless connectivity and flexibility combined with reduced installation cost enable comprehensive measurement and verification. Use wireless energy metering to monitor and verify energy consumption. |
| Indoor Environmental Quality | | | <i>Up to 4 Points</i> |
| IEQ Credit 1 | Outdoor Air Delivery Monitoring | 1 | Monitor outdoor air flow rates and CO ₂ levels within the occupied spaces. |
| IEQ Credit 6.1 | Controllability of Systems - Lighting | 1 | Enable occupants with flexible and convenient control over their lighting levels in both individual and common spaces. |
| IEQ Credit 6.2 | Controllability of Systems - Thermal Comfort | 1 | Enable occupants with flexible and convenient control over their environment and comfort in both individual and common spaces with sensors and switches that can be flexibly placed virtually anywhere and on any surface. Provide feedback on to building systems on comfort parameters and related factors, such as detection of open windows. |
| IEQ Credit 7.2 | Thermal Comfort - Verification | 1 | Temperature and humidity sensors can be located and relocated as needed to collect data necessary to verify thermal comfort. |
| IEQ Credit 10 | Mold Prevention | 1 | Monitor humidity, condensation, |

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| Credit | Title | Points | EnOcean Technology Impact |
|-----------------------------|----------------------|--------|--|
| (Schools) | | | moisture, and detect mold spores. |
| Innovation in Design | | | <i>Up to 5 Points</i> |
| ID Credit 1 | Innovation in Design | 1-5 | <p>In projects with a substantial number of sensors, a case can be made for reduction in waste over time yielded by the absence of batteries.</p> <p>Substantial quantities of wire, conduit, and other materials may be displaced from a project.</p> <p>Wireless connectivity and flexibility to locate and relocate wireless devices may yield a greater degree of comfort and controllability.</p> <p>Plus, other innovative and novel applications may apply.</p> |

LEED for Existing Buildings: Operations and Maintenance

Opportunities in the *LEED 2009 for Existing Buildings: Operations and Maintenance* rating system expand relative to the *LEED 2009 For New Construction and Major Renovations*, with major provisions focused on existing buildings centered on a handful of key themes:

- ➔ Monitoring, tracking and reporting of water use, energy use, space conditions and ventilation, and emissions
- ➔ Occupant education
- ➔ Oversight and execution of re-commissioning and continuous commissioning
- ➔ Understanding of metering, energy data acquisition and analysis

Thus, in a general sense, there are numerous opportunities for application of wireless sensing and measurement. Relative to the New Construction rating system, more credit categories present potential for EnOcean technology:

- ➔ Sustainable Sites
- ➔ Water Efficiency
- ➔ Energy and Atmosphere
- ➔ Indoor Environmental Quality
- ➔ Innovation in Operations

Also, similar to New Construction, there is the opportunity to propose an innovative approach under the Innovation in Operations credit.

As in the previous section, the following three tables provide a set of tools to navigate the *LEED 2009 for Existing Buildings: Operations and Maintenance* rating system and to facilitate identification of opportunities to apply technology in support of LEED certification.

- ➔ Table 8 shows the relevant credit categories with their associated available points.
- ➔ Table 9 cross references applicable credits with EnOcean technology applications.
- ➔ Table 10 indicates the number of possible points for each of the credits where EnOcean technology may apply, and it summarizes how the technology may impact and/or contribute to achievement of each credit's intent.

The section *Application Concepts & Considerations* offers additional discussion of the credit categories and greater depth on potential ways to apply EnOcean technology.

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Table 8: LEED for Existing Buildings: Operations and Maintenance credit categories

| EnOcean May Apply | Category | Available Points |
|-------------------|---|------------------|
| ✓ | SS Sustainable Sites | 26 |
| ✓ | WE Water Efficiency | 14 |
| ✓ | EA Energy and Atmosphere | 35 |
| | MR Materials and Resources | 10 |
| ✓ | IEQ Indoor Environmental Quality | 15 |
| ✓ | IO Innovation in Operations | 6 |
| | Regional Priority | 4 |
| | Total | 110 |

Table 9: EnOcean technology applications in Existing Buildings

| Correlation of EnOcean Technology Applications with LEED Credits | | Application | | | | | | |
|---|--|-------------|---------------------------------------|--------------------------------|-------------------|------------------------------|------------------|--|
| | | Lighting | Shading | Presence Detection (Occupancy) | Window Monitoring | HVAC (Temperature, Humidity) | Data Acquisition | |
| LEED 2009 For Existing Buildings: Operations and Maintenance | | | | | | | | |
| Sustainable Sites | | | | | | | | |
| SS Credit 8 | Light Pollution Reduction | ● | ○ | ○ | ○ | ○ | ○ | |
| Water Efficiency | | | | | | | | |
| WE Credit 1 | Water Performance Measurement | ○ | ○ | ○ | ○ | ○ | ○ | |
| WE Credit 4 | Cooling Tower Management | ○ | ○ | ○ | ○ | ● | ● | |
| Energy & Atmosphere | | | | | | | | |
| EA Prereq 1 | Energy Efficiency Best Management Practices | ● | ● | ● | ● | ● | ● | |
| EA Prereq 2 | Minimum Energy Efficiency Performance | ● | ● | ● | ● | ● | ● | |
| EA Credit 1 | Optimize Energy Performance | ● | ● | ● | ● | ● | ● | |
| EA Credit 2.1 | Existing Building Commissioning - Investigation and Analysis | ● | ● | ● | ● | ● | ● | |
| EA Credit 2.3 | Existing Building Commissioning - Ongoing Commissioning | ● | ● | ● | ● | ● | ● | |
| EA Credit 3.1 | Performance Measurement - Building Automation System | ● | ● | ● | ● | ● | ● | |
| EA Credit 3.2 | Performance Measurement - System Level Metering | ○ | ○ | ○ | ○ | ○ | ● | |
| Indoor Environmental Quality | | | | | | | | |
| IEQ Prereq 1 | Minimum Indoor Air Quality Performance | ○ | ○ | ○ | ○ | ○ | ○ | |
| IEQ Credit 1.2 | Indoor Air Quality Best Management Practices - Outdoor Air | ● | ● | ● | ○ | ○ | ○ | |
| IEQ Credit 2.2 | Controllability of Systems - Lighting | ○ | ○ | ○ | ○ | ○ | ○ | |
| IEQ Credit 2.3 | Occupant Comfort - Thermal Comfort Monitoring | ○ | ○ | ○ | ○ | ○ | ○ | |
| IEQ Credit 7.2 | Thermal Comfort - Verification | ○ | ○ | ○ | ○ | ○ | ○ | |
| Innovation in Operations | | | | | | | | |
| IO Credit 1 | Innovation in Operations | ● | ● | ● | ● | ● | ● | |
| Legend | | ● | Potentially applicable to credit | | | | | |
| | | ○ | Minimally or not applicable to credit | | | | | |

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Table 10: LEED for Existing Buildings: Operations and Maintenance

| Credit | Title | Points | EnOcean Technology Impact |
|-------------------------------------|---|--------|---|
| Sustainable Sites | | | <i>Up to 1 Point</i> |
| SS Credit 8 | Light Pollution Reduction | 1 | Enable measurement of outdoor light levels at the perimeter of the property. |
| Water Efficiency | | | <i>Up to 4 Points</i> |
| WE Credit 1 | Water Performance Measurement | 1-2 | Monitor and measure water use for various purposes. |
| WE Credit 4 | Cooling Tower Management | 1-2 | Monitor water conductivity and/or meter non-potable make-up water. |
| Energy & Atmosphere | | | <i>Up to 26 Points</i> |
| EA Prereq 1 | Energy Efficiency Best Management Practices | | Enable validation of operating plan parameters that cover heating, cooling, ventilation, and lighting. |
| EA Prereq 2 | Minimum Energy Efficiency Performance | | Apply wireless sensors to monitor and control building system status and energy usage. Use wireless energy metering to enable collection of energy consumption data. |
| EA Credit 1 | Optimize Energy Performance | 1-18 | Apply technology to improve energy efficiency of HVAC, lighting, appliances, and other energy systems. Use wireless energy metering to monitor, control, and verify energy usage. |
| EA Credit 2.1 | Existing Building Commissioning— Investigation and Analysis | 2 | Apply wireless sensors to cost effectively perform testing associated with existing building commissioning. |
| EA Credit 2.3 | Existing Building Commissioning – Ongoing Commissioning | 2 | Apply wireless sensors to facilitate system testing, performance verification, and ongoing measurement. |
| EA Credit 3.1 | Performance Measurement – Building Automation System | 1 | Apply wireless sensors to performance measurement integrated with BAS. |
| EA Credit 3.2 | Performance Measurement – System Level Metering | 1-2 | Enable sub-metering to enable collection of energy use data. |
| Indoor Environmental Quality | | | <i>Up to 4 Points</i> |
| IEQ Prereq 1 | Minimum Indoor Air Quality Performance | | Measure outdoor air ventilation flow rates at the equipment. |
| IEQ Credit 1.2 | Indoor Air Quality Best Management Practices - | 1 | Monitor outdoor air ventilation flow rates or CO ₂ levels. |

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| Credit | Title | Points | EnOcean Technology Impact |
|---------------------------------|---|--------|---|
| | Outdoor Air Delivery Monitoring | | |
| IEQ Credit 2.2 | Controllability of Systems - Lighting | 1 | Enable occupants with flexible and convenient control over their lighting levels in both individual and common spaces. |
| IEQ Credit 2.3 | Occupant Comfort – Thermal Comfort Monitoring | 1 | Temperature and humidity sensors can be located and relocated as needed to collect data necessary to monitor thermal comfort. |
| IEQ Credit 7.2 | Thermal Comfort—Verification | 1 | Temperature and humidity sensors can be located and relocated to collect data necessary to verify thermal comfort. |
| Innovation in Operations | | | <i>Up to 4 Points</i> |
| IO Credit 1 | Innovation in Operations | 1-5 | Enable innovative operations practices, or achieve exemplary performance for another prerequisite or credit. |

Application Concepts & Considerations

For each of the credit categories in the LEED rating systems, the following sections discuss application concepts and considerations. Of course, in addition to contributing to satisfaction of LEED requirements, wireless solutions offer flexibility and the potential for lower installed cost, both very positive attributes in their own right.

Sustainable Sites

| <i>LEED 2009 For New Construction and Major Renovations</i> | <i>LEED 2009 for Existing Buildings: Operations and Maintenance</i> |
|---|---|
| N/A | ➔ SS Credit 8: Light Pollution Reduction |

For existing buildings, the light pollution reduction credit offers three options, the third of which calls for measurement of night illumination levels at regularly spaced points around the perimeter of the property. Measurement of lighting levels, both outdoors and indoors, is a common technology requirement associated with LEED.

Water Efficiency

| <i>LEED 2009 For New Construction and Major Renovations</i> | <i>LEED 2009 for Existing Buildings: Operations and Maintenance</i> |
|---|---|
| N/A | ➔ WE Credit 1: Water Performance Measurement |

| | |
|--|---|
| | ➔ WE Credit 4: Cooling Tower Management |
|--|---|

Metering of water usage and flow is the theme here, for indoor and outdoor uses, and for both potable and non-potable water. Possible applications include metering of water usage for irrigation, indoor plumbing and fixtures, cooling tower make-up water, domestic hot water, and other process water for uses such as humidification, laundry, and pools. In all cases, meter data must be logged continuously.

Energy and Atmosphere

| <i>LEED 2009 For New Construction and Major Renovations</i> | <i>LEED 2009 for Existing Buildings: Operations and Maintenance</i> |
|---|--|
| <ul style="list-style-type: none"> ➔ EA Prereq 1: Fundamental Commissioning of Building Energy Systems ➔ EA Credit 1: Optimize Energy Performance ➔ EA Credit 3: Enhanced Commissioning ➔ EA Credit 5: Measurement and Verification | <ul style="list-style-type: none"> ➔ EA Prereq 1: Energy Efficiency Best Management Practices ➔ EA Prereq 2: Minimum Energy Efficiency Performance ➔ EA Credit 1: Optimize Energy Performance ➔ EA Credit 2.1: Existing Building Commissioning—Investigation and Analysis ➔ EA Credit 2.3: Existing Building Commissioning – Ongoing Commissioning ➔ EA Credit 3.1: Performance Measurement – Building Automation System ➔ EA Credit 3.2: Performance Measurement – System Level Metering |

Existing buildings may offer more opportunities than new construction to apply technology in the name of energy efficiency. But, in all cases, some general themes apply:

- ➔ **Commissioning:** Requires measurement of all types of parameters, including temperature, humidity, pressure, flow, lighting levels, and so on. The key is to seek opportunities where a wireless solution may offer advantages in sensing and measurement for both commissioning and on an ongoing basis.
- ➔ **Measurement and Verification:** Measurement of energy is the name of the game here, and all types including electricity, natural gas, other fuels, steam, and hot or chilled water. The Measurement and Verification Plan for the project is the place to start when identifying opportunities.
- ➔ **Energy Performance:** A large number of points are available for energy performance based on the level of performance sought. Many opportunities may be available as part of the solutions required for high levels of energy performance. Some of the concepts and strategies apply primarily to HVAC and lighting and may include, but are not limited to:
 - Ventilation control, including demand control ventilation
 - Heat recovery
 - Variable-air-volume control, including supply air temperature reset
 - Radiant heating and cooling

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- Evaporative cooling
 - Economizer control
 - Variable speed control
 - Fault detection and diagnostics
 - Daylighting
 - Occupancy
- ➔ **History:** For many of the above considerations, it may be necessary or beneficial to log measurement data over time.

Indoor Environmental Quality

| <i>LEED 2009 For New Construction and Major Renovations</i> | <i>LEED 2009 for Existing Buildings: Operations and Maintenance</i> |
|---|--|
| <ul style="list-style-type: none"> ➔ IEQ Credit 1: Outdoor Air Delivery Monitoring ➔ IEQ Credit 6.1: Controllability of Systems - Lighting ➔ IEQ Credit 6.2: Controllability of Systems - Thermal Comfort ➔ IEQ Credit 7.2: Thermal Comfort - Verification ➔ IEQ Credit 10: Mold Prevention (Schools only) | <ul style="list-style-type: none"> ➔ IEQ Prereq 1: Minimum Indoor Air Quality Performance ➔ IEQ Credit 1.2: Indoor Air Quality Best Management Practices - Outdoor Air Delivery Monitoring ➔ IEQ Credit 2.2: Controllability of Systems - Lighting ➔ IEQ Credit 2.3: Occupant Comfort – Thermal Comfort Monitoring ➔ IEQ Credit 7.2: Thermal Comfort—Verification |

Next to Energy and Atmosphere, Indoor Environmental Quality is the next largest opportunity to put technology to the task.

- ➔ **Ventilation:** Monitoring of outdoor air delivery (flow rates) and CO₂ levels are key to ventilation and indoor air quality under LEED. Verification: For IEQ, verification refers primarily to thermal comfort parameters such as temperature and humidity.
- ➔ **Control:** In general, LEED encourages greater degrees of control over personal environments, both in terms of thermal comfort and lighting.
- ➔ **History:** As for Energy and Atmosphere, for the above considerations, it may be necessary or beneficial to log measurement data over time. This is especially true of data relevant to space conditions.

Note that some facilities may also require monitoring of other parameters associated with indoor air quality, such as volatile organic compounds, mold, dust, and other contaminants that may adversely impact people occupying the space.

Innovation

| <i>LEED 2009 For New Construction and Major Renovations</i> | <i>LEED 2009 for Existing Buildings: Operations and Maintenance</i> |
|---|---|
| ➔ Innovation in Design | ➔ Innovation in Operations |

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Finally, innovative applications that do not apply directly to existing LEED credits or that dramatically enhance sustainability may serve as a basis for innovation credits. Exemplary performance under an existing credit is another path to innovation credit points.

Project Profiles

Real projects go a long way in illustrating some of the concepts in action of course. Two projects are profiled here to do just that:

- ➔ Place de l'Escarpement Building I
 - Quebec City, Quebec, Canada
- ➔ 1000 Continental Drive
 - King of Prussia, Pennsylvania, USA

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Place de l'Escarpement Building I

Location: 2000, Lebourgneuf Boulevard
Quebec City, Quebec
Canada

LEED Certification: Gold

About the Building:

- ➔ Corporate office
- ➔ 145,000 square feet
- ➔ Owned and managed by Immostar
- ➔ Tenants include Canadian Promutuel and DMR (a division of Fujitsu)



EnOcean technologies are incorporated in the following solutions that contribute to the sustainability of this insurance provider's headquarters:

- ➔ Intelligent lighting and shading control with daylight harvesting
- ➔ Occupancy detection
- ➔ Integration to BACnet-based building automation system, where data from wireless sensors, including occupancy, light levels, and outdoor temperature are used in control of HVAC systems

Overall, the building makes use of 800 EnOcean-enabled products to support sustainability and to achieve significant energy and operating cost savings.



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1000 Continental Drive

Location: 1000 Continental Drive
King of Prussia
Pennsylvania, USA

LEED Certification: Silver

About the Building:

- Commercial Office
- 200,000 square feet
- Owned and managed by BPG Properties, Ltd.



EnOcean technologies contribute to the following sustainable features in this multi-tenant commercial office building:

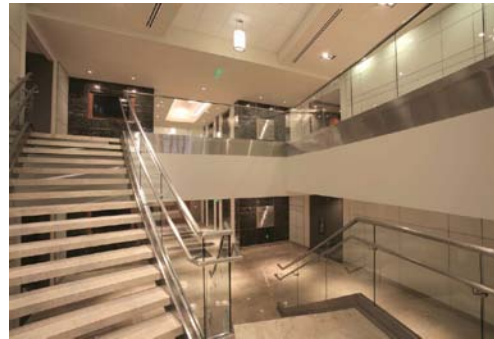
- Energy efficient zone temperature control, with wireless communicating temperature sensors serving Distech Controls VAV unit controllers with on-board wireless receivers
- Flexible placement of sensors to accommodate changes in space utilization
- Significant reduction of copper cabling



According to one account, "this design has reduced copper cabling by 65 percent and is projected to save 52 percent in tenant spaces."⁶

⁶ (Mirel, 2009)

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