Lighting for LEED

Application guide for sustainable offices

PHILIPS

Sustainable lighting

For most people, sustainability takes on different meanings depending on the context. A practical and actionable definition of sustainable lighting is meeting user needs with the least consumption of energy and other resources. User needs include adequate task and ambient illumination, visual comfort, and an interesting environment. How well lighting minimizes the consumption of energy and other resources can be evaluated by certification through LEED – Leadership in Energy and Environmental Design.

Audi, Neckarsulm, Germany

Using this guide

This Application Guide summarizes the LEED provisions relating to lighting and applies these practices to a typical office building to demonstrate how lighting can support both occupant and building performance. The demonstration design details five typical spaces – open office, cell office, meeting room, circulation, and reception – and describes the lighting approaches taken for each, along with key lighting and energy performance metrics.

LEED overview

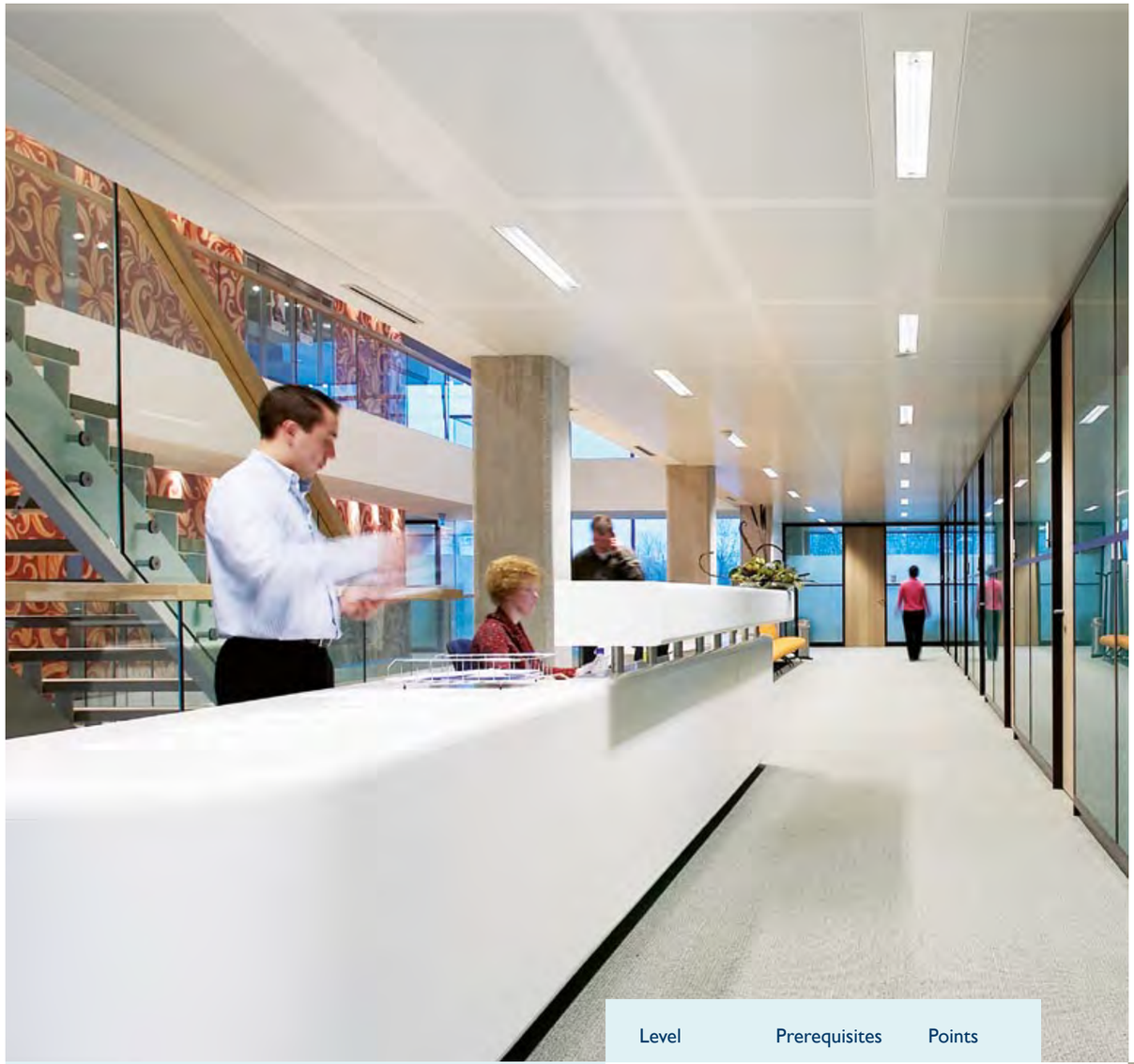
LEED offers a system for evaluating and certifying energy efficient and environmentally responsive buildings. Implicit in the evaluation system are guiding principles for design and construction.

To achieve LEED certification, a building project must satisfy prerequisites (for example, a minimum level of energy performance) and then earn points from a menu of credit options. The credits fall into seven topics as indicated below.

LEED for New Construction and Major Renovations (LEED – NC 2009)

Topic	Prerequisites	Credits	Possible Points
Sustainable Sites	1	14	26
Water Efficiency	1	3	10
Energy and Atmosphere	3	6	35
Material and Resources	1	8	14
Indoor Environmental Quality	2	15	15
Innovation in Design	0	2	6
Regional Priorities	0	1	4

Menzis, Groningen, the Netherlands



Under LEED for New Construction and Major Renovations (Version 3, 2009), there are 8 prerequisites and 49 credits, worth a total of 110 points. Projects can qualify at four levels, based on the number of points earned.

Level	Prerequisites	Points
Platinum	8	80+
Gold	8	60-79
Silver	8	50-59
Certified	8	40-59

LEED offers certification for a variety of project types, each with a slightly different menu of credit options and points. An office building designed for a single tenant, such as the example in this Guide would certify under LEED-NC (for new construction). LEED-NC also covers a major renovation of an existing building. A "speculative" project could certify while the lease spaces are unfinished under LEED-CS (for Core and Shell). Once leased, tenant space projects could then certify under LEED-CI (for Commercial Interiors). The illustrative design in this Guide is evaluated under LEED-NC but would have rated comparably under LEED-CI.

LEED and lighting

LEED affects lighting in four areas: Sustainable Sites, Energy and Atmosphere, Indoor Environmental Quality, and Innovation in Design. Lighting design, in turn, can significantly influence key credits, as discussed on the following page.

Topic	Credit	Description	Possible Points
Sustainable Sites	SS Credit 8	Light Pollution Reduction	1
Energy and Atmosphere	EA Prerequisite 1	Fundamental Commissioning	Required
Energy and Atmosphere	EA Prerequisite 2	Minimum Energy Performance	Required
Energy and Atmosphere	EA Credit 1	Optimize Energy Performance	1-19*
Energy and Atmosphere	EA Credit 3	Enhanced Commissioning	2
Energy and Atmosphere	EA Credit 5	Measurement and Verification	3
Indoor Environmental Quality	IEQ Credit 6.1	Controllability of Systems – Lighting	1
Indoor Environmental Quality	IEQ Credit 8.1	Daylight and Views – Daylight	1
Indoor Environmental Quality	IEQ Credit 8.2	Daylight and Views – Views	1
Innovation in Design	ID Credit 1	Innovation in Design	1-5
Innovation in Design	ID Credit 2	LEED Accredited Professional	1

* Minimum and optimized energy performance is rated on the performance of the entire building, rather than on the separate performance of its various energy-consuming systems.

Green Office®, Meudon, France, Photographer: Xavier Boymond

Light pollution reduction

The lighting design must avoid light trespass from exterior luminaires onto neighbouring property, as well as prevent sky glow from both interior and exterior luminaires.

Energy performance:

To satisfy the pre-requisite, the overall building design must demonstrate a 10% improvement in building energy performance compared to a baseline performance simulation according to ANSI/ASHRAE/IESNA Standard 90.1-2007 and must also comply with mandatory provisions – notably lighting controls. Standard 90.1-2007 is the minimum requirement for energy codes in the United States. Key lighting provisions of Standard 90.1-2007 are noted in the Glossary, on page 35. Projects may use local energy codes for LEED certification provided the code is demonstrated to be equivalent to Standard 90.1-2007(prior approval required).

To earn points under this credit, the overall building design must demonstrate additional energy reductions beyond the prerequisite (using the same simulation methodology). A 12% reduction earns 1 point. Each 2% additional reduction earns 1 point, up to a maximum of 19 points (for a 48% reduction).

Controllability of systems

The lighting design must provide individual control so that 90% of the building occupants can adjust lighting to suit individual task needs and preferences. Additionally, all shared, multi-occupant spaces must have lighting system controls.

Daylight and views

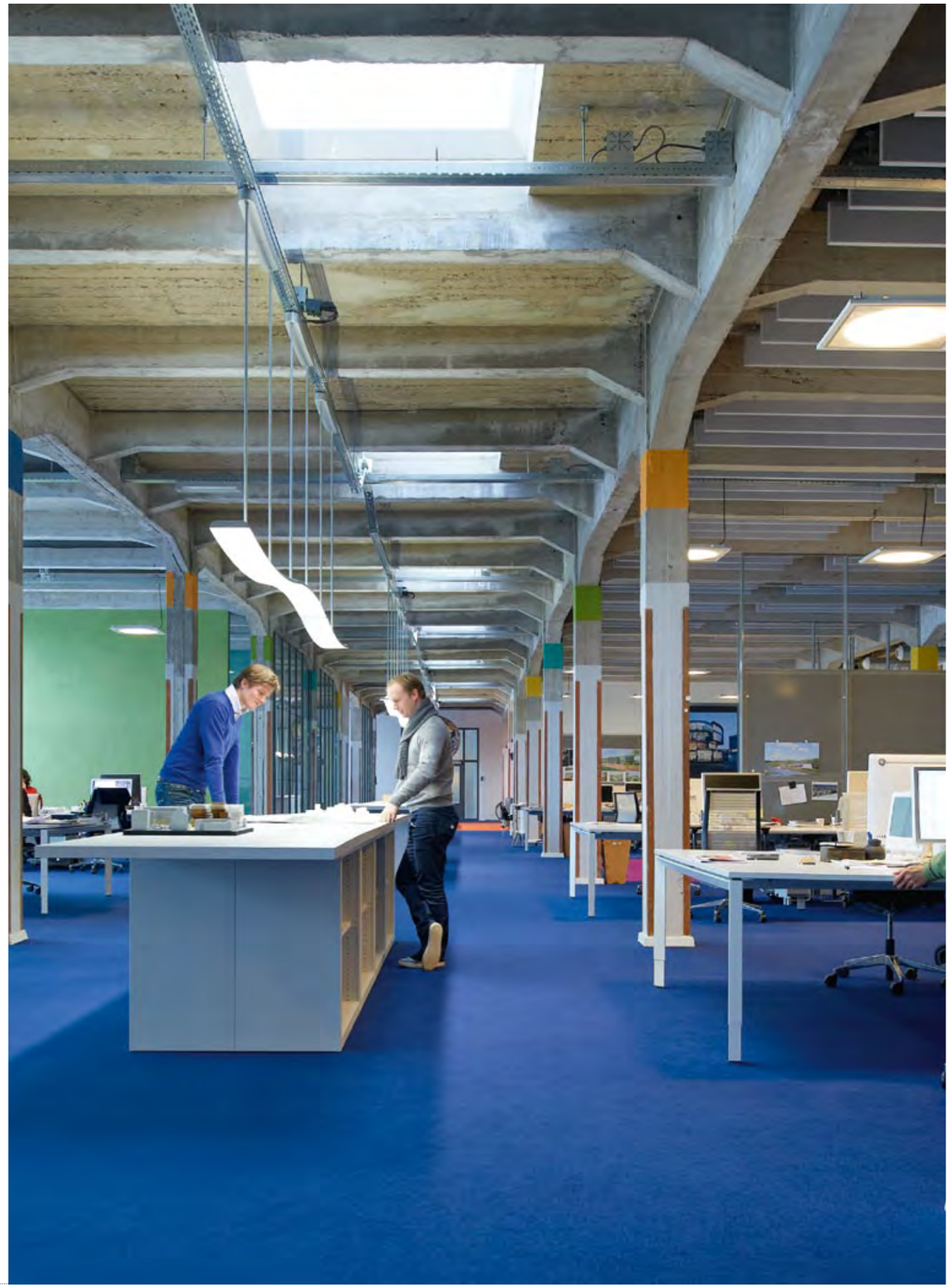
To earn 1 point, the design must provide daylight to 75% of the regularly occupied space. The requirement may be met using one of four different methods (all of which require glare control devices to avoid high-contrast situations that could impede visual tasks): simulation, prescriptive analysis, post-construction measurement, or a combination.

To earn a second point, the design must provide direct line of sight to the outdoor environment via vision glazing between 0.8 and 2.3 meters above the finished floor for building occupants in 90% of all regularly occupied areas.

Interior lighting quality

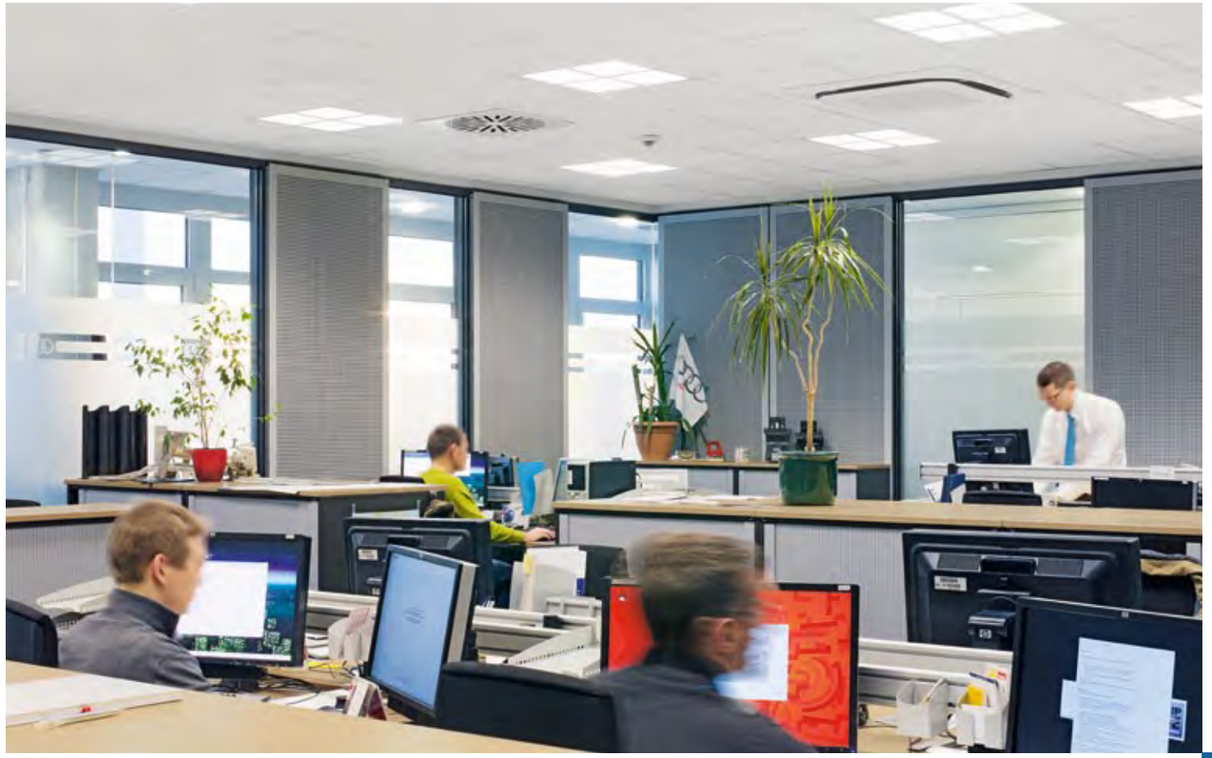
To earn a point under this Pilot Credit, the design must satisfy the lighting power allowance established by the newer Standard 90.1-2010 and incorporate at least four of the eight features below in 50% of the regularly occupied areas where occupants work, study, or perform other focused activities.

- Use luminaires with a luminance < 12500 cd/m^2 above 45° from nadir (excluding wall wash or indirect luminaires).
- Use light sources with a CRI of at least 80 for at least 95% of the connected load.
- Use lamps with a minimum rated average life of 24,000 hours for at least 60% of the connected load, with less than 10% below 6000 hours.
- Provide indirect or direct/indirect ambient lighting for up to 75% of the connected lighting load.
- Provide minimum average surface reflectances of 85% for ceilings, 60% for walls, and 30% for floors.
- Provide minimum average surface reflectances of 50% for both work surfaces and movable partitions.
- Keep the ratio of average wall to work plane illuminance above 0.10.
- Keep the ratio of average ceiling to work plane illuminance above 0.10.



RAU Architects, Amsterdam, the Netherlands

General lighting strategies for LEED certification



Lighting for performance and comfort

Although LEED only addresses lighting "quality" in limited terms, lighting for occupant performance and comfort clearly has value in a LEED context. The European Standard for Light and Lighting for Indoor Work Spaces (EN12464-1: 2011) also sets out recommended and minimum standards. Key EN12464-1: 2011 parameters include:

- Appropriate task illuminance. The minimum for office work is 500 Lux with a minimum-to-average uniformity of 0.6. For circulation and lobby areas, the minimum is 100 Lux.
- Appropriate ambient illuminance in the near and far surround areas to assure balanced brightness and visual comfort. The minimum uniformity is 0.4 and 0.1.
- Adequate wall and ceiling illuminance to create a comfortable visual environment. The EN12464-1 recommended minimum values are 75 and 50 Lux, respectively, but still brighter ceilings and walls can create a desirable sense of spatial openness.
- Generous illumination for facial recognition. This can be gauged by mean cylindrical illuminance (vertical illuminance measured from four directions 90° apart). The minimum recommendation is 150 Lux for work areas and 50 Lux for circulation spaces. Where an organization's effectiveness depends on human interaction, facial lighting is particularly important.
- Glare control. The Unified Glare Rating, which evaluates luminaires in a specific design, is the principal metric. The maximum UGR is 19 for work areas, 22 for the reception area, and 25 for corridors.

The Optima demonstration is designed to meet or surpass these criteria.

Daylight and views

Generally, designing for daylight and views begins by siting the building with a long axis to maximize favorable North and South daylight exposure and minimize the glare and heat gain to which East and West exposures are vulnerable.

- An elongated footprint allows a daylighted open area up to about 6 meters deep on the North and South sides, depending on ceiling height. Fenestration, glazing, and shading are all critical design parameters for optimizing for daylight while minimizing thermal problems.
- Locating private offices and other enclosed spaces to the East and West ends of the building preserves view for occupants of open plan offices along the North and South sides. Using glass interior partitions can extend both daylight and view.
- The Optima demonstration design is based on a building footprint and fenestration that follow these principles.

Surface finishes

High reflectance, low gloss finishes improve the energy-efficiency of the lighting system by reducing the amount light absorbed by ceilings, walls, and even the floor. The Optima demonstration design applies finishes that meet the LEED Pilot criteria of 85/60/30 for ceiling, wall, and floor reflectances (CWF). This reduces consumption by nearly 10%, compared to using finishes with the minimum reflectances in EN12464-1.

Impact of Surface Reflectance on Lighting in a Cell Office

Reflectances (CWF)	Task Illuminance at 5.3 W/M²	Lighting Power Density Required for 450 Lux
85-60-30	450	5.3 W/M²
80-50-20	430	5.5 W/M²
70-50-20*	420	5.7 W/M²

Data based on Optima cell office using ceiling luminaires only (page 18). * Minimum values in EN12464-1.

Task + ambient lighting

Using separate "layers" of light for local task-oriented illumination and ceiling-mounted ambient illumination – rather than a single, general lighting system – reduces energy, improves the alignment of illuminance to key task areas, and provides for individual control.

In the same way, reflecting light off of walls with dedicated luminaires can provide both wall and ambient illumination, balancing surface brightness, and do it more effectively than relying on a single overhead system to do both.

The Optima demonstration design applies this approach using desktop task lighting in both open plan and cell offices, wall wash luminaires in the conference room, and recessed downlights near interior walls in the open office.

The table below compares the Optima demonstration design (using an 8W task light) to a hypothetical general lighting scheme with 20% higher light output and wattage.

Alternative Lighting Approaches in a Cell Office

	Task + Ambient Scheme	General Lighting Only
Illuminance from ceiling luminaires - Avg	450 Lux	540 Lux
Illuminance from task luminaire	200 Lux	–
Total Illuminance on task	650 Lux	540 Lux
Lighting power density (all luminaires)	5.7 W/M^2	6.4 W/M^2

Illuminance values are based on task area illuminance of the Optima cell office (page 18). The general lighting solution is hypothetical based on increasing the output and power of the ceiling lighting system.

High Performance Light Sources and Luminaires

In terms of building performance, a light source with high efficacy – including the fluorescent ballast or LED driver – contributes directly to energy efficiency and economical operation. Sources with long life further support sustainability through reduced material consumption and cost effectiveness through reduced maintenance. In terms of occupant performance, good color rendering is especially important in workspaces that support face-to-face interaction.

All other factors equal, a luminaire that is 10% more efficient reduces energy by 10% (see table below), compared to a less efficient version. However, raising efficiency at the expense of visual comfort or the appropriate distribution of light is a bad trade off. Instead, it makes sense to look for luminaires that provide the desired glare control and luminous distribution, and then select the most efficient one from those that meet the criteria.

The LED and fluorescent T5 light sources in the demonstration design were selected for high efficacy, long life, and good color rendering. Luminaires were selected to meet the glare control parameters (Unified Glare Rating) of EN12464-1 and the LEED Pilot Credit for Lighting Quality, while providing the appropriate light distribution with high efficacy.

Performance Luminaires at Different Efficacies

Luminaire Efficacy	Average Illuminance at 5.3 W/M^2	Lighting Power Density Required for 450 Lux
110 Lumens/Watt*	450 Lux	5.3 W/M^2
100 Lumens / Watt	395 Lux	5.8 W/M^2
90 Lumens/Watt	360 Lux	6.4 W/M^2

Data based on demonstration Optima cell office using ceiling luminaires only. (page 18). * Luminaire used in the demonstration lighting design

One Shelley Street, Sydney, Australia

Controls

Energy codes require a minimum level of control, but a more aggressive controls strategy enhances both building and occupant performance. Automatic occupancy sensing and photosensor control provide additional energy savings, while individual controls permit lighting to adjust for different task needs and individual preferences.

Occupancy controls turn lighting off when sensors no longer detect the presence of occupants. Depending on the design of the control, it can turn lighting on automatically when occupancy is detected. This is an auto on/auto off device. Auto on/auto off devices can be incorporated in, or linked to, a photosensor so that lighting is only switched on automatically when there is insufficient daylight to meet the specified illuminance. This is a daylight switching device. Alternatively, the control can be linked to a manual switch so lighting is on only when an occupant turns it on. This is a manual on/auto off device and saves more energy than auto on devices.

Photosensors and controllers, together with dimming drivers or ballasts, can adjust electric lighting so that delivered illuminance conforms to target levels. Daylight harvesting dims electric lighting when sufficient daylight is available. A lumen maintenance strategy dims the "excess" lighting provided to compensate for light loss over time. Task tuning trims actual illuminance (constrained by luminaire performance and layout) to the target levels. A system designed for daylight harvesting will also dim for lumen maintenance and task tuning.

The success of any controls installation depends on three principal factors: system design, proper commissioning and providing adequate user comfort as lighting changes automatically. All three factors affect estimated energy savings, which also depend on the baseline for comparison. Overall, combining several controls strategies can generate energy savings of 30-55% for a complete building, depending on the application.

The Optima demonstration design uses multiple strategies, which also eliminate nighttime sky glow from the interior luminaires. The intent of the lighting controls and the assumptions behind the energy savings estimates are detailed on page 28.

The Optima project

The Optima Project is a hypothetical mid-rise office project in Southern Europe, designed with the objective of securing LEED certification while meeting EN12464-1 workplace lighting standards, without extraordinary construction expenditure or methodology.

The building sits on a predominantly East-West axis, with an elongated floor plate of about 1500 square meters. A 600mm x 600mm grid ceiling is suspended at 2.7 meters above the floor.

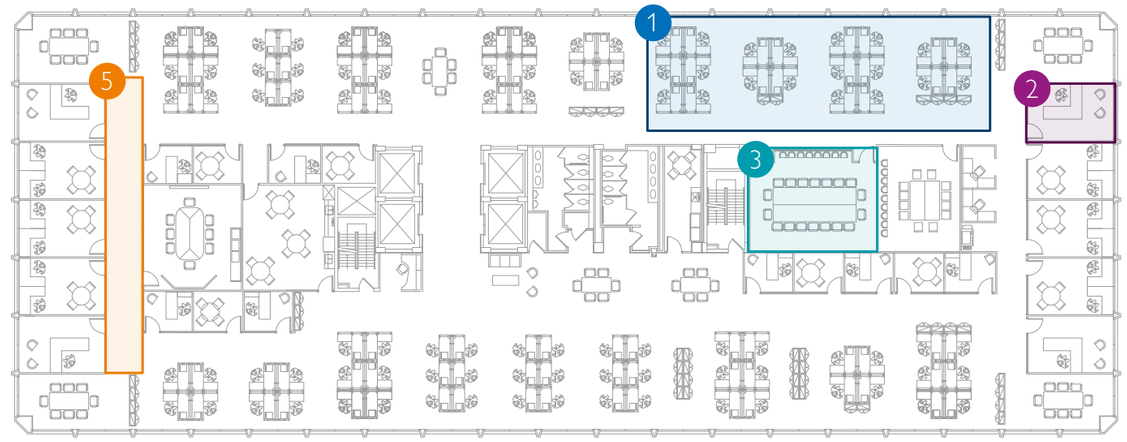
The Optima organization is a forward-thinking enterprise with a typical workforce in terms of age and office tasks. The workspace program includes cell offices and open plan areas, conference and meeting rooms, circulation areas and reception, as well as supporting mechanical and utility spaces.

To maximize daylight and views, open office work areas with minimal dividing partitions occupy the North and South exposure; cell offices; meeting rooms, and conference spaces are limited to the East and West exposures and the core interior area. Furniture, paint, and ceiling finishes are of high reflectance: 85% for ceilings, 60% for walls, and 30% for the floor and 50% for furniture, including work surfaces

The layout diagram illustrates a typical floor, identifying the specific locations where lighting and energy performance have been calculated. The table opposite shows the area of each type of space, the lighting power allowance under ASHRAE/IES Standard 90.1-2007, the connected power for the Optima lighting design, and the percentage savings.

Audi, Neckarsulm, Germany

Optima office layout



1 Open office
2 Cell office
3 Conference/meeting room
4 Reception
5 Circulation

Space	Area M²	% of Total	Standard 90.1 Allowance		Connected Watts	Savings
			W/M²	Watts		
Open office	873	50%	11.9	10412	6275	40%
Cell offices	238	14%	11.9	2835	1350	52%
Meeting room	170	10%	14.1	2391	1585	34%
Corridors	72	4%	5.2	391	318	19%
Reception (ground floor)	211	12%	14.1	2980	2069	31%
Other	168	2%	9.8	1166	1049	10%
TOTAL	**1732**	**100%**	–	**20175**	**12646**	**37%**

"Other" spaces were not designed but assumed at 10% below the allowance. Connected watts for the Open offices are based on using recessed LED luminaires. See pages 16/17 for details

Optima lighting design

The Optima lighting design addresses three objectives, applying the principles described earlier.

- A high quality visual environment for the building occupants
- Maximum LEED points
- Cost-effective lighting in terms of both construction and operation.

The lighting result exceeds the EN12464-1 standard in terms of illuminance, uniformity, and glare control (among other metrics). Wall wash and downlight luminaires help to balance the brightness of walls; this more focused illumination also introduces elements of visual interest. The lighting design and luminaire selection also meet LEED lighting quality parameters (CRI, Life, Reflectances, work plane/wall illuminance, and work plane/ceiling illuminance).

Most luminaires in the design feature LED sources, which improve luminaire efficacy by 20-40%, compared to similar luminaires with conventional sources. The general lighting uses 4000K white light with CRI of 80 or higher, designated by the color code of 840 in the tables that follow.

Combining a task/ambient lighting approach with high efficacy luminaires reduces the connected lighting load by 37% below the ASHRAE/IES Standard 90.1-2007 allowance (see table above) and provides for individual control. Controls, including both occupancy sensing and daylight harvesting, further reduce energy consumption by an estimated 20-30%, compared to the baseline controls required by LEED. The combined energy savings are estimated at more than 50%. Detail is provided in the Lighting Controls Performance Narrative on page 28.

Assuming that all other building systems performed as well as the lighting, EA Credit 1 would be worth the maximum 19 points.

Daylight and views are provided by the building orientation, fenestration, sun control, and furniture layout.

The LEED results are summarized in the table below.

Credit	Description	Result
SS Credit 8	Light Pollution Reduction	Not in scope
EA Prerequisite 2	Minimum Energy Performance	Achieved 37% reduction in lighting power, compared to ASHRAE/IES Standard 90.1-2007.
EA Credit 1	Optimize Energy Performance	Achieved 37% reduction in lighting power, compared to ASHRAE/IES Standard 90.1-2007. Occupancy sensing and daylight harvesting controls further reduce usage by an estimated 20-30% for total lighting energy reduction of more than 50%.
IEQ Credit 6.1	Controllability of Systems – Lighting	Individually controlled task lighting satisfies this credit.
IEQ Credit 8.1	Daylight and Views – Daylight	Fenestration and interior configuration satisfy this credit.
IEQ Credit 8.2	Daylight and Views – Views	Fenestration and interior configuration satisfy this credit.
Pilot Credit 22	Interior Lighting – Quality	Luminaire specification and illuminance distribution satisfy this credit

Menzis, Groningen, the Netherlands

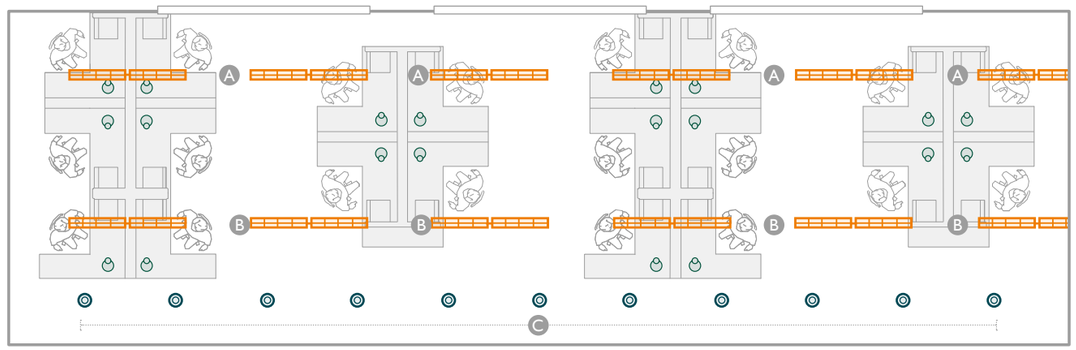
1 Open office

Lighting design

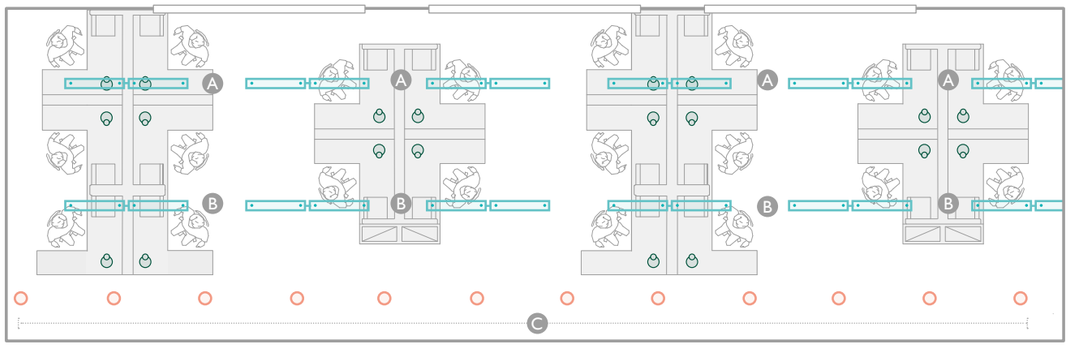
Energy efficient design in an open plan office locates luminaires so that the primary working areas are appropriately illuminated; the circulation spaces around them can receive less light (and so use less energy). For effective daylight harvesting, luminaires need to be arranged into separately controlled zones corresponding to the penetration of daylight into the area.

Two typical schemes are shown here:

Floorplan: Recessed scheme



Floorplan: Pendant scheme



In the recessed scheme, PowerBalance 300mm x 1200mm LED luminaires, shielded by white smart pyramid louvers, provide the primary illumination.

In the pendant scheme, Arano direct/indirect luminaires use high efficiency T5 fluorescent lamps (4000K) with a 70% direct / 30% indirect distribution. The luminaire has a slim 150mm x 1200mm profile.

In both schemes, the luminaires form two rows parallel to the window wall. This provides excellent task coverage and uniformity for flexible location of the workstations, while facilitating daylight control. Low wattage TaskFlex desk-mounted luminaires provide individually controllable lighting for personal preference (and increased satisfaction), as well as for more difficult visual tasks. A line of low wattage LuxSpace LED downlights illuminates the interior wall, balancing window brightness and delineating the primary circulation path.

All ceiling lighting in each of the two large open work areas (North and South) is divided into smaller zones for occupancy-based control. Each row of luminaires closest to the windows is on a separate daylighting zone and independently dimmed so that the target illuminance is maintained on the work surfaces when daylight is available.

Control zone designation: A B C

Luminaire		Nominal Size	Source	Luminaire			Rated Life
				Watts	Lumens	LPW	
	Recessed Scheme - PowerBalance	300W x 1200L	LED 840	31	3400	110	50000
	Pendant Scheme- Arano	150W x 1200L	25W T5 Eco 840	30	2258	75	25000
	Downlight – LuxSpace Decorative	150 dia	LED 830	15	878	59	50000
	Downlight – LuxSpace Open	150 dia	LED 840	15	1076	72	50000
	Desk –TaskFlex	500H x 550Ext	LED 830	8	370	46	50000

Lumen and LPW values are initial and do not reflect lumen depreciation. Lumen maintenance of .95 and .80 for fluorescent and LED sources, respectively, are used in the illuminance calculations.

Results

- Overhead lighting in both schemes delivers over 450 Lux (average, maintained) to the desk tops, with excellent uniformity.
- Individual task lighting adds about 200 Lux when used and satisfies the LEED Credit for controllable lighting. The combination of task and overhead illumination exceeds the EN12464-1 minimum illuminance recommendation.
- Wall lighting exceeds standards for illuminance and uniformity and provides effective balance to daylighted windows.
- Lighting power is 40% below the Standard 90.1-2007 allowance for open office spaces. Occupancy and daylight controls reduce energy usage still further. See page 28 for a more detailed discussion.

Lighting analysis

Lighting Scheme	Area Avg Lux	Desks Avg Lux	Desks Min Lux	Far Surround Min Lux	Uniformity Desks	Task:Wall (Avg Lux)
Recessed scheme	500	540	450	350	0.87	3.0:1
Pendant scheme	400	450	350	180	0.79	3.6:1

Illuminance is at maintained levels, using total light loss factors of .72 for the recessed LED scheme and .86 for the pendant fluorescent scheme and do not include desk-mounted task luminaires.

Energy analysis

Lighting Scheme	Calculation Area	Watts Ceiling	Watts Downlights	Watts Task	Watts Total	LPD (W/M^2)	LPA (W/M^2)	Reduction in Lighting Watts
Recessed Scheme	$151M^2$	744	180	160	1084	7.19	11.93	40%
Pendant Scheme	$151M^2$	720	180	160	1060	7.03	11.93	41%

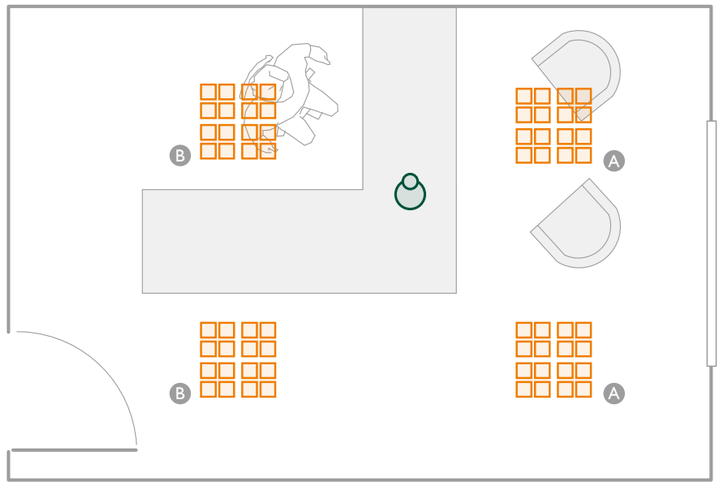
2 Cell office

Lighting design

Maintaining a bright feeling in a cell office improves user comfort and satisfaction. A major challenge is arranging luminaires in a regular pattern so they provide appropriate illumination with minimal energy usage. This design uses PowerBalance 600mm x 600mm luminaires which use high efficiency LED modules. Low wattage TaskFlex desk-mounted luminaires provide individually controllable lighting for personal preference (and increased satisfaction), as well as for more difficult visual tasks. Ceiling lighting is controlled in two zones: the two perimeter luminaires dim in response to daylight, and all luminaires turn off when the office is unoccupied.

The design approach also serves for small meeting rooms of similar size.

Floorplan



Control zone designation: A B

Luminaire		Nominal Size	Source	Luminaire			Rated Life
				Watts	Lumens	LPW	
	Recessed - PowerBalance	600W x 600L	LED 840	25	2800	112	50000
	Desk - TaskFlex	500H x 550Ext	LED 840	8	370	46	50000

Lumen and LPW values are initial and do not reflect lumen depreciation. Lumen maintenance of .80 for LED sources is used in the illuminance calculations.

Results

- Overhead lighting delivers over 450 Lux (average, maintained) to the work surfaces, with excellent uniformity.
- Individual task lighting adds about 200 Lux when used and satisfies the LEED Credit for controllable lighting. The combination of task and overhead illumination exceeds the EN12464-1 minimum illuminance recommendation.
- Wall lighting exceeds standards for illuminance and uniformity, provides effective balance to daylighted windows, and brightens the enclosed space.
- Lighting power is 47% below the Standard 90.1-2007 allowance for open office spaces. Vacancy sensing and daylight controls reduce energy usage still further. See page 28 for a more detailed discussion.

Lighting analysis

Area Avg Lux	Desks Avg Lux	Desks Min Lux	Far Surround Min Lux	Uniformity Desks	Task:Wall (Avg Lux)
400	450	375	80	0.83	4.3:1

Illuminance is at maintained levels, using total light loss factors of .72 for the recessed LED scheme and do not include desk-mounted task luminaires.

Energy Analysis

Calculation Area	Watts Ceiling	Watts Downlights	Watts Task	Watts Total	LPD (W/M^2)	LPA (W/M^2)	Reduction in Lighting Watts
19 M^2	100	–	8	108	5.68	11.93	52%

Cas Sombroek, Volendam, the Netherlands

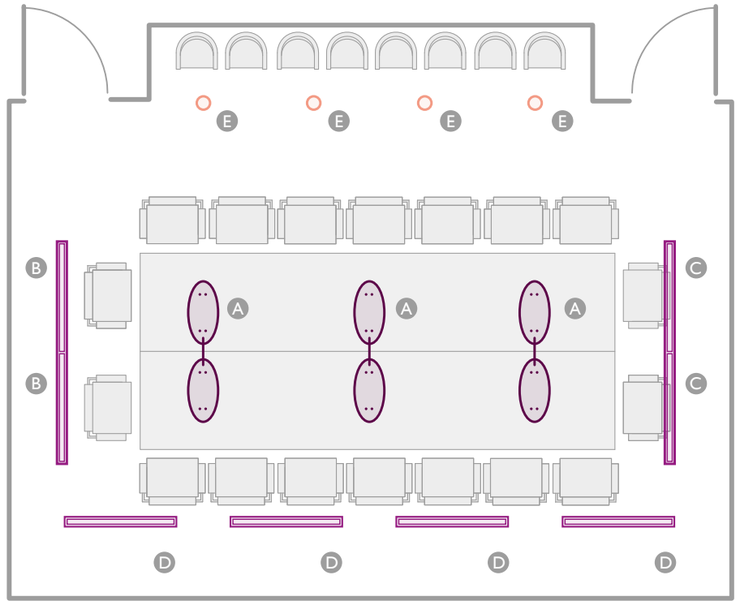
3 Conference/meeting rooms

Lighting design

Meeting rooms support face-to-face interaction, as well as visual tasks on both horizontal and vertical surfaces. These spaces also provide a diversion from everyone's routine work areas.
This design lights the main conference table using three distinctive LumiStone LED pendants with a 75% direct/25% indirect light distribution. SmartForm T5 fluorescent wall washers illuminate walls on three sides, while LuxSpace downlights highlight the fourth wall.

A multi-scene dimming control provides five distinct control channels for the central pendants and each wall. An occupancy sensor, integrated with the multi-scene system, turns lights off when the space is no longer occupied.

Floorplan



Control zone designation: A B C D E

Luminaire		Nominal Size	Source	Luminaire			Rated Life
				Watts	Lumens	LPW	
	Pendant – LumiStone	330W x 1500L	LED 840	38	4000	105	50000
	Downlight – LuxSpace	150 dia	LED 840	15	1076	72	50000
	Linear Wall Wash – SmartForm	90W x 1200L	25W T5 Eco 840	30	2179	73	25000

Results

- Overhead lighting delivers over 500 Lux (average, maintained) to the work surfaces, with excellent uniformity.
- Facial and wall lighting values are also very good, supporting various types of meeting activities.
- Lighting power is 37% below Standard 90.1-2007 allowance for open office spaces. Vacancy sensing and multi-scene controls reduce energy usage still further and satisfy LEED Credit for controllable lighting. See page 28 for a more detailed discussion of controls.

Lighting analysis

Area Avg Lux	Table Avg Lux	Table Min Lux	Far Surround Min Lux	Uniformity Table	Task:Wall (Avg Lux)
500	550	400	240	0.73	1.3:1

Mean Cylindrical Illuminance (for assessing facial lighting) is 217 Lux. Illuminance is at maintained levels, using total light loss factors of .72 for the recessed LED scheme and do not include desk-mounted task luminaires.

Energy analysis

Calculation Area	Watts Pendant	Watts Downlights	Watts Wallwash	Watts Total	LPD (W/M^2)	LPA (W/M^2)	Reduction in Lighting Watts
46 M^2	114	60	256	440	9.35	14.10	34%

Pentagon Design, Helsinki, Photographer: Tomi Nuotsalo

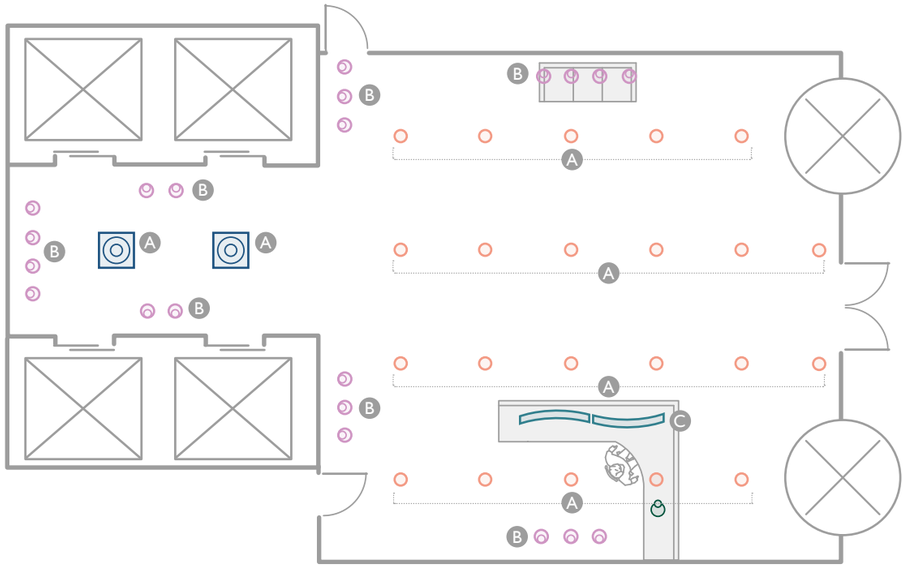
4 Reception

Lighting design

Reception lighting orientates visitors to the building and establishes the forward-looking image of the Optima organization. This design uses luminaires that are both decorative and functional to serve as way-finders. The prominent, undulating DayWave LED downlight pendant clearly announces the reception desk for visitors. Supplemented by a TaskFlex desk-mounted adjustable luminaire, the DayWave pendants also provide ample task illumination for the receptionist. Similarly, a pair of DayZone LED luminaires with a circle-in-a-square design locate and illuminate the elevator vestibule. Simple LuxSpace LED downlights fill in with ambient illumination, while adjustable accent StyliD LED luminaires light up corporate art in key locations.

Multi-scene dimming control with integral time switch allows for different lighting arrangements for primary and after-work hours, as well as nighttime security.

Floorplan



Control zone designation: A B C

Luminaire	Nominal Size	Source	Luminaire			Rated Life
			Watts	Lumens	LPW	
Pendant - DayWave	150W x 1450L	LED 840	166	4000	24	50000
Downlight - LuxSpace	150 dia	LED 840	15	1076	72	50000
Downlight - StyliD	150 dia	LED 840	30	1279	43	50000
Recessed - DayZone	600W x 600L	LED 840	29	2000	69	50000
Desk - TaskFlex	500H x 550Ext	LED 840	8	370	46	50000

Lumen and LPW values are initial and do not reflect lumen depreciation. Lumen maintenance of .80 for LED sources is used in the illuminance calculations.

Results

- Ambient lighting of 200 Lux meets standards while providing effective vertical illumination for facial recognition.
- Substantial wall illumination enhances the sense of spaciousness and invites visitors to enter in comfort.
- Lighting power is 30% below Standard 90.1-2007 allowance for open office spaces.

Lighting analysis

Area Avg Lux	Desk Avg Lux	Table Min Lux	Far Surround Min Lux	Uniformity Area	Task:Wall (Avg Lux)
220	480	280	60	0.59	1.3:1

Mean Cylindrical Illuminance (for assessing facial lighting) is 185 Lux. Illuminance is at maintained levels, using total light loss factors of .72 for the recessed LED scheme and do not include desk-mounted task luminaires.

Energy analysis

Calculation Area	Watts Pendant	Watts Downlights	Watts Accent	Watts Total	LPD (W/M^2)	LPA (W/M^2)	Reduction in Lighting Watts
141 M^2	322	330	660	1388	9.84	14.10	30%

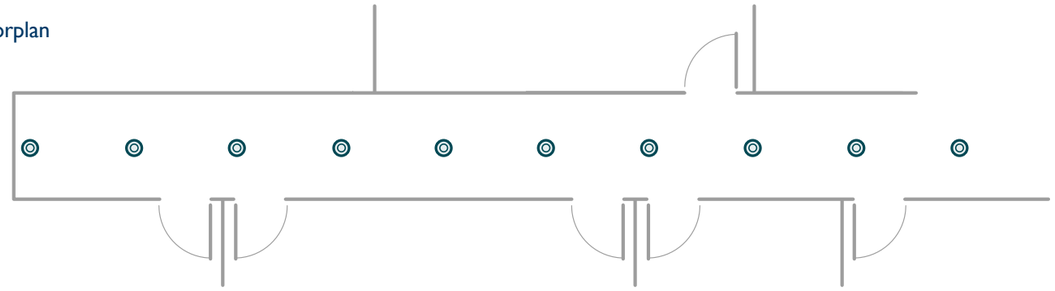
5 Circulation

Lighting design

Circulation spaces are among the most difficult to light well, whilst reducing energy for LEED credit.
This design uses simple LuxSpace LED downlights fitted with a decorative glass disk below the aperture. Although the decorative element reduces the average illuminance by about 20%, the glowing disk creates a more interesting environment, increases light on faces and walls, and meets EN12464-1 standards. The circulation space thus serves as a brief respite from ordinary work areas as office occupants move through it.

A time switch keeps corridor lights turned on during normal business hours. After hours, an occupancy sensor linked to the adjacent spaces maintains lighting at a dimmed level until all linked spaces are no longer occupied.

Floorplan



Luminaire		Nominal Size	Source	Luminaire			Rated Life
				Watts	Lumens	LPW	
◎	Downlight- LuxSpace Decorative	150 dia	LED 840	15	878	59	50000

Lumen and LPW values are initial and do not reflect lumen depreciation. Lumen maintenance of .80 for LED sources is used in the illuminance calculations.

Results

- Ambient lighting of 100 Lux meets standards while providing balanced illumination for facial recognition and sufficient wall illumination to maintain a pleasing transient space.
- Lighting power is 19% below Standard 90.1-2007 allowance for open office spaces.

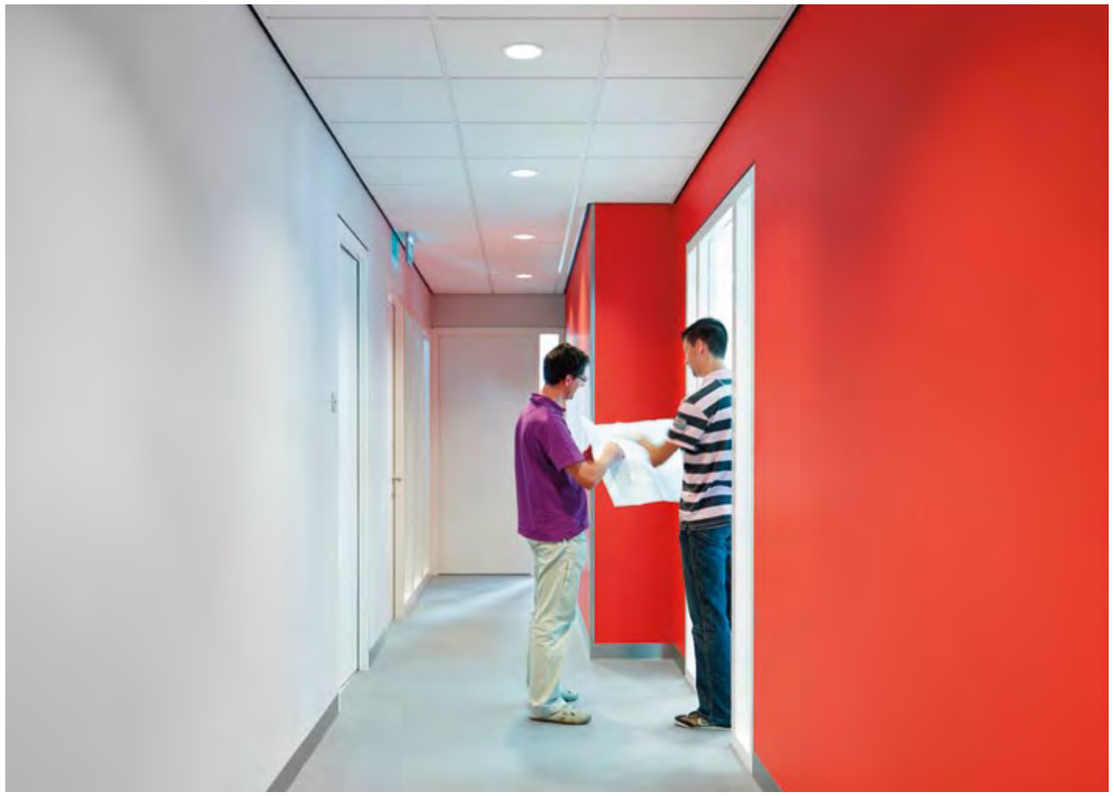
Lighting analysis

Area Avg Lux	Uniformity Area	Wall Avg Lux	Area:Wall (Avg Lux)
120	0.60	80	1.5:1

Mean Cylindrical Illuminance (for assessing facial lighting) is 72 Lux. Illuminance is at maintained levels, using total light loss factors of .72 for the recessed LED scheme and do not include desk-mounted task luminaires.

Energy analysis

Calculation Area	Watts Downlights	Watts Total	LPD (W/M^2)	LPA (W/M^2)	Reduction in Lighting Watts
34 M^2	150	150	4.41	5.42	19%



Cas Sombroek, Volendam, the Netherlands

Luminaire schedule

Luminaire type	Location	Luminaire image	Luminaire Description	Philips catalogue series	Fixture Code*	Light Source	UGR	System Light Output (Lumens)	Input Wattage (Watts)	Efficacy (Lumens Per Watt)**
	Open Office		Recessed LED micro-lens optic 300mm x 1200mm Dimmable	PowerBalance RC461B	RC461B W30L120 1xLED34S/840*	LED 4000K, 80+ CRI	15	3400	31	110
	Open Office		Linear fluorescent pendant 70% direct/30% indirect 150mm x 1200mm Dimmable	Arano TPS642	TPS642 1xTL5-25W HFD C8*	TL5HE/Eco 4000K, 80+ CRI	15	2258	30	75
	Open Office Cell Office Reception		LED adjustable desk lamp	TaskFlex FS400D	FS400D 1xLED5/830	LED 3000K,80+ CRI	n.a.	370	8	46
	Open Office Circulation and Corridors		Recessed LED downlight Decorative glass accessory 150mm aperture Dimmable	LuxSpace Mini High Efficacy BBS488	BBS488 1xDLED-4000 +ZBS480 SG-O	LED 4000K, 80+ CRI	25	878	15	59
	Elevator vestibule Reception		Recessed LED micro-lens optic 600mm x 600mm Dimmable	DayZone BBS560	BBS560 1xLED20S/840 AC-MLO-C*	LED 4000K, 80+ CRI	14	2000	29	69
	Cell Office		Recessed LED smart pyramid optics 600mm x 600mm Dimmable	PowerBalance 461B	RC461B W60L60 1xLED28S/840*	LED 4000K, 80+ CRI	14	2800	25	112
	Conference Room		LED pendant 75% direct/25% indirect 330mm x 1500mm Dimmable	LumiStone SP522P	SP522P 2xLED20S/840*	LED 4000K, 80+ CRI	15	4000	38	105
	Conference Room Public Areas		Recessed LED downlight 150mm Dimmable	LuxSpace Mini High Efficacy BBS488	BBS488 1xDLED-3000 M PG*	LED 4000K, 80+ CRI	22	1076	15	72
	Conference Room		Recessed linear fluorescent asymmetric wall wash optic 90mm x 1200mm Dimmable	SmartForm TBS411	TBS411 1xTL5-25W HFD A*	TL5HE/Eco 4000K, 80+ CRI	n.a.	2179	30	73
	Public Areas		Recessed LED accent light adjustable optic 150mm Dimmable	StyliD ST502B	ST502B 1xSLED 1200/930 MB*	LED 4000K, 80+ CRI	n.a.	1279	30	43
	Public Areas		Decorative LED pendant 150mm x 1450mm Dimmable	DayWave PBS800	BPS800 1xLXML/NW AC-MLO*	LED 4000K,80+CRI	15	4000	166	24

* Verify that ballast or driver is compatible with selected control system.
** Luminaire efficacy is based on initial luminaire lumens and input watts.

Lighting control performance narrative

LEED certification requires compliance with the mandatory control provisions of Standard 90.1. These include automatic shut-off for each floor of the Optima project, a separate control for each enclosed space in the project (including the open plan areas), and occupancy sensors or multi-scene controls for conference rooms. Projects must comply with local codes, of course. LEED IEQ Credit 6.2 is available if occupants can independently control lighting. While these measures reduce energy consumption and enhance user satisfaction, advanced controls can go much further.

Basic control strategies in the Optima design

- Occupancy and time-based control to turn off lighting when spaces are no longer occupied.
- Photosensor-based dimming control to maintain target light levels (as when daylight is available).
- Multi-scene dimming controls to adjust lighting effects for different activities

Occupancy controls use a manual-on /auto-off design. Manual-on/auto-off permits workers to leave lights off until electric lighting is needed and to turn them on manually at that point; sensors turn them off automatically once the space has been vacated. This optimizes energy savings and user comfort. Each enclosed space is controlled by one or more sensors and a manual wall switch. Time-based switches are used for after-hours circulation spaces.

Experience shows that, with current lighting practice, simply reducing electric lighting by one Lux for each Lux from daylight does not prove comfortable or effective for most office occupants. With the diffuse quality of reflected daylight and the strong brightness cues from windows, daylight harvesting needs more contrast and task brightness to be successful. This is accomplished by dimming only after the combined daylight and electric lighting is 30-50% higher than the target illuminance level for electric lighting alone.

In the Optima design, the daylight harvesting control is programmed for a maximum of 400 Lux from the primary electric lighting in working areas. Luminaires dim once the combined daylight and electric lighting exceeds 550 Lux, which provides a comfortable feeling of daylight brightness before the electric lighting begins to dim.

Outside the daylight zones photosensor controls are programmed so that luminaires maintain the illuminance target for local functions in each area and adjust for light loss over time. This strategy – task tuning plus lumen maintenance – is also incorporated into the daylight harvesting program.

Multi-scene controls are used in conference rooms and other areas with several layers of lighting and different settings for multiple activities and different users in the shared space.

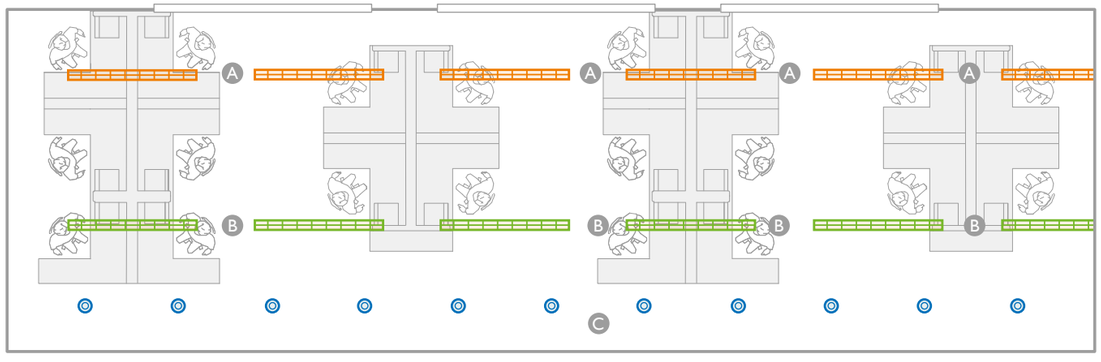
Open office

For control purposes, the open office – 873 square meters total – is divided into six areas, three on each side of the building. This improves response to occupancy patterns and small differences in daylight.
As the drawing on page 29 indicates, each row of luminaires is a separately controlled zone in its area. Although the control set points are the same for the two zones over the primary work areas, the zone close to the windows dims fully most often; the second row – with less daylight – dims partially most often. Task luminaires on each desk are independently controlled by the user (see cell office, below).
The interior row of downlights over the circulation dims with photosensor input for lumen maintenance.
A single occupancy control with a manual switch turns on the two rows of luminaires over the work surfaces, which turn off automatically when the space is no longer occupied. All downlights on each side of the building are controlled together: after-hours, lighting dims to the minimum egress criteria, and increases to full-on via automatic occupancy sensing.

Cell office

Each enclosed office space is designed for two dimmable zones, one close to the windows and the second one inboard. This provides flexibility for multiple desks and daylight harvesting. Photosensor input maintains lighting at target levels. Controls at the entry allow for independent control of the two zones, with manual-on and dimming capability (to dim below the photosensor setting). After the room has been vacated, the occupancy sensor turns off the lights automatically.

Open offices



Lighting control zone A Lighting control zone B Lighting control zone C

In both cell and open offices, occupants independently control their desk-mounted task lighting, providing higher light levels for more difficult tasks, personal comfort, and a valuable sense of control of the environment. Task lights plug into an electrical outlet. If the outlet can be controlled by an occupancy sensor, the task lights can be excluded from the connected load under Standard 90.1.

Conference/meeting rooms

To provide appropriate flexibility, conference spaces with multiple layers of lighting use multi-scene controllers, along with an occupancy sensor. Five zones of lighting are shown in the Optima design, and all luminaires are dimmable. Switches at both doors allow the occupants to turn on one preset (typically the most energy efficient one), The occupant can move to interior of the room, typically next to a lectern or podium, to activate the remaining presets. Alternatively, a portable remote control device can be provided.

Reception

Since public spaces are continuously occupied during normal business hours, the lighting is typically set on full; after hours, lighting is dimmed. Photosensor input also dims for lumen maintenance. Lighting is controlled in three zones: ambient recessed lighting, accent lighting aimed at art on the walls, and the pendant over the reception desk. A multi-scene preset system establishes the various levels for selection by the receptionist, or automatically by time switch. After-hours energy reduction can also be achieved by simply switching off the pendant and accent lighting.

Circulation

The use of LED luminaires in the corridors allows for low-cost dimming and lumen maintenance: previously, this was not a cost-effective with fluorescent sources. Corridor lighting is expected to be on full during the day. After-hours, the lighting dims to the minimum egress criteria, and increases to full-on via automatic occupancy sensing. Alternatively, lighting can be linked to occupancy in adjacent spaces.

Options

These control strategies can be achieved using various technologies and levels of building integration. The table on pages 30-31 shows some of the available options. Sensors can be integrated into the luminaire (Actilume, for example) or installed separately on the ceiling or wall.

Dimming signals can be sent using analog 0-10 volt control wires or a digital addressable lighting interface (DALI), built into the driver or ballast. DALI facilitates flexible, cost-effective installation and provides more control functionality (for example, allowing dimmed illumination of adjacent unoccupied areas for enhanced comfort in open offices). All the luminaires used in the Optima design are available with DALI drivers or ballasts.

Since each DALI luminaire and sensor is individually addressed, it is not necessary to wire luminaires into fixed control zones. The zone assignment can be done after the electrical installation, which reduces initial wiring and labor costs. Upgrades and modifications are also easier as the space functions change and evolve. Finally, a DALI system can send information back to the operator, indicating if any lamps, ballasts or controls are not functioning, greatly aiding the maintenance and operation of the lighting system.

Higher levels of networking are also available, allowing integration with shading or other building management systems, and even extending to multiple buildings.

Controls options

Functionality	Description of operation	OccuSwitch	OccuSwitch Wireless	OccuSwitch DALI	Actilume 1-10V	ActiLume	Lightmaster modular	Dynalite Lytemaster KNX
		Installer based smart sensors			Luminaire based systems		Lighting management systems	
Presence Detection	Auto-on, auto-off. PIR technology.	●	●	●	●	●	●	●
Absence Detection	Manual-on, auto-off. PIR technology. Requires remote electronic wall switch.		●	●	●	●	●	●
Daylight Harvesting	Maintains daylight + electric light at constant set point.			●	●	●	●	●
Lumen Maintenance	Maintains light at constant set point to adjust for lumen and dirt depreciation over time.			●	●	●	●	●
Task Tuning	Dims to target illuminance level, compensating for luminaire performance or layout.			●	●	●	●	●
Background Period	Time lighting stays on at reduced dimming level after an area has become vacant. Will be between zero and infinite.			●		●	●	●
Corridor Hold On	While the linked areas are occupied, the lights in the corridor stay on.			●		●	●	●
"Night Watch" Mode	The night watch mode disables selected auto-on occupancy sensors (requires a clock device).						●	●
Peak Saving	Reducing energy load at peak times.						●	●
Multi-Scene Preset Control	Multiple zones and scenes, with integral time clock, dimming, fade, and absence detection.							●
Management Functions	Maintenance, energy measurement, insights in operations			●		●	●	●
Drivers and Ballasts	Compatibility with system	Fixed	Fixed	DALI	0-10V	DALI	DALI	DALI

Night Watch mode is intended to prevent someone from outside following the night watch doing its rounds in the building by simply looking at the areas that switch on. Switching off works normally so if the night watch decides to switch on some lamps they fade off automatically. It only disables the automatic switch on.

Baker & McKenzie, Amsterdam, the Netherlands

AB Group, Orzinuovi, Italy

Glossary

Arano	Pendant T5 fluorescent luminaire (used in the Optima open office areas).
Ballast	Electrical gear necessary for the operation of discharge light sources (fluorescent or HID) and typically provided in the luminaire. Ballasts must be electrically compatible with the lamps they operate. Dimming ballasts are needed to be able to dim fluorescent luminaires.
Closed Loop	An option for the operation of a photosensor. Closed loop describes a daylight-based dimming system where the photocell detects the combination of daylight and electric light in the space, and the controller dims the electric to maintain a specific level of illuminance. Closed loop design is commonly used for daylight harvesting. It is also used for lumen maintenance dimming (where the sensor is detecting the changing level of electric lighting over time). See also Open Loop.
Commissioning	Commissioning is the process of assuring that a lighting control system (and other adjustable equipment in a building) performs as expected. Commissioning includes establishing design criteria (expectations), fine-tuning the final installation (typically, calibrating and programming), and verifying that it meets the criteria.. Basic commissioning is a LEED prerequisite; additional points are available for enhanced commissioning practice.
Connected Load	Total installed wattage (of luminaires) before consideration of switching or dimming control.
Control Zone	A group of luminaires controlled together. A zone may represent an area or a type of luminaire or lighting effect.
Credit	In LEED, a credit is an action or a design attribute that awards one or more points if it is implemented. In LEED NC-2009, there are 49 credits, grouped into seven topic areas.
CRI	Color Rendering Index. A standard method for evaluating how well a light source illuminates object colors. CRI is often shown as Ra; the scale runs from 0 to 100. CRI of 80 or higher is recommended for good quality office environments.
Cylindrical Illuminance	Illuminance measured in the vertical plane at either seated or standing height. Mean cylindrical illuminance is the average of measurements from multiple directions. Useful for evaluating the lighting of faces or objects.
DALI	Digital Addressable Lighting Interface. DALI is a communication protocol linking compatible controls, sensors, and luminaires (drivers and ballasts) into a network, in which each device can be independently addressed and signaled. DALI permits easy reconfiguration of control zones and two-way communication of the status of the lighting system.
Daylight Harvesting	Daylight harvesting is a form of lighting control that reduces electric lighting when daylight is available, thereby saving energy. Daylight harvesting may use switching control, but dimming control (while more costly) is necessary for occupant acceptance in the workplace.
Daylight Switching	Occupancy control with integral photosensor. The control automatically keeps the electric lights off, as long as the photosensor detects adequate daylight illumination (as programmed into the control).
DayWave	Pendant LED luminaire in curvilinear form (used in the Optima lobby reception area).
DayZone	Recessed LED luminaire with circle-in-square design (used in the Optima lobby elevator vestibule).
Driver	Electrical gear necessary for the operation of LED sources and typically provided in the LED luminaire. Drivers must be compatible with the LED's they operate. Dimming drivers are needed to be able to dim LED luminaires.
Efficacy	Luminous efficacy – expressed in lumens per watt and abbreviated LPW - commonly measures the energy efficiency of lighting. It is the ratio of lumens emitted by a light source or luminaire to the input power. In this guide, the efficacy values shown are based on initial luminaire lumens and system input power, including driver or ballast.
Facial Recognition	Used here, facial recognition means adequate and sufficiently diffused illumination so that faces appear natural and their expressions can be clearly seen in an office context. Also called facial modeling.
Illuminance	Total luminous flux incident on a surface, per unit area. Unit of measure: Lux (one lumen per square meter).
Layers of Light	Layers of light, or lighting, refers to both the use of multiple lighting systems and lighting effects in a space (for example, light specifically directed to different surfaces and objects.)
LEED NC 2009	LEED (Leadership in Energy and Environmental Design) is an internationally recognized and voluntary green building certification system with third-party verification. LEED systems cover different building types; LEED NC applies to new construction and major renovations. The rating systems are updated regularly; the latest edition of LEED NC is 2009 (version 3).
Light Emitting Diode (LED)	A semi-conductor device that emits visible energy. LED's enjoy high (and increasing) luminous efficacy and long life. LED performance, color quality, and life depend on the design of the LED chip, the driver, and the luminaire in which it is used.
Light Loss Factors	Factors used to estimate actual illumination over time, taking into account lumen depreciation of the light source, dirt accumulation, and other factors. To compensate for this light loss, initial illuminance levels can significantly exceed target values. A lumen maintenance control strategy dims to save energy by eliminating this excess.
Light Pollution	Light Pollution generally refers to exterior lighting or light emitted from buildings at night, and includes light trespass on neighbouring property, light directed upward into the sky (called sky glow), and excessive levels of illumination.
LPW	Lumens per watt, a measure of luminous efficacy.
Lumen	Measure of luminous flux, the flow (quantity) of light from a light source or luminaire.
Lumen Maintenance	Control strategy that dims the "excess" lighting provided to compensate for light loss over time.
Luminaire	Complete lighting device, including light source, auxiliary gear (ballast, driver, etc), optics, housing, mounting attachments and electrical connection.
Luminance	Photometric brightness of a surface in the direction of view. Unit of measure is candela per square meter.
LumiStone	Decorative LED pendant (used in the Optima conference room).
Lux	Measure of illuminance. 1 Lux = 1 lumen per square meter.
LuxSpace	LED downlight (used in the Optima open office, conference room, corridor and lobby areas).
Maintained Illuminance	The initial illuminance from luminaires, adjusted by a light loss factor (LLF), to represent the expected illuminance after several years of use. Losses include depreciation of lumen output by aging, effects of dirt accumulation on luminaire surfaces and room surfaces, ballast factor, and other factors that reduce illuminance.
Minimum Illuminance	Lowest Lux value among calculation points in the relevant area.
Multi-Occupant Space	In LEED, Multi-Occupant Spaces are places of egress, congregation, or where occupants pursue overlapping or collaborative tasks. Multi occupant spaces may be regularly or non-regularly occupied spaces.

Multi-Scene Control	Dimming and/or switching system that adjusts several zones of lighting to different settings ("scenes") in order to conveniently serve various activities or time-of-day arrangements.
Occupancy control	The combination of a sensor and a switch or relay. The sensor detects human presence through motion (either changes in the thermal image received by the sensor (passive infrared or PIR) or in the reflection of ultrasonic waves). As long as the sensor detects motion, the lighting will stay on; after the sensor no longer detects motion, lighting will be turned off. An auto ON/auto OFF device turns on automatically as soon as presence is detected. A manual ON/Auto OFF device turns on only when an occupant operates a switch. Both devices turn off automatically when presence is no longer detected.
Open Loop	An option for the operation of a photosensor. Open loop describes a daylight-based dimming system where the photocell detects incident daylight only, and the controller dims the electric light to preset levels based on the daylight reading. Open loop design is commonly used for outdoor lighting and for balancing daylight.
Photosensor	A meter that measures light and sends a signal to a controller that will either turn lighting on or off or dim according to a program.
Pilot Credit	In LEED, a Pilot Credit is a provisional credit available for use, evaluation, and modification before adoption as a final credit in a future version.
Point	In LEED, points are awarded for meeting the criteria specified in the different credits. More than one point may be available for certain credits. The total number of points awarded determines the level of LEED certification.
PowerBalance	Recessed LED luminaire (used in the Optima open and cell offices).
Prerequisite	In LEED, prerequisites are requirements that must be met before any points can be earned.
Prescriptive	Prescriptive compliance to standards and codes follows prescribed actions or rules. Prescriptive compliance is typically an alternative to whole-building energy simulation modeling.
Preset	Setting of a lighting "scene" that is programmed into the dimming/switching control and can be recalled as desired. Presets are typically user adjustable.
Rated Average Life	The median time to failure in a statistically significant sample of light sources. For LED sources failure is commonly defined as delivering less than 70% of initial light output (L70). For other sources, failure is commonly defined as no longer operating.
Regularly Occupied Space	In LEED, regularly occupied spaces are areas where one or more individuals normally spend time (more than one hour per person per day on average) seated or standing as they work, study, or perform other focused activities inside a building.
Simulation	Computer model for estimating building performance. Approved computer programs simulate the energy consumption of an entire building for both code compliance and LEED certification. Daylight levels, penetration, and gradients are also generally simulated using popular computer programs.
SmartForm	Recessed T5 fluorescent wall washer (used in the Optima conference room).
Standard 90.1-2007	ASHRAE/IESNA/ANSI Standard 90.1-2007 is the minimum energy code permitted in the United States. An American National Standard, it is jointly developed by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and the Illuminating Engineering Society of North America (IESNA). LEED uses Standard 90.1 as a baseline for Energy and Atmosphere Prerequisite 2 and Energy and Atmosphere Credit 1. Local code may be used for LEED if it is at least as rigorous and has prior approval from LEED. Key lighting provisions of Standard 90.1-2007 include Interior and Exterior Lighting Power Allowances (maximum wattage permitted for a building or space, based on its use and area) and mandatory lighting controls for the entire building, each enclosed space and its exterior.
StyliD	Recessed adjustable LED downlight (used in the Optima lobby).
Target Illuminance	Illuminance setting for daylight harvesting, lumen maintenance, and task tuning control strategies. Without daylight, the system maintains electric lighting at the required design level. As daylight increases, the system typically dims the electric lighting so that the combination of electric and daylight is about 30%-50% higher than the electric lighting alone (based on experience with user comfort).
Task Illuminance	Light falling on the principal work surfaces. In the Optima design, task illuminance is calculated on a 100mm x 100mm grid.
Task Tuning	Control strategy that dims to bring the delivered illuminance to the target levels.
TaskFlex	Adjustable, desk-mounted, portable luminaire (used in the Optima open and cell offices and lobby reception desk).
Time Switch	On/Off control connected to a clock for time-of-day control.
Unified Glare Rating (UGR)	Unified Glare Rating (UGR) evaluates the direct glare produced by a specific arrangement of luminaires in a specific space. Lower values indicate less glare. UGR requirements vary by application. UGR is also calculated in standard tables for specific luminaires.
Uniformity (of Illuminance)	Uniformity measures the consistency of illuminance across the task area, between the task and other areas, and across other surfaces. Under EN12464-1, uniformity is generally calculated as the ratio of minimum to average illuminance, with 1.0 indicating perfectly even illuminance. For office task areas, a minimum uniformity of 0.6 is needed.

Lighting designs by HORTON LEES BROGDEN LIGHTING DESIGN INC. New York, USA

For further information on Lighting for LEED,
please contact Philips via **www.lighting.philips.com**

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