Efficient Lighting

EarthCheck

Improving the efficiency of lighting can be one of the most simple and cost effective strategies for tourism operations seeking to reduce energy consumption. The wide range of lighting now available can make selecting the best efficient lighting option for your business confusing. This fact sheet will help to provide useful information on different types of lighting and tips on how to balance functionality, cost and environmental considerations.

Don't be fooled by low capital costs!

The small premium for purchasing efficient lighting can usually be offset by reduced costs across the life of the products.

Where to start?

It is important that you understand the fundamentals of lighting so that you can discuss lighting issues with suppliers, electricians and architects. It is also important to understand your sites lighting needs. Lighting needs can be defined by the tasks being undertaken in a particular area. For example, different lighting levels will be required for guest rooms, kitchens, offices and outdoor public spaces.

The key lighting issues to consider include:

- Lighting levels (task requirements, workplace health and safety concerns, aesthetics and guest comfort)
- Costs (capital, operational and disposal)
- Building regulations

It is important to collaborate with a range of stakeholders when reviewing facility lighting. Stakeholders might include:

- Building/facility manager/engineer
- Maintenance staff
- Electrician
- Environmental officer
- Finance department
- Procurement officer

After deciding to investigate efficient lighting options conduct a site survey and collect the following information:

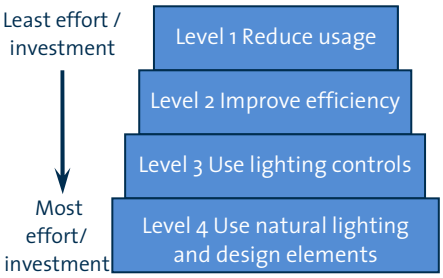
- Number, wattage and type of existing lighting fixtures
- Operational hours and procedures
- Current lighting levels, lighting level requirements and floor area

Talk to staff about lighting level requirements and current lighting adequacy. Consider purchasing an inexpensive light meter to help review lighting levels[1].

After conducting your site survey consider alternative lighting solutions. Identify short, medium and long term targets and consider life cycle costs including purchase and installation costs, estimated operational savings and replacement and maintenance costs.

What opportunities are available to improve lighting efficiency?

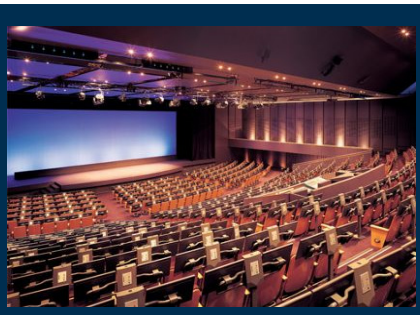
There are four main areas for lighting improvement. The levels do not imply any preferred opportunities but rather the level of investment and effort required to implement[2].



Level 1: Reduce usage

The first opportunity to improve the efficiency of lighting systems should be to reduce the number of lights and the operating hours of lighting. Investigate the following opportunities:

- Establish standard procedures for lighting operation. Request staff and guests switch off lighting when it is not required. Use staff meetings and visual reminders such as signs near light switches to remind staff and guests
- Remove lighting from areas with excessive lighting
- Remove or reduce the operational hours of night lighting not directed at a surface
- Optimise use of lighting (for example, by reducing intensity of room lighting and providing specific task lighting)



Case Study:

Sydney Convention and Exhibition Centre, Darling Harbour, Australia

The Sydney Convention and Exhibition Centre replaced eight hundred 500W high bay light fittings in the Centre's exhibition halls with 400W bulbs which were then connected to a digital control system. The control system provides four levels of standard light: 25%, 50%, 75% and 100% with each level providing a corresponding energy saving. The Centre's large Bayside Convention Room has also been fitted with a new lighting control system that automatically adjusts according to the amount of natural light available throughout the day.

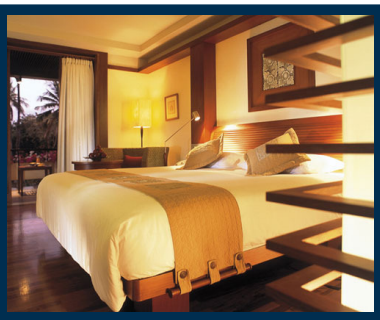
Level 2: Change lamps

After identifying opportunities to reduce the number and operating hours, opportunities to replace lights should be investigated. Replacing lights can be as simple as replacing existing bulbs with ones of a reduced wattage (i.e. replacing 100W lights with 60W lights) or by changing the type of lighting.

Simple tips for changing lights

One simple opportunity for upgrading the efficiency of fluorescent lights is to replace halophosphate fluorescents with triphosphorous fluorescents which have up to a 20% greater light output. By increasing light output it may be possible to reduce the number of light fixtures whilst achieving equivalent lighting levels. Other replacement opportunities include:

- Replacing incandescent lights with compact fluorescents or LEDs
- Replacing fluorescent T12s or T8s with more efficient T5s to achieve up to a 30% reduction in energy use[3]
- Replacing mercury vapour lamps with metal halide or fluorescents



Case Study:

Meliã Bali
Bali, Indonesia

Meliã Bali achieved energy savings of 336,276 kWh by reducing the operational hours of lighting and replacing inefficient lighting. Overall, the resort:

1. Replaced 1000, 80W garden lamps with 23W energy saving lamps
2. Replaced 1200, 50W spot lamps with 1.5W LED lamps
3. Replaced 291, 60W incandescent lamps with 11W PLC
4. Halved the number of lights in its back office

Not only did this save energy, but significant cost savings were achieved. **With a total capital and installation cost of US$39,000 and annual savings of US$32,148, a payback period 14 months was estimated** for these initiatives.

Different types of lighting

There are many different types of lighting available. Your existing infrastructure may dictate replacement opportunities, however if you are investing in a complete retrofit or new design, it is worthwhile taking the time to select the most efficient lighting available. Tasks being carried out in lighting areas will also affect the appropriateness of certain types of lighting.

The two main issues to consider when comparing lighting systems include:

- Quality of light
- Energy consumption and costs

Note: The following information should be used as a guide only. The lighting industry is constantly undergoing change with new and more efficient products being regularly made available. The characteristics of available lighting options will also vary by region and supplier. Request the following information from suppliers when comparing available lighting options.

Safety

It is vital that health and safety concerns are taken into account when assessing lighting opportunities. Certain tasks require specific lighting levels, colour rendering and colour temperature characteristics. Task specific lighting requirements are often specified in terms of lux. Lux is a measure which relates light output to the area requiring lighting. Lux is calculated as lumens/m2. Typical outdoor lux levels on a clear day are 10,000 lumens/m2 whilst standard lux levels for office work are around 500 lux[9].

Before removing or changing lights or reducing lighting levels review building codes and regulations and assess the tasks being carried out in the lighting space. For more information on task specific lighting levels review the Illuminating Engineering Society Lighting Handbook; the standard lighting guide for lighting quality and quantity.

Light output is measured in lumens whilst the efficacy of lighting is measured as a ratio of lumens to Watts (lumens/W). This measure gives an indication of how effective the system is at producing light per Watt of power. Table 1 provides examples of efficacy for different lighting options.

Table 1 Light efficacy

Type of light	Typical wattage (W)	Efficacy[4] (lumens/ Watt)
Incandescent - Standard	15-1,500	10-15
Incandescent - Tungsten halogen	10-2,000	15-20
Fluorescent	8-36	55-105
High Intensity Discharge (HID) - Mercury vapour	40-1,000	45-50
High Intensity Discharge (HID) - High pressure sodium	35-180	85 - 105
Low pressure sodium[5]	35-180	Up to 180
Metal halide	35-3,500	60-80
Light emitting diodes (LED)	3-4.2	11-15

Colour Rendering Index (CRI) is used to determine the appropriateness of lighting to specific spaces and tasks. CRI differentiates lighting based on the appearance of standard colours subject to specific lighting conditions. A CRI of 100 will not significantly affect colour rendering, however as the CRI decreases, colour distortion increases[6]. CRI should be considered when selecting lighting based on task requirements of an area. See Table 2 for standard CRI values of common light sources. Similarly, colour temperature refers to the 'feel' of the light with standard incandescent lights providing a 'warm' yellow feel whilst lighting with higher colour temperature produce a 'cool' blue light. Refer to Table 3 for information on typical colour temperatures of different lights.

Table 2 - Typical CRI values for commonly used light sources

Type of light	Colour rendering[7] (Ra)
Incandescent Standard	100
Incandescent - Tungsten halogen	100
Fluorescent	Halo-phosphate 55-60 Triphosphor and multi-phosphor 80-95 Compact fluorescents 82-98
High Intensity Discharge (HID) - Mercury vapour	42-52
High Intensity Discharge (HID) - High pressure sodium	25
Low pressure sodium	N/A
Metal halide	60-93
Light emitting diodes (LED)	Wide range

Table 3 – Colour temperature

Type of light	Colour Temperature[8] (Kelvin)
Incandescent Standard	2,500-2,700
Incandescent - Tungsten halogen	3,000-3,400
Fluorescent: Cool white Intermediate white Warm white Compact	 4,000-6,000 3,500 2,700-3,000 2,700-6,000
High Intensity Discharge (HID) - Mercury vapour	3,300-3,800
High Intensity Discharge (HID) - High pressure sodium	2,000-3,000
Low pressure sodium	1,800
Metal halide	3,000-10,000
LED	Wide range

Table 4 provides some qualitative information on typical capital and operating costs and an indication of the relative average life of different lighting types.

Table 4: Cost considerations[10]

Type of light	Capital cost	Relative operating costs	Average life (hours)
Incandescent - Standard	Low	Very high	~1,000
Incandescent - Tungsten halogen	High	High	2,000-8,000
Fluorescent tubes: Halo-phosphate Triphosphor and multi-phosphor	Low Low	Low Low	7,000-8,000 8,000 - 18,000
Compact Fluorescent (CFL)	Low	Low	8,000-10,000
High Intensity Discharge (HID) - Mercury vapour	Moderate	Low/ moderate	8,000-12,000
High Intensity Discharge (HID) - High pressure sodium	Moderate /high	Low	12,000-30,000
Low pressure sodium	Moderate /high	Low	14,000-18,000[11]
Metal halide	Moderate /high	Low	8,000-12,000

Ballasts

Lamp efficiency may be restricted by the type of ballast installed. Ballasts transform and control electrical power for fluorescent, high-intensity discharge and low-pressure sodium lights. The efficiency of ballast-lamp combinations needs to be considered when reviewing lighting options.

There are three standard types of ballast; Magnetic (least efficient), Hybrid, and Electronic (most efficient). Electronic ballasts can reduce electricity consumption of lights by 10 to 15 % over the use of magnetic ballasts[12]. Factors to consider when determining effectiveness include:

- Ballast factor – A factor indicating the relative light output of a particular lamp-ballast combination
- Ballast efficacy factor (%/W)– A ratio of ballast factor to power
- System efficacy (lumens/W)– ratio of light output to power.

Level 3: Use lighting controls

Automatic control of lighting systems may be a more feasible option than trying to encourage staff and guests to actively manage lighting. Opportunities for automated lighting control include:

- *Timers:* Timers can be electromechanical or electronic. They are used to limit the duration a light stays on for after being switched on, or they can be used to turn lights on and off at specified times
- *Occupancy detectors:* are sensors that switch lighting on when occupants are identified in a room. Three main types of occupancy detectors are available:
  - Passive infrared that sense movement of a heat-emitting body
  - Ultrasonic that sense changes in sound wave patterns
  - Hybrid passive infrared/ultrasonic[13]
- *Photosensors:* work by sensing the availability of light and adjusts the lighting levels according to predetermined requirements
- *Room key card switches:* reduce lighting use in guest rooms by switching power off when the key card is removed
- *Building Management System (BMS) control:* allows for central control of equipment within a building or business. If there is already a BMS in operation on site, it may be possible to incorporate lighting into this system
- *Power reducers:* reduce the overall power supply to the lighting system. They can be used on fluorescent lighting systems to reduce power demand of the system. Care should be taken to ensure that a power reducer is compatible with the lighting system. These systems are generally only used in retrofit applications

To improve the effectiveness of lighting controls businesses should consider efficient lighting initiatives based on lighting requirements. This can be achieved by:

- Implementing lighting 'zones' where lighting for specific areas of different functions are controlled separately. Typical zones include:
  - Facade and outdoor lighting
  - Public areas (pools, gyms, etc)
  - Restaurants and retail spaces
  - Lobby and reception
  - Guest rooms
  - Corridors
  - Bathrooms
  - Conference and meeting rooms
- Providing individual light switches for areas with infrequent use or areas which commonly only require partial lighting

These separate areas may benefit from being controlled independently. For example, facade and outdoor lighting could be controlled by a timer or photosensor set to turn lights on at night and off in the morning, whilst corridor and stairwell lighting would benefit from occupancy detectors which only switch on when the space is occupied.

Level 4: Use natural lighting and design elements

Use of natural lighting can have significant benefits in terms of reduced lighting energy consumption and enhanced guest and staff comfort. Incorporating natural light into buildings and rooms is most effective in new design and retrofit applications. Some simple opportunities to improve daylight effectiveness include:

- Installing skylights or open roofs
- Installing windows that transmit visible light but absorb or reflect heat (depending on climate)
- Brightening interior surfaces and using direct and indirect lighting in combination to reduce harsh contrasts[14]
- Using daylight for general room lighting and incorporating task lighting for specific tasks

References

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[3] Carbon Trust, 2007, *CTV021: Technology overview: Lighting: Bright ideas for more efficient illumination*

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[7] Adapted from Lighting Industry Federation Limited, 2001, *Lamp Guide* and Carbon Trust, 2007, *CTV021: Technology overview: Lighting: Bright ideas for more efficient illumination*

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[10] Adapted from Carbon Trust, 2007, *CTV021 Technology overview: Lighting: Bright ideas for more efficient illumination*

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[13] US DOE, 2008, *Energy Efficiency and Renewable Energy: Building and Technologies Program: Commercial buildings: Lighting and daylighting*

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