Fact Sheet

Improving Lighting Efficiency in Public Areas of Live Performance Venues

Greener Live Performances

through energy efficiency

Improving the efficiency of lighting can be one of the most simple and cost effective strategies for performance venues seeking to reduce energy consumption. The public areas of live performance venues, also known as 'Front of House' areas, often have flexible requirements that allow combination of lighting efficiency improvement approaches from simply replacing bulbs to retrofitting fixtures.

Lighting requirements for the public areas within a venue can differ enormously from lighting requirements of performance areas. This fact sheet will provide information on different types of lighting and tips on how to balance functionality, cost and environmental considerations within the public areas of live performance venues.

Key lighting issues to consider include:

- What lighting levels are required for each space or task?
- How it looks and feels (aesthetics and visitors' comfort)?
- Does the lighting in each area affect patrons' personal safety?
- What are the capital, operational and disposal costs of fixtures and bulbs?
- What are the relevant building lighting codes and regulations?
- Is the space indoors or outdoors? Will the lights be operating in a broad range of weather conditions?

How to start?

Refresh your understanding of lighting fundamentals

When considering the lighting efficiency of your venue, it's important to start with the basics. Understanding the fundamentals of lighting will allow you to discuss specific issues with equipment suppliers, electricians, lighting designers, sound and light engineers and architects.

Identify needs of your venue's public areas and examine current lighting equipment and systems

Secondly, you will need to consider the specific lighting requirements across different public areas such as indoor and outdoor space, public entrances and foyers, seating areas, and public toilets. This is best started by conducting a site survey to collect the following information:

- Type, wattage and number of existing light fixtures;
- Floor area being lit within each public space;
- Recommended lighting levels for each area or task;
- Current lighting levels within each area;
- Average number of visitors using each space, at various times throughout the day and week;
- Venue operational hours and procedures.

Create a usage profile as a basis for developing energy and cost efficient solutions

The information collected in your site survey will help you to create a usage profile of the venue's public areas. Creating a usage profile should be the first step taken as you need to be aware of lighting issues at your venue before you can identify suitable opportunities and solutions to improve lighting efficiency.

When reviewing and upgrading the lighting in your venue, include a range of stakeholders in the discussions. These stakeholders may include, but are not limited to:

- Venue managers / engineers;
- Lighting engineers / designers;
- Interior designers;
- Maintenance staff; and
- Electricians.

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Opportunities to Improve Lighting Efficiency

Once you have created a usage profile, you can start looking at energy and cost efficient solutions. There are five main areas for lighting improvement. The levels do not imply any preferred opportunities but rather the level of investment and effort required to implement. When considering these opportunities short, medium and long term energy consumption targets should be identified considering life cycle costs including purchase and installation costs, estimated operational savings and replacement and maintenance. Improved lighting efficiency in public areas might bring such benefits as better safety, enhanced public perception, and reduced running costs.

Least effort/ investment

Level 1
Reduce usage

Level 2
Change lamps

Level 3
Use lighting controls/automation systems

Level 4
(Re)Design lighting to suit the task

Level 5
(Re)Design building to utilise natural light and design elements for lighting

Most effort/ investment

Don't be fooled by capital costs!

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

Level 1: Reduce Usage

Reduce the number of lights and the operating hours of lighting. Investigate the following opportunities:

- Establish standard procedures for lighting operation (for example, only spot lighting in the foyer at all times except 1 hour before and after the performance; public toilets having occupancy sensors on from 23:00 to 18:00, and lights turned on permanently between 18:00 and 23:00);
- Remove lighting from areas with excessive lighting;
- Remove or reduce the operational hours of lighting not directly needed for task;
- Optimise use of lighting (for example, by reducing intensity of room lighting and providing specific task lighting).

Table 1: Costs of using different bulbs

Bulb Type	Cost*/ Annum	Lumen [i]
Incandescent Bulb (75W)	$4056	930
Fluorescent Bulb (15W)	$811	930

**Assuming 100 light bulbs are running for 8 hours a day 5 days a week with electricity at a price of $0.26 per kilowatt hour (Australian National Average for 2011-2012 [ii]).*

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Level 2: Change Lamps

Improving lighting energy efficiency can be as simple as replacing existing bulbs with ones of a different type and smaller wattage (i.e. replacing standard incandescent 75W bulbs with 15W compact fluorescent lights – see Table 1).

In Australia, inefficient light bulbs such as incandescent are being phased out, and replaced with many different types of more efficient light bulbs.[iii] As depicted in Table 2, the relative operating costs for incandescent lights are high and exchanging incandescent lights is an opportunity for easy energy savings to be made. New types of bulbs such as compact fluorescent and LED, have a much longer lifespan, provide lower capital cost per unit of light emitted in comparison with incandescent bulbs, and don't require frequent replacement. If you still use incandescent light bulbs in your venue, they should be replaced with more cost-effective and energy efficient alternatives.

When choosing the appropriate lamps for your venue's public areas, remember to consider the colour parameters of each, such as available temperature range, rendering index, consistency and stability, as well as lamp directionality, potential to be dimmed, and environmental impacts. Also, consider re-lamping in groups as it tends to cost less on a per-lamp basis and helps ensure consistent lighting quality.

Case Study: Mackay Entertainment and Convention Centre (MECC)

131 lights were replaced by LED lights in the MECC Foyer changing from 120W bulbs to 12W, which resulted in a reduction in energy consumption from 14,320W down to 1,637W.

Before the refit, the MECC foyer required a total of 14,320 W, which was reduced to now only 1,637 W. The 131 old lights cost MECC $7,700 yearly just in electricity bills, while the new, brighter, less heat producing and less service intensive LED lights only cost $880 a year in electricity bills – a reduction in cost by 89% equalling to 50.000 tonnes less in carbon emissions. Other related cost savings were reduced labour cost as no maintenance is required and less heat generated from lamps resulting in a reduced need for air conditioning.

Trying to replace a 120W bulb for something like a 10-20W LED fixture without any loss in brightness was initially a challenge, but a 12W LED solution was found, which was even brighter and nicer in colour temperature than the old lights including a 5 year warranty from the manufacturer. The key of replacing the bulbs is the "lumen", the measure of the power of light perceived by the human eye - MECC used 1000 lumen LED lights (Cree LR6) creating an extreme wide and even beam and a pleasant colour temperature. The entire fittings of the old lamps had to be replaced by LED lights, but looking at the result, it was worth the effort.

For these achievements in the MECC, Mackay Regional Council was awarded the Energy Conservation Champions Award in the Keep Australia Beautiful Sustainable Cities Awards for 2011.

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Table 2: *Lighting Comparison Chart* [iv]

Example Picture	Type of light	Efficacy (lumens/W)	Lifetime (h)	Colour Rendering Index	Colour temperature (K)	Indoors or outdoors	Capital cost	Relative operating costs
	Incandescent	*(In Australia, incandescent light bulbs are being phased out and replaced by more efficient light bulbs* [iii]*)*						
 Source:Edokter	Standard	10-17	750-2500	98-100 (excellent)	2700-2800 (warm)	Indoors/ outdoors	Low	Very high
	Energy Saving Incandescent (Halogen)	12-22	1000-4000	98-100 (excellent)	2900-3200 (warm to neutral)	Indoors/ outdoors	Low/ Moderate	High
	Reflector	10-19	2000-3000	98-100 (excellent)	2800 (warm)	Indoors/ outdoors	Low	High
	Fluorescent							
 Source: Ekolist	Straight tube	30-110	7000-24000	50-90 (fair to good)	2700-6500 (warm to cold)	Indoors/ outdoors	Low	Low
	Compact Fluorescent Lamp (CFL)	50-70	10000	65-88 (good)	2700-6500 (warm to cold)	Indoors/ outdoors	Low	Low
	Circline	40-50	12000	60-85	2700-4100 (warm to cold)	Indoors	Low/ Moderate	Low
	High Intensity Discharge							
 Source: Tylercat	Mercury vapour	25-60	16000-24000	50 (poor to fair)	3200-7000 (warm to cold)	Outdoors	Moderate	Low/ moderate
	Metal halide	70-115	5000-20000	70 (fair)	3700 (cold)	Indoors/ outdoors	Moderate/ high	Low
	High pressure sodium	50-140	16000-24000	25 (poor)	2100 (warm)	Outdoors	Moderate/ high	Low
	Light emitting diodes							
 Source: Orcho	Cool white	60-92	25000-50000	70-90 (fair to good)	5000 (cold)	Indoors/ outdoors	Moderate/ high	Low
	Warm white	27-54	25000-50000	70-90 (fair to good)	3300 (neutral)	Indoors/ outdoors	Moderate/ high	Low
	Low pressure sodium	60-150	12000-18000	-44 (very poor)	1700 (warm)	Outdoors	Moderate/ high	Low

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Tips for Changing Lights

One 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 (See the Australian Government Department of Industry for more information www.ee.ret.gov.au/node/1129);
- Replacing fluorescent T12s or T8s with more efficient T5s to achieve up to a 30% reduction in energy use [iv]. Existing T8 lamps can be retrofitted with high-output T5 lamps without necessarily changing the fixture;
- Replacing mercury vapour lamps with metal halide or fluorescents.

Disposal of Lamps

A number of light globes used in Australia contain mercury. While they are safe to use, special care needs to be taken at the end of their working life. Waste disposal is regulated by State and Local Governments in Australia - contact your local authority to find out about conditions on disposal.

An estimate of 95 per cent of lamps containing mercury is sent to landfill every year contaminating surrounding land and water [vi]. Lamps containing Mercury include:

- High Intensity Discharge (HID) lamps, such as mercury vapour lamps ;
- Linear Fluorescent tubes which are used in most commercial and public buildings (required by an Australian standard to contain less than 15 mg of mercury);
- Compact Fluorescent lamps (CFLs) (required under a new Australian Standard to contain a maximum of 5 mg), and some neon tubes. [vii]

Lamp Recycling

Lamp recycling can help reduce the amount of mercury being sent to landfill. Valuable resources can be saved and land contamination can be avoided as recyclers can recover the mercury for reuse and even the glass, phosphor and aluminium contained in the lamps is reusable. The two major waste lighting recyclers are Ecocycle Australia and Toxfree, which have facilities in most states and territories. Recycling services provide collection boxes and collection services. Chemical collection programs may also be an option – several states in Australia have collection programs and/or drop-off points accepting small numbers of lamps for recycling from small businesses. Check with your local council for types and quantities of lamps accepted at local collection points. Halogen and incandescent lamps do not contain mercury and so can be disposed into normal rubbish bins. Consider wrapping bulbs before disposal to ensure safe handling. Light bulbs do not belong in recycling bins as the heatproof glass contaminates the recyclable glass. LED lights should be recycled as all LED components can be reused for new products. Lighting manufacturers and waste management companies offer collection and recycling services for LEDs. [viii]

An overview of recycling services across Australia is available at FluoroCycle:
www.fluorocycle.org.au

To specifically look for lighting recycling options in your suburb visit Business Recycling:
www.businessrecycling.com.au

Elektrostandard LED Light Bulb by Anton Fomkin (flickr.com)/CC

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Level 3: Use lighting Controls / Automation Systems

Automatic control of lighting systems may be a more feasible option than trying to encourage staff or patrons to manage lighting in larger areas. Opportunities for automated lighting control include:

- **Timers:** 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:** sensors that switch lighting on when occupants are identified in a room. Three main types are:
  - Passive infrared that sense movement of a heat-emitting body;
  - Ultrasonic that sense changes in sound wave patterns; and
  - Hybrid passive infrared/ultrasonic; [ix]
- **Photosensors:** work by sensing the availability of light and adjusts the lighting levels according to predetermined requirements. Sensors are a simple technique of reducing energy consumption;
- **Building Management System (BMS) control:** allows for central control of equipment within a building or venue space. 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.

Have you considered adjusting the wattage output of the lighting in your venue?

Melbourne Recital Centre are running their LED house lighting at 90% wattage across the three modes (concert, day, night). The difference in light level is hardly noticeable to patrons and it saves on the life of the globe as well as on energy cost. Melbourne Recital Centre have also exchanged expired 50-watt globes with 35-watt globes, resulting in a 33% reduction in power consumption.

Level 4 (Re)-Design lighting to suit the task

While your existing lighting infrastructure may limit replacement opportunities, if you are investing in a complete retrofit or new design, it is worthwhile taking the time to select the most efficient lighting available. Therefore, ensuring the correct types of fittings are specified for their intended purposes, can offer great improvements in energy efficiency.

For example, in a public area with low ceilings and light-coloured walls, downlights are a less effective option for general uniform lighting when compared to pendant lamps which provide a concentrated area of illumination. In order to provide a comparable level of lighting to that of a pendant lamp, more downlights will be needed, which would likely cost more to purchase, install and operate.

However, if you need to make an area look visually interesting, intriguing or dramatic, or to bring visitors' attention to a particular part of the venue, spotlights are best to create such effects. One might also consider installing adjustable light fixings such as track lights, floodlights or accent lights that can be arranged to throw light in specific directions or onto display items.[1]

[1] It is vital that health and safety concerns are taken into account when assessing lighting options. Standards AS/NZS1680.0 Interior lighting - Safe movement and AS/NZS 1680.1 Interior and Workplace Lighting

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Level 5: (Re)-Design areas to utilise natural light and design elements for lighting

If an indoor venue is used predominantly during the day, optimising natural light in public areas can significantly reduce energy consumption from lights, and enhance visitor and staff comfort.

Depending on their usage profile, each venue will experience different energy savings. So this option needs to be carefully assessed on a case-by-case basis. Generally speaking, incorporating natural light into a venue is most effective in a new design or a full retrofit.

Some simple opportunities to incorporate natural light include:

- Installing skylights or open roofs;
- Removing window obstructions like curtains, posters and excessive window décor;
- Installing windows (or tinting films) that transmit visible light but absorb or reflect heat;
- Painting walls and ceilings in a light colour to increase reflection of natural light into the space, and
- Opting for light colours of furniture, and reflective materials and elements for interior design.

References

[i] *Australian Department of Industry, 2013, Light Globe Conversion Table, http://ee.ret.gov.au/energy-efficiency/lighting/light-globe-conversion-table*

[ii] *Australian Energy Market Commission (AEMC), 2013, Household Electricity Price Trends, http://www.aemc.gov.au/Media/docs/National-Information-Sheet-c544496d-80fa 4705-8566-dfccc840dd3d-0.pdf*

[iii] *Living Greener, 2013, Energy-efficient Lights, http://www.livinggreener.gov.au/home*

[iv] *US DOE, 2012, Types of Lighting, http://energy.gov/energysaver/articles/types-lighting*

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[vi] *Business Recycling, 2013, Recycling Information: Lighting, http://businessrecycling.com.au/category/lighting*

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[viii] *Business Recycling, 2013, Recycling Information: Lighting, http://businessrecycling.com.au/category/lighting*

[ix] *US DOE, 2008, Energy Efficiency and Renewable Energy: Building and Technologies Program: Commercial buildings: Lighting and day lighting*

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