LIGHTING EFFICIENCY– U7

Eco-efficiency resources for the food processing industry

Benefits of correct lighting

While the lighting of work and office areas may only comprise a small portion of a food processor's energy bill, savings can often be made by implementing low cost measures.

Options to reduce the amount of energy lighting consumes include:

- installing energy efficient lighting and control technology
- good housekeeping practices and making the most of natural lighting
- removing unnecessary lighting in non-critical or unoccupied areas.

LIGHTING AND AIR CONDITIONING IMPROVEMENTS[1]

Arnott's biscuit processing plant in New South Wales saved $13,740 per year by installing occupancy detectors, delay push buttons in some areas and reducing office lamps by 30 per cent. Photoelectric sensors were installed in the manufacturing area and air conditioning schedules were adjusted to suit occupancy. The payback period was two years.

Energy efficient lighting

Light emitting diodes (LEDs)

LEDs have a long lifespan and are useful in areas where maintenance and replacement costs are expensive.

Unlike incandescent bulbs that radiate light in 360 degrees, LED light is focused and directional. For this reason small arrays of the diodes are typically grouped together as an alternative to incandescent and florescent bulbs.

This type of lighting currently requires components such as a circuit board and driving components, all of which make LEDs relatively expensive.

However, LEDs do have a long-lifespan of around 35,000-50,000 hours, compared to about 10,000 hours for fluorescents and 1,000 hours for incandescent. For this reason best value for commercial use often occurs where maintenance and replacement costs for lighting are expensive.

Because they produce very little heat energy (3.4 BTUs/hour, compared to 85 BTUs/hour for incandescent bulbs)[2] they can be a good option for refrigerated areas where the heat generated from light increases the heat load on the cooling system.

Unlike fluorescent lamps, LEDs also contain no toxic mercury and also have no filament, like incandescent bulbs do, that can be damaged due to shock and vibrations. As they do not emit UV rays they also tend not to attract insects.

Because of their low power requirement, LEDs are ideally suited to solar power.

Correct installation is vital as the typical incandescent fusing requirements are too robust for LEDs. Incorrect fuse sizing can cause damage to electrical systems.

Productdose.com provides an online energy saving calculator that can determine savings from replacing incandescent bulbs with compact fluorescents or LEDs. For further information visit: www.productdose.com/LightBulb_Comparison.xls

[1] Sustainable Energy Authority Victoria (SEAV), 2003, Energy Best Practice Tips for Lighting www.seav.vic.gov.au
[2] Eartheasy, 2007, Energy Efficient Lighting www.eartheasy.com/live_energyeff_lighting.htm

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Different types of lighting

Table 1 Comparison of different types of lighting[3]

Type of light	Wattage (W)	Capital cost	Relative operating costs	Efficacy (lumens/ watt)	Average life (hours)	Deterioration of light quality over time	General information	Application
Incandescent	15-1,500	Low	High	10-17	750-2,500	Light output falls 15 per cent through life	Electricity heats a tungsten filament to produce bright light. 90 per cent electricity lost to heat.	Bulbs to be phased out by 2010.
Tungsten halogen (240 V)	50-2,000	Low	High	22	2,000	Very little	Electricity to heat a tungsten filament enclosed in pockets of halogen gas. Emits bright white light using less than 10-20 per cent[4] of the energy of an incandescent bulb, also lasts around twice as long.	Dimmable so often used for 'mood' or display lighting. Typically used for uplighting.
Tungsten halogen (6-21 V)	10-75	Low/ medium	Medium	30-50	2,000-4,500	Very little		Low voltage used for downlighting.
Fluorescent	8-36	Low/ medium	Low	Tube 30-110 Compact 50-70	Tube 7,000-24,000 Compact 10,000	<20 per cent	Fluorescent lamps pass an electrical current through a tube filled with argon and mercury producing UV radiation that bombards the phosphorous coating to emit light. They produce little heat, are efficient (use 20 per cent of the power of incandescent bulbs) and long lasting.	Good for small areas with low ceilings or task-level lights, or large areas requiring no detail work.
Metal halide	35-3,500	High	Very low	60-115	5,000-20,000	<45 per cent	Metal halides provide bright white point light. They are more efficient than mercury vapour and brighter than sodium lights.	Lighting in areas where ceiling is greater than 4m
Mercury vapour	40-1,000	Low	High	25-60	16,000-24,000	High	Producing a cool blue/green light, mercury vapour lamps have a longer lifespan to metal halides.	Exterior lighting and lighting were colour rendering is not important.
Sodium high pressure	35-3,500	High	Medium	50-140	16,000-24,000	<15 per cent	Sodium high-pressure lights provide a warm white light. The colour rendering is not as good as metal halide but the lifespan is longer.	Exterior, security lighting. Internal use in factories with ceiling height over 4m and where colour rendering is not important.
Light emitting diodes (LED)	3-4.2	High	Very low	11-15	50,000	Very little	Light Emitting Diodes (LEDs) are tiny semiconductors encapsulated in plastic. LEDs produce very little heat and are extremely efficient in both consumption and light output, surpassing both incandescent and halogen lamps. Lighting is available in a large range of colours.	In the past this type of lighting has been used predominantly for back lighting, such as signs. With the development of white LEDs, they can now be used to replace fluorescent and incandescent bulbs.
Intelligent fluoro high-bay	200		Low	87	20,000+ hours	Very little	Light fitting set with sensors to adjust the level of lighting in response to natural lighting and occupancy.	High bay installations between 6-16m.

[3] Queensland Government, 2006, Marine Fact Sheet 3 Lighting www.gpa.uq.edu.au/CleanProd/marine_project/FactSheets/Marine_Fact_Sheet_3.pdf;
Governmnet of South Australia, Department of Transport, Energy and Infrastructure,Commercial and Factory Lighting www.energysafety.sa.gov.au/__data/assets/pdf_file/0019/15661/com_factorylighting_web.pdf
[4] Klipstein,D.L., 2006, The Greater Internet Light Bulb Book Part 1 members.misty.com/don/bulb1.html

High intensity discharge (HID) lighting

- Mercury vapour lamps are the oldest type of HID and are used primarily for street lighting. Most indoor mercury vapour lamps have been replaced by metal halide lamps.
- Metal halide lamps produce a bright, white light with the best colour rendition of all HIDs. Metal halide lamps do, however, have shorter life spans than both mercury vapour and high-pressure sodium lamps. They come in standard or pulse start with pulse start more efficient and quicker starters.
- High-pressure sodium lights produce a warm white light and are commonly used for outdoor lighting. They have poorer colour rendition than metal halide lamps but a longer lifespan.

Fluorescents

There are two main types of fluorescent lamps, the tube and compact lamps, both of which are designed to fit into conventional fittings.

Fluorescent lamps need magnetic or electronic ballasts. Electronic ballasts can solve flickering and humming and are more efficient, but are more costly than magnetic ballasts.

Replacement of incandescent lights with CFLs can save significant amounts of money.

Fluorescent tubes

The standard tube, florescent halophosphor T8, has a standard magnetic ballast and a lifespan of around 6,000 hours.

The fluorescent triphosphor T8 is no more efficient than the standard T8 but they do have 20 per cent greater light output. This can mean fewer lamps are needed. They also have a longer lifespan, lasting around 13,000 hours (magnetic ballast) and 16,000 hours (electronic ballast)[5]

The fluorescent triphosphor T5 is the most energy-efficient tube, being 23 per cent more efficient than triphosphor T8 and 38 per cent more efficient than standard T8s.[6]

T5s are most economical when they are installed as new fixtures as they require different fittings to T8s. They only operate with electronic ballasts and have a lifespan of around 16,000 hours.

Compact fluorescents

Compact fluorescent lamps last up to 10 times longer than incandescent bulbs and consume 75 per cent less energy.[7]

Intelligent lighting

Intelligent lighting uses fluorescent tubes in a specific reflective design to maximise the utilisation of light, particularly in high bay installations. These are installed in conjunction with sensors which can adjust the amount of light in response to natural light when installed in rooms with skylights or window. In addition the lights can be installed with sensors to detect occupancy. The lights will turn off when rooms are not occupied, saving energy.

These lights can generally be installed to replace metal halide light and use 50-80 per cent less operating energy due to the lower wattage requirements for the same light output.[8]

[5] NSW Department of Energy and Utilities and Sustainability, Planning for Efficiency – Assessing Your Lighting Efficiency – a technical guide www.cityofsydney.nsw.gov.au/3cbds/pdf/assesslightingefficiency.pdf
[6] Queensland Government, 2006, Marine Fact Sheet 3 Lighting www.gpa.uq.edu.au/CleanProd/marine_project/FactSheets/Marine_Fact_Sheet_3.pdf
[7] Klipstein, D.L. (2006) The Greater Internet Light Bulb Book Part 1 members.misty.com/don/bulb1.html
[8] Powerboss Eluma, 2007 Somar www.powerbosseluma.co.uk

Halogen lights

While halogen lights are more energy efficient and longer lasting than incandescent bulbs, it is important to remember that these types of lamps only provide a small, direct beam of light. Often this means that several lamps will be required to meet lighting requirements, negating any energy benefits.

Halogen bulbs also get hotter than other bulbs and should not be used in areas where they are likely to come in contact with flammable material.

Phase out of inefficient light bulbs

The Australian Government is working towards a full phase out of inefficient light bulbs by 2009-2010. Bulbs targeted are those with an efficiency less than 15 lumens per watt. For the food industry, the impact will be most commonly seen in office/administration areas and hallway lighting. Currently, alternative options for equipment such as ovens are still being explored.

For more information visit: Australian Department of Environment, Water, Heritage and the Arts. www.environment.gov.au/index.html

Table 2 demonstrates the potential savings achievable by retrofitting efficient lighting.

Table 2 Typical savings from replacing inefficient lights with efficient lights[9]

Existing lamp	Energy efficient lamp	No. of lights	Light wattage (kW)	Cost to run per year	Annual savings
Incandescent		15	0.075	$347	
	Compact fluorescent	15	0.015	$69	$278 Bulbs last 10 times longer
Dichroic down lights		10	0.035	$108	
	Compact fluorescent	10	0.007	$22	$86 Bulbs last up to twice as long
Mercury		20	0.700	$4,322	
Metal halide		20	0.400	$2,464	
	Intelligent fluoro high-bay	20	0.220	$1,355	$2,967
Halophosphate Fluorescent		16	0.040	$197	
	Triphosphate fluorescent	8	0.040	$99	$98 Bulbs last 60 per cent longer
				Total saving	$3,429

Good housekeeping

Lighting use, design and maintenance

Consideration of lighting needs, design and maintenance can provide significant savings. The following methods can help reduce energy for lighting.

- Task-level lighting can direct light to where it is needed rather than lighting large areas.
- Occupancy and movement sensors can automatically turn off lighting in inactive areas such as freezers and storage rooms.
- Light switch segregation can allow lights in areas not in use to be switched off.

[9] Queensland Government, 2006, Marine Fact Sheet 3 Lighting
www.gpa.uq.edu.au/CleanProd/marine_project/FactSheets/Marine_Fact_Sheet_3.pdf

- Retrofitting fluorescent light fittings with high frequency eco-controllers, which increase efficiency and reduce energy use.
- Natural light utilisation, e.g. skylights, can reduce light requirement. The downside is they must be cleaned and can create glare and reflection. The additional heat load from sunlight must be considered for air conditioned areas. Proper design and installation of skylights can minimise these downsides.
- Regular cleaning of light fittings, reflectors and diffusers will reduce energy losses.
- Photoelectric sensors can measure natural light and adjust lights accordingly, including security lights.
- Auto or step dimmers can reduce total energy demand by up to 20-30 per cent.
- Walls and ceilings painted in light colours reduce light requirements.

Remove unnecessary lighting

Replacing lights with lower energy units will reduce energy use. De-lamping is another simple method to reduce lighting costs. Investigate if it is possible to remove lights in areas where lighting levels are currently higher than the Australian Standards require. A lux meter can be used to measure lighting levels. When removing fluorescent tubes consider replacing remaining tubes with efficient tri-phosphor tubes that produce 15 per cent more light and last longer than standard tubes.

To calculate annual savings from 'de-lamping' use the following equation:

$\$ = ((N \times P \times H \times T)/1000) + \text{cost of replacing lighting}$

$\$$ = annual savings
N = number of lamps removed
P = Power rating of lamps (W)
H = usage per year (h/year)
T = cost of electricity ($/kWh)

This series of fact sheets provides examples and suggestions to the modern food processor on how to achieve both economic and environmental benefits from eco-efficiency. Visit the project website www.ecoefficiency.com.au for more ideas and case studies.

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