



**LIGHTING
ENERGY EFFICIENT
EQUIPMENT TOOLKIT**



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PARTNERS

This Toolkit is brought to you the following partners.



Australian Government
**Department of Resources,
 Energy and Tourism**



**Government
 of South Australia**

Zero Waste SA

INTRODUCTION



Lighting systems deliver light to occupied spaces. Daylighting systems comprise a daylighting device and, sometimes, a control system. Artificial lighting systems comprise luminaires (lamp, socket, body, and switch) and controls. Lamps come in many types, including incandescent, fluorescent, dichroic halogen, LED, mercury vapour, metal halide, high pressure sodium. Lighting systems contribute 5-15% of the total site energy use as electricity

EQUIPMENT & PROCESSES

By using your equipment settings more efficiently you can reduce your energy consumption.

UPGRADE EQUIPMENT

You can evaluate what energy reduction benefits your organisation could gain from upgrading to more efficient equipment and/or adjusting combinations of equipment. Consider adopting a selection of the following opportunities according to available resources.

SELECT & PRIORITISE

Learn how to get the best from your equipment and processes and whether you need to upgrade.

COLLECT & CHECK

Learn how to collect data and engage with your suppliers.

MANAGE LOAD

In many situations, lighting is not required, for example in unoccupied spaces or where sufficient natural lighting is available from windows or skylights.

USE LIGHTS ONLY WHEN REQUIRED

Train staff to understand the energy costs of leaving lights on, or of using excessive artificial lighting, and to manage lighting responsibly and thereby help to reduce lighting power use.

POTENTIAL ENERGY SAVINGS

- Savings vary depending on conditions and choices made

OTHER BENEFITS

- Staff involvement

EQUIPMENT/MATERIAL

- None needed

Dust accumulates on lamps and luminaires, blocking up to 20% of light.

CLEAN LIGHTS

This encourages businesses to use more lighting in order to counteract this dimming effect. Clean light surfaces regularly to maximise available light. Costs depend on how accessible lamps and luminaires are for maintenance.

POTENTIAL ENERGY SAVINGS

- Savings can be to 20% of lighting power use through turning-off or removing excess lighting

OTHER BENEFITS

- Higher staff productivity
- Cleaner workplace

EQUIPMENT/MATERIAL

- Variable depending on choices made

Under-lighting and over-lighting adversely affect staff productivity.

USE MINIMUM LEVEL OF LIGHTING

Lamps are most effective when they produce the right level of light for the task in that location. The light is brightest near the lamps. Use a calibrated light meter (available from camera equipment shops and test equipment suppliers) to measure illumination and adjust lighting to recommended levels. Table 1 below offers recommended lighting levels for various types of tasks.

You can reduce power use by:

- Accessing daylight wherever possible
- Repositioning lamps so they're above work spaces and where glare is avoided Lowering the height of high bay lighting
- Removing excess lamps (one light tube might be enough to light a desk, rather than having two in the same desk fitting)

POTENTIAL ENERGY SAVINGS

- Savings vary depending on conditions and choices made

OTHER BENEFITS

- Higher staff productivity

EQUIPMENT/MATERIAL

- Variable depending on choices made



Encourage staff to turn off lights when possible



Calibrated light meter

MANAGE LOAD CONT.

(Table 1) Recommended illumination levels to be maintained for various zones and tasks in buildings (AS/NZS 1680.1:2006 – Interior and Working Lighting).

CLASS OF TASK		RECOMMENDED ILLUMINATION LEVELS (LX)	ZONE/TASK CHARACTERISTICS	APPLICATION
Movement and orientation		40	Interiors that are rarely visited and where visual tasks are limited to movement and orientation	Corridors, cable tunnels, indoor storage tanks, walkways
Rough intermittent		80	Interiors that are visited intermittently and where visual tasks are limited to movement, orientation and coarse detail	Live storage of bulky materials, dead storage of materials needing care, locker rooms, loading bays
Normal range of tasks and work places	Simple	160	Any continuously occupied interior where there are no tasks requiring perception other than coarse detail or occasional reading of clearly printed documents for short periods	Waiting rooms, staff canteens, rough checking of stock, rough bench and machine work, entrance halls, automated process monitoring
	Ordinary or moderately easy	240	Continuously occupied interiors with moderately easy visual tasks that have high contrasts or large detail	Food preparation, counters for transactions
	Moderately difficult	320	Areas where visual tasks are moderately difficult, that is, have moderate detail or with low contrasts	Routine office tasks e.g. reading, writing, typing, and enquiry desks
		400		
	Difficult	600	Areas where visual tasks are difficult, that is, have small detail or with low contrast	Drawing boards, most inspection tasks, proofreading, fine machine work, colour matching
Very difficult	800	Areas where visual tasks are very difficult, that is, have very small detail or with very low contrast	Fine inspection, fine manufacture, grading of dark materials	
Extremely difficult		1200	Areas where visual tasks are extremely difficult, that is, have extremely small detail or with very low contrast Visual aids may assist	Graphic arts inspection, inspection of dark goods, extra-fine bench work
Exceptionally difficult		1600	Visual aids will give advantage	Assembly of minute mechanisms

USE DAYLIGHT

Daylighting devices are most cost effective for new buildings, and warehouses with large roof areas and open spaces.

INSTALL DAYLIGHTING DEVICES

Use daylight to minimise use of artificial light. You can reduce lighting power use by installing:

- Windows, light shelves, light-guiding shades, and optical venetian blinds
- Sawtooth rooves, roof monitors, and glare-reducing skylights
- Light pipes

POTENTIAL ENERGY SAVINGS

- Savings can average 14% of lighting power use and can be 30-70% of office space lighting power use providing artificial lighting is switched off in areas with sufficient daylight. This is equivalent to an approximate 4-year payback (2013 prices)

OTHER BENEFITS

- Higher staff productivity
- Aesthetics (reduced number of light fittings and switches and perception of more open space)

EQUIPMENT/MATERIAL

- Variable depending on choices made

You can facilitate the distribution of light deep into the indoor space.

DISTRIBUTE DAYLIGHT INTERNALLY

Reduce lighting power use by painting walls, ceilings, and floors in light colours and installing curved ceilings or light reflectors.

POTENTIAL ENERGY SAVINGS

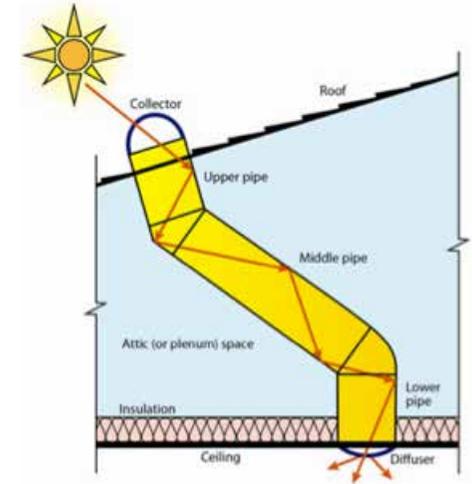
- Savings vary depending on conditions and choices made

OTHER BENEFITS

- Higher staff productivity
- Aesthetics (reduced number of light fittings and switches, and a perception of more open space)

EQUIPMENT/MATERIAL

- Variable depending on choices made



Example of a low-glare skylight device

(Table 2) Recommended surface reflectance for various building surfaces. Use these figures to discuss this with interior designers or suppliers.

SURFACE	RECOMMENDED RANGE OF SURFACE REFLECTANCE
Ceiling	0.8+
Walls	0.3-0.7
Floor	0.2-0.3
Large furniture and equipment	0.2-0.5

EFFICIENT LIGHT

Reduce lighting power use by installing efficient EXIT signs.

INSTALL LED OR SELF-LUMINOUS 'EXIT' SIGNS

In comparison to traditional incandescent signs that use about 40W and have a useful life of about 1 year, LED signs use about 4-8W and have a useful life of about 10 years. Self-luminous signs do not require any power and have a useful life of about 10 years. It is best to upgrade EXIT signs when they require replacement, as there are labour costs associated with replacement and the signs are not high-energy users.

Capital cost is \$20-30 per LED EXIT sign or retrofit kit and \$200 for a self-luminous EXIT sign (2013).

POTENTIAL ENERGY SAVINGS

- Savings can be 80-90% of sign power use

OTHER BENEFITS

- Lower maintenance costs due to less-frequent replacement

EQUIPMENT/MATERIAL

- Purchase and installation



Example of an exit light

Efficient lighting equipment often has greater energy cost saving over its lifespan than its initial capital cost.

INSTALL EFFICIENT LAMPS AND LUMINARIES

This equipment is especially cost effective when existing lamps require replacement because installation (labour) costs are often greater than equipment cost and do not count as an additional capital cost. Reduce lighting power use by installing efficient lamps and luminaries.

You can minimise recurring installation costs by giving a high priority to equipment that will have a long working life. To remain flexible for possible future additions, install equipment compatible with a control system, whether or not the control system is installed yet.

Capital cost can be \$5-500 per unit (2013).

POTENTIAL ENERGY SAVINGS

- Savings can be 30-80% of lighting power use depending on the types of lamp and luminaires.

OTHER BENEFITS

- Lower maintenance costs due to less-frequent replacement
- Corresponding reduction in the HVAC cooling load

EQUIPMENT/MATERIAL

- Purchase and installation



Dichroic Halogen Lamps



Compact Fluorescent Lamp



Sodium Vapour Lamp



Metal Halide Lamp



Fluorescent Tube



Mercury Vapour Lamp



Linear Led Lamp



Led Lamp

EFFICIENT LIGHT CONT.

EQUIPMENT OPTIONS FOR GENERAL INTERIOR LIGHTING

(Table 3) Equipment options for general interior lighting. NOTE: *Luminous efficacy* is the amount of visible light generated (lm) per input electrical power (W).

LUMINARIES	LAMP COST	POWER	LAMP LIFE	LUMINOUS EFFICACY
Typically installed				
T8 linear fluorescent luminaries (36W) (need 2 lamps for comparison)	\$5	36W + 9W	6000-8000h	80-100lm/W
Recommended options				
T5 linear fluorescent luminaire (28W)	\$7.50	28W	9600-12,800h	70-104lm/W
Alternatives options				
T8 lamp (36W) with high efficiency reflector and electronic ballast	\$5	36W	9600-12,800h	80-100lm/W
Linear LED lamps (24W)	\$100	24W	30,000-50,000h	55-93lm/W

EFFICIENT LIGHT CONT.

EQUIPMENT OPTIONS
FOR INTERIOR
DISPLAY LIGHTING

(Table 4) Equipment options for interior display lighting.

LUMINARIES	LAMP COST	POWER	LAMP LIFE	LUMINOUS EFFICACY
Typically installed				
MR16 low voltage dichroic halogen lamps (50W)	\$6	50W + 15W	2000-3000h	20-30lm/W
Recommended options				
LED luminaries (16W)	\$6	16W	30,000-50,000h	55-93lm/W
Alternatives options				
LED lamp (10W)	\$6	10W + 5W	25,000h	55-93lm/W
Infra-red coating (IRC) halogen lamp (35W)	\$12	35W + 10W	2000-3000h	25-35lm/W
Infra-red coating (IRC) halogen lamp (35W) with an electronic transformer	\$12 + \$20 (transformer)	35W + 3W	2000-3000h	25-35lm/W
Compact fluorescent luminaries (13W)	\$5	15W	6000-16,000h	46-75lm/W
Compact fluorescent lamp (15W) and lamp holder	\$6 + \$29 (lamp holder)	15W	6000-15,000h	46-75lm/W

EFFICIENT LIGHT CONT.

EQUIPMENT OPTIONS
FOR LOW BAY LIGHTING

(Table 5) Equipment options for low bay lighting.

LUMINARIES	LAMP COST	POWER	LAMP LIFE	LUMINOUS EFFICACY
Typically installed				
Mercury vapour luminaries (400W)	\$40	400W + 32W	6400-24,000h	15-70lm/W
Recommended options				
Metal halide luminaries (250W)	\$50	250W + 20W	8000-9600-16,000h	65-115lm/W
Alternatives options				
T5 fluorescent luminaries (54W) (need 4 lamps for comparison)	\$7.50	54W + 3W	9600-12,800h	70-104lm/W
LED luminaries (150W)	\$500	150W	30,000-50,000h	55-93lm/W
Induction lamp luminaries (200W)	–	200W + 10W	100,000h	

(Table 6) Equipment options for high bay lighting.

LUMINARIES	LAMP COST	POWER	LAMP LIFE	LUMINOUS EFFICACY
Typically installed				
Metal halide luminaries (400W)	\$60	400W + 54W	8000-16,000h	65-115lm/W
Recommended options				
Pulse-start metal halide luminaries (320W)	\$90	320W + 29W	16,000-32,000h	65-115lm/W

EFFICIENT LIGHT CONT.

EQUIPMENT OPTIONS
FOR EXTERIOR LIGHTING

(Table 7) Equipment options for exterior lighting.

LUMINARIES	LAMP COST	POWER	LAMP LIFE	LUMINOUS EFFICACY
Typically installed				
Linear halogen lamp shovel and box floodlight (500W)	\$5	500W	2000h	17-20lm/W
Recommended options				
LED luminaries (90W)	\$50	90W	30,000-50,000h	55-93lm/W
Alternatives options				
High pressure sodium luminaries (120W)	\$50	120W	14,000-24,000h	85-150lm/w
Metal halide luminaries (150W)	\$50	150W + 20W	8000-9600-16,000h	65-115lm/W

EQUIPMENT AND PROCESSES

Use the following table to select which energy efficiency opportunities your business would be interested in pursuing, as well next steps in terms of actions and responsibilities.

Tick the box if you plan to pursue an Energy Efficiency Option.

<input checked="" type="checkbox"/>	ENERGY EFFICIENCY OPTION	NEXT STEPS & TIMING	WHO RESPONSIBLE	NOTES
Manage Load				
<input type="checkbox"/>	Use lights only when required			
<input type="checkbox"/>	Use minimum level of lighting			
Maintain lighting equipment				
<input type="checkbox"/>	Clean lights			

UPGRADE EQUIPMENT

Use the following table to select which energy efficiency opportunities your business would be interested in pursuing, as well next steps in terms of actions and responsibilities.

Tick the box if you plan to pursue an Energy Efficiency Option.

<input checked="" type="checkbox"/>	ENERGY EFFICIENCY OPTION	NEXT STEPS & TIMING	WHO RESPONSIBLE	NOTES
Use daylight				
<input type="checkbox"/>	Install daylighting devices			
<input type="checkbox"/>	Distribute daylight internally			
Efficient Light				
<input type="checkbox"/>	Install efficient lamps and luminaries			
<input type="checkbox"/>	Install LED or self-luminous EXIT signs			

CHECKLIST TO ENGAGE WITH SUPPLIERS

By gathering the information suggested in this supplier checklist, you can build a complete picture of your equipment and energy uses.

This will help you to identify which actions are likely to benefit your business so that you can establish a business case to support decision making now and planning for the future. Some of the information you can collect within your own business resources, but some may need you the help of suppliers or experts (e.g. an energy audit).

Note: This checklist can be used by either the food business or the supplier.

COMPILE A LIGHTING INVENTORY

COMPILE A LIST OF THE FOLLOWING LAMPS, LUMINARIES AND CONTROLS IN YOUR WORKPLACE

Tick those that apply to your business

- Incandescent
- Compact fluorescent
- Dichroic halogen
- LED
- T12 fluorescent
- T8 fluorescent
- T5 fluorescent
- Linear LED
- Mercury vapour
- Metal halide
- High pressure sodium
- Incandescent EXIT signs
- Fluorescent EXIT signs
- LED EXIT signs
- Other

CHOOSE AN APPROACH TO ESTIMATE TIME IN USE

Tick those that apply to your business

- Use existing lighting timer settings
- Examine logs
- Consult staff

COMPOSE A MAP OF YOUR LIGHTS

SPECIFYING THE FOLLOWING CHARACTERISTICS OF EACH LIGHT

Tick those that apply to your business

- Type
- Power rating (kW)
- Time in use (h/y)
- Location
- Illumination in spaces (use a calibrated light meter)

CHECKLIST TO ENGAGE WITH SUPPLIERS CONT.

By gathering the information suggested in this supplier checklist, you can build a complete picture of your equipment and energy uses.

This will help you to identify which actions are likely to benefit your business so that you can establish a business case to support decision making now and planning for the future. Some of the information you can collect within your own business resources, but some may need you the help of suppliers or experts (e.g. an energy audit).

Note: This checklist can be used by either the food business or the supplier.

DETERMINE THE BUSINESS PARAMETERS OF THE LIGHTING SYSTEM

QUANTIFY OR QUALIFY THE FOLLOWING VALUES

Tick those that apply to your business

- Energy price(s) (\$/kWh)
- Capital budget (\$)
- Targets for running costs (\$/y)
- Required level of redundancy in the system
- Acceptable payback period or return on investment
- Acceptable level of risk for new technologies
- Equipment constraints, such as specific brands of equipment, specifications for electrical wiring, compatibility with existing infrastructure or floor space and adaptability to future upgrades

If the existing equipment needs to be replaced, then calculate the payback period (y) based on the extra (rather than total) costs (\$) (if any) of the efficient equipment.

DETERMINE THE LIGHTING REQUIREMENTS

QUANTIFY OR QUALIFY THE FOLLOWING VALUES

Tick those that apply to your business

- Financial: lifetime (h), efficacy (lm/W)
- Physical environment: surrounding, users, glare, ambient temperature (°C), fire safety, time of day
- Ecological: disposal, emissions (kg), embodied energy (J)
- Operational: colour rendering, colour preference (°C), illumination (lx), spectrum
- Purpose: ambient, task, accent, decorative

ACCOUNT FOR NON-ENERGY BENEFITS

QUANTIFY OR QUALIFY THE FOLLOWING VALUES

Tick those that apply to your business

- Higher productivity, better mood, lower absenteeism, fewer errors from employees
- Higher safety
- Improved colour rendering
- Improved aesthetics/ambience
- Smaller cooling load (kW) for the HVAC and refrigerator systems

CHECKLIST TO ENGAGE WITH SUPPLIERS CONT.

By gathering the information suggested in this supplier checklist, you can build a complete picture of your equipment and energy uses.

This will help you to identify which actions are likely to benefit your business so that you can establish a business case to support decision making now and planning for the future. Some of the information you can collect within your own business resources, but some may need you the help of suppliers or experts (e.g. an energy audit).

Note: This checklist can be used by either the food business or the supplier.

MANAGE THE COMMISSIONING PROCESS

ONCE THE SPACE IS OCCUPIED, ADJUST THE FOLLOWING FEATURES OF THE SYSTEM TO EFFICIENTLY MEET ACTUAL USE PATTERNS

Tick those that apply to your business

- Switching times
- Time delays
- Sensor placement
- Zoning

CONFIRM LIGHTING SYSTEM PERFORMANCE

CHECK THE FOLLOWING CONDITIONS

Tick those that apply to your business

- Light quality and quantity (lx) meets the requirements of Australian Standard AS1680.1: use a calibrated light meter and refer to the Standard
- Daylight does not cause discomfort or make tasks difficult

SELECT A SERVICE PROVIDER

SELECT AN AIR COMPRESSOR SERVICE PROVIDER THAT CAN PROVIDE THE COMBINATION OF SERVICES THAT YOU SEEK

Tick those that apply to your business

- Measurement and analysis of the lighting requirements
- Reporting on equipment and process performance
- Optimisation of the lighting system, including reduction in lighting requirements, and optimisation of the control system and illumination levels (lx)
- Supply, service, and installation of lighting components (e.g. skylights, lamps, ballasts, and controls) for optimal energy efficiency (%)
- Guarantee of minimum efficiency (%) of the proposed system
- Guarantee of maximum running costs (\$/y) of the proposed system
- Technical support and after sales service

- Emergency service
- Work done by lighting professionals who are registered with the Illumination Engineering Society of Australia and New Zealand
- Appropriate removal and disposal of old equipment
- Other

NEGOTIATE A CONTRACT

DETERMINE YOUR PREFERRED TYPE OF CONTRACT

Tick those that apply to your business

- Service contract - the supplier performs certain actions for a fixed price (\$)
- Energy performance contract - the supplier performs certain actions that meet certain levels of energy reduction (kWh) for a lower upfront price (\$) and a share of the cost savings (\$/y)

The following references were used in the development of the Lighting section of the Food SA BCEEE toolkit. We encourage you to access these references as they may provide additional useful information for your business in evaluating energy efficiency opportunities.

REFERENCES

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Abraham, L.E. (1996) 'Daylighting', in Public Technology Inc. and US Green Building Council (1996) Sustainable Building Technical Manual, Public Technology Inc., pp iv.7-iv.20

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Standards Australia and Standards New Zealand (2006) AS/NZS 1680.1:2006 – Interior and Working Lighting, Part 1: General Principles and Recommendations, Standards Australia and Standards New Zealand.

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