COMMERCIAL SOLAR LIGHTING GUIDE

For providing fit-for-purpose solar lighting compliant to commercial and industry requirements

This guide is intended to assist in choosing solar lighting installations that will be fit-for-purpose and compliant with industry technical specifications and requirements.

The lack of appropriate regulations and standardisation for these products has resulted in many unsatisfactory installations that may not provide the required amount of light, fail prematurely or have inadequate storage capacity. Fit-for-purpose solar lighting must be specifically designed to accommodate the situational conditions of the application.

Quick Reference Checklist

	1. Lighting	
1.1	Lighting Category	Compliance is demonstrated using the appropriate calculation method described in the request technical specification or Standard (e.g AS/NZS 1158)
1.2	Dimming Functionality	Independent from supply and compliant to the requested standard at the lowest level of dimming
	2. Photovoltaic Cells	
2.1	Panel Orientation	Generally orientated north, unless situationally obstructed and compensated by design
2.2	Tilt Adjusted	Optimised based on the path of the sun during the period of lowest expected solar insolation
	3. Batteries & Charge Controllers	
3.1	Charge Controller	MPPT or PWM (MPPT is more efficient)
3.2	Battery Capacity	Enough capacity to provide illumination for at least 3 nights without charge
	4. Sizing	
4.1	Components suitably sized	System is designed to meet specified requirements

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1. Lighting

Lighting for use in solar installations is designed to meet the illumination requirements defined by technical specifications and Standards specific to the intended application.

A commonly used Standard for the specification of public lighting installations is *AS/NZS 1158: Lighting for roads and public spaces*. The illumination requirements described by this series of standards is split into two distinct categories:

- AS/NZS 1158.1.1: 'Category V' Lighting applicable to roads on which the visual requirements of the motorist are dominant, e.g. highways.

- AS/NZS 1158.3.1: 'Category P' Lighting applicable to roads and other outdoor public spaces on which the visual requirements of the pedestrians are dominate e.g. outdoor car parks.

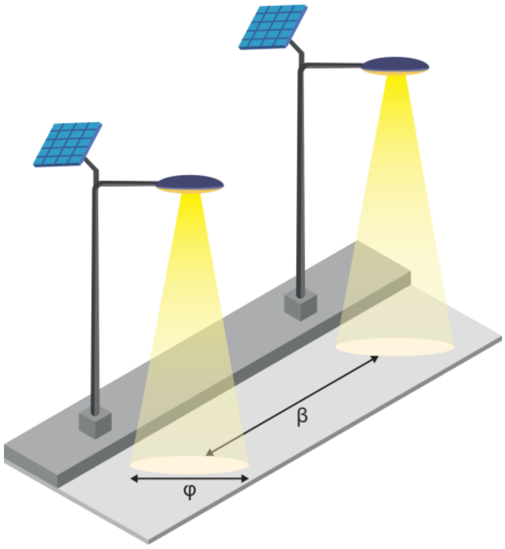

FIGURE 1: EXAMPLES OF COMMON LIGHTING TECHNICAL PARAMETERS INCLUDE HORIZONTAL ILLUMINANCE AND UNIFORMITY

1.1 Solar lighting installations are designed to meet the illumination requirements of the requested specification. It is important that your supplier or consultant can demonstrate that these requirements have been designed to the requested level of compliance by providing calculations in accordance to the procedure described in the relevant section of the specification.

1.2 Some installations will dim their lights to reduce power consumption. Ensure dimming is activated either by a sensor or timer and is independent of battery capacity. The provided level of illumination should not decrease as the battery is drained throughout the night. Dimming is best used to enhance lighting outcomes during peak traffic hours and can be used to dim to a lower level of compliant lighting during off-peak hours.

Questions to Ask Your Supplier:

- Has my lighting been designed to the requested technical specification?
- Is the dimming used in my installation independent from battery capacity and compliant to the requested standard at the lowest level of dimming?

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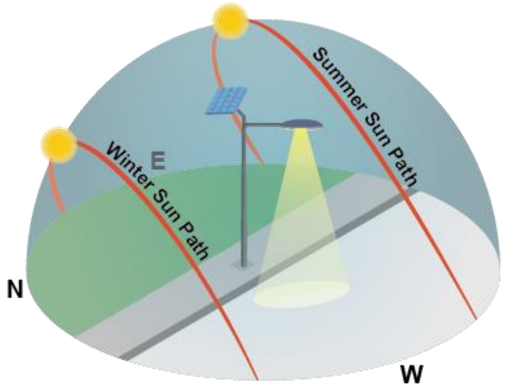
2. Photovoltaic Solar Panels

Photovoltaic solar panels capture energy from the sun, known as solar insolation, and convert it to electricity. For solar lighting they enable standalone installations that are independent of mains supply.



Example Panel Angles*

Location	Winter	PSH_W	Summer	PSH_S
Adelaide	51°	3.48	4°	7.56
Brisbane	42°	3.31	0°	7.33
Canberra	56°	2.93	2°	7.72
Darwin	50°	5.21	0°	9.64
Hobart	63°	2.24	5°	7.58
Melbourne	55°	2.55	4°	7.18
Perth	47°	3.56	0°	9
Sydney	34°	2.71	0°	7.32

*These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center Surface meteorological and Solar Energy (SSE) web portal supported by the NASA LaRC POWER Project

FIGURE 2: SEASONAL SUN PATH AND OPTIMAL PANEL ANGLE

Note: Solar insolation varies greatly depending on specific location. The data included above is for example purposes only. You will need to request data specific to your installation from your supplier.

2.1 In the southern hemisphere the sun rises in the east and sets in the west, moving northwards throughout the season. Energy captured from the sun is highest when solar panels are orientated to face North. In cases where northerly obstruction exists alternative facing panel may be viable however, suppliers must demonstrate how this variation has been accommodated in the sizing and selection of the solar panels.

2.2 The solar energy provided by the sun is dependent on both geological positioning and seasonal conditions. For reliable performance during seasonal change solar panels are sized and positioned according to the period of the year when solar insolation is expected to be at its lowest. Generally, this occurs during the shortest day of the year, which usually occurs on the 22nd of June. The angle that a solar panel is facing the sun can make a dramatic difference to the amount of energy that is gathered and should be adjusted for optimal performance during the time of lowest solar insolation.

The average daily solar insolation time is commonly measured in units of PSH (peak sun hours). This term refers to the solar insolation which a location would receive if the sun were shining at its maximum values ($1kW/m^2$) for a certain number of hours.

Questions to Ask Your Supplier:

- Are my solar panels appropriately sized for the lowest expected solar insolation considering physical location, orientation with respect to sun position and allowances for degradation?
- Are the panels facing north and has the angle been adjusted for the optimal performance during the time of lowest solar irradiance? if not can you demonstrate how this variation has been accommodated in the sizing and selection of the solar panels?

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3. Batteries & Charge Controllers

3.1 Charge controllers regulate the supply of energy between solar panels and batteries and are available in as either Pulse Width Modulation (PWM) or Maximum Power Point Tracking (MPPT) configurations. MPPT charge controllers dynamically adjust the power supplied to batteries to provide the maximum amount of charge possible and is used more widely in commercial solar lighting application due to better efficiency.

Batteries are generally the most expensive component of a solar lighting installation and can be supplied in a variety of range of different chemistry types. It is often an area where quality is compromised in order to offer a cheaper product.

When sizing a battery for energy storage capacity three main criteria are important to consider:

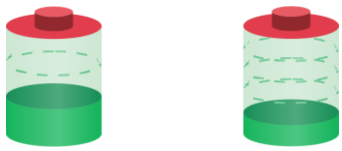
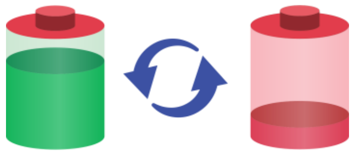
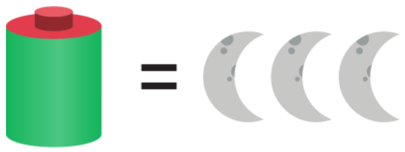
Depth of Discharge		Referred to as the usable capacity, is the level of discharge a battery can reach before irreversible damage is caused to the chemistry of the battery.
Cycle Life		The number of discharge-recharge cycles that the battery is expected to withstand at specified depth of discharge.
Autonomy Period		The number of days of operation of the battery at its highest rate of discharge without additional energy input before exceeding the design maximum depth of discharge of the battery.

FIGURE 3: BATTERY SIZING CRITERIA

3.2 Fit-for-purpose batteries used in solar lighting installations will provide a 5-year design life and an autonomy period of at least 3 days based on the probability of the number of consecutive days with low solar irradiation. A battery of enough capacity is important to provide contingency and reliability in the worst conditions.

The two most common battery chemistries commonly using in solar powered applications are sealed lead acid (SLA) and lithium-ion (Li-Io). Within these two types of batteries there exists many variations of chemistry making the batteries suitable for different applications. Generally, lead acid batteries are cheaper, have less usable capacity and a shorter cycle life. Cycle life can be extended by limiting the depth of discharge and increasing total capacity. For example, a comparable number of recharge cycles from a lead acid battery would require a battery 2-3 times larger in capacity than a comparable lithium ion battery.

Questions to Ask Your Supplier

- What battery chemistry is used in my installation?
- What is the design life, depth of discharge and autonomy period of the batteries used in my installation?
- Are my batteries compliant to the requirements of AS/NZS 4509.2?

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4. Sizing Worked Example

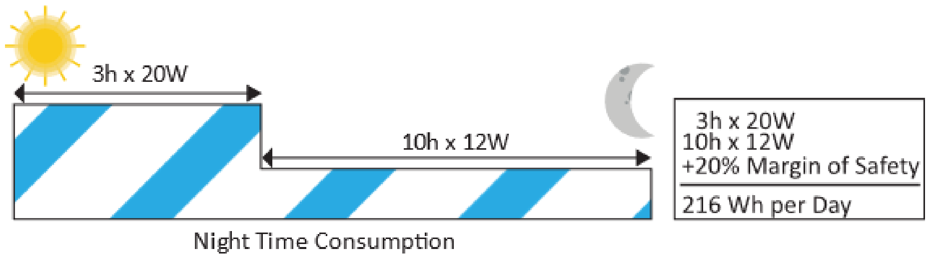
The various components of a solar lighting installation form a versatile system that is designed to meet the conditional requirements of a specific application and location. It is important that parameters relevant to the installation are considered to ensure fit-for-purpose and quality solar lighting outcomes.

4.1 The following example is a high-level procedure for designing a solar lighting installation. It has been included to promote an understanding of relevant factors and demonstrate the limitations of 'all-in-one' and 'off-the-shelf' products. It is not intended to replace the professional design procedure required to accommodate the specific project requirements of an installation.

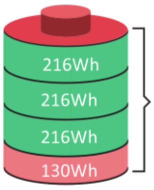
<u>Example requirements / specification:</u>

- AS/NZS 1158.3.1 Category P3 lighting for 3 hours during peak traffic, with 20Wh lights
- AS/NZS 1158.3.1 Category P4 for 10 hours during off-peak traffic, with 12Wh lights
- 20% margin of safety
- 3 days of autonomy
- Lowest expected solar insolation: 2.5 PSH (1 peak sun hour = 1kW/m^2)

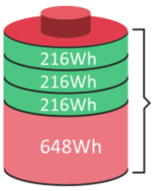
<u>Power Consumption:</u>



<u>Battery Requirements:</u>



<u>Lithium Ion Battery</u>
778Wh - minimum lithium battery capacity required
(3 days autonomy at 216 Wh per day, 80% DoD)



<u>Lead Acid Battery</u>
1280Wh - minimum lead acid battery capacity required
(3 days autonomy at 216 Wh per day, 50% DoD)

<u>Solar Panel Sizing:</u>

$$\frac{\text{Power Consumption}}{\text{Solar Insolation}} = \frac{216\ \text{Wh}}{3.0\ \text{PSH}\ \left(\frac{1\text{kW}}{\text{M}^2}\right)} = 72\,\frac{\text{W}}{\text{M}^2}\,\text{Panels}\ (MPPT\ charge\ controller)$$

$$= \frac{216\ \text{Wh}}{3.0\ \text{PSH}\ \left(\frac{1\text{kW}}{\text{M}^2}\right) * 0.88\ (\text{PWM charge controller})} = 82\,\frac{\text{W}}{\text{M}^2}\,\text{Panels}\ (PWM\ charge\ controller)$$

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