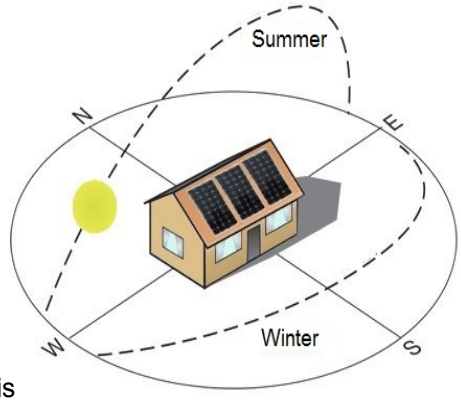
GREENSTAR	**Installation Instructions** DESCRIPTION: This document describe how to issue the optimal orientation and angle for the Greenstar Security Lamp solar panel.	Document Number: REV: A

Solar Panel Installation

Solar power offers many advantages in the generation of electricity. It has zero raw fuel costs, unlimited supply and no environmental issues such as transport, storage, or pollution. Solar power is available everywhere, even on the moon. But to get the most out of a solar panel or solar array, it has to be pointed or "orientated" directly at the suns radiant energy because as we know, the more surface area that is exposed to direct sunlight, the more output the photovoltaic panel will produce, but here lies the problem.

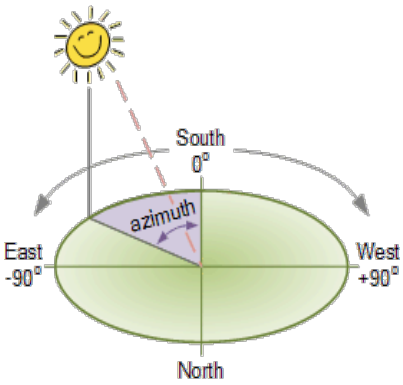


While the photovoltaic solar panel may be perfectly aligned to receive the suns energy, it is a stationary object being fixed to either a roof or mounted directly onto a frame. With regards to a solar panel, the sun however is not in a stationary position and is constantly changing its position in the sky relative to the earth from morning through to night making the correct solar panel orientation difficult.

So the challenge in getting the maximum benefit of free solar power is to ensure that a photovoltaic solar panel or a complete PV array, is correctly orientated and positioned with regards to the direct sunlight coming from the sun at all times of the day. As well as the "solar panel orientation", the number of hours of sunlight a day the solar panel receives as well as the intensity or brightness of the sunlight are also important. For example, when the sun is lower in the sky during the winter months the solar panels orientation needs to be more vertical as the solar radiation passes through more atmosphere to reach the solar panel and therefore its intensity is reduced by the scattering and absorption effect of atmosphere and clouds. In the summer months when the sun is higher in the sky the solar radiation is more direct and therefore stronger as it has less distance to travel through the Earth's atmosphere so the solar panel orientation is more horizontal

Solar Panel Azimuth and Zenith Orientation

Solar PV modules and panels work best when their absorbing surface is perpendicular to the suns incoming rays. The position of the sun in the sky can be plotted using two angles, azimuth and zenith and the angle of the solar panel orientation relies upon these two values.



Solar Panel Orientation – Azimuth Orientation

Azimuth – This is the compass angle of the sun as it moves through the sky from East to West over the course of the day. Generally, azimuth is calculated as an angle from true south. At solar noon which is defined as an azimuth angle of zero degrees, therefore Azimuth = 0°, the sun will be directly south in the northern hemisphere and directly north in the southern hemisphere.

Solar azimuth angles to the east of due south are negative in nature, with due east having an azimuth angle of -90°. Solar azimuth angles to the west of due south are positive in nature, with due west having an azimuth angle of +90°. In general however, the azimuth angle required for the correct solar panel orientation varies with the latitude and time of year.

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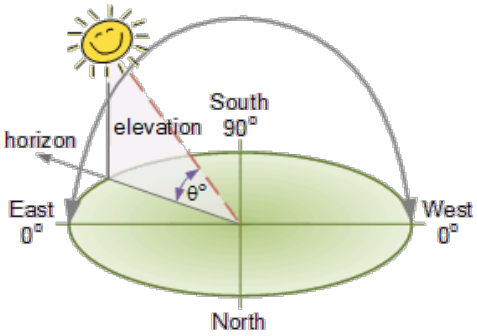
Solar Panel Installation

Solar Panel Azimuth and Zenith Orientation



Solar Panel Orientation – Zenith Orientation
Zenith – This is the angle of the sun looking up from ground level or the horizon. The zenith angle of the sun varies throughout the day in the form of an arc with the sun reaching its maximum elevation (also called solar altitude) around midday. The suns elevation is defined as 0°at sunrise and sunset, and 90° at midday when the sun is directly overhead.
However, the elevation of the sun at midday is different between the summer solstice and the winter solstice representing the longest and shortest days of the year as the suns path forms an arc across the sky representing either spring or autumn.

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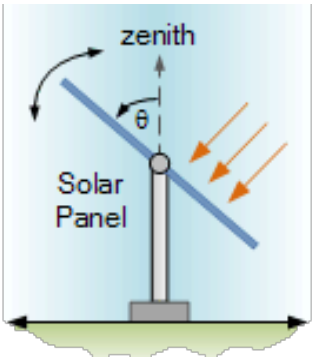
Solar Panel Tilt



For a fixed solar installation in case of the **Greenstar Security Lamps**, it is preferred that the PV panels are installed with a **centralised tilt angle representing the vernal equinox, or the autumnal equinox,** and in our example data above this would be about **38 degrees (38°).** However, this tilt orientation is not as critical with regards to the solar panels orientation as even at a tilt angle of nearly 45 degrees (45°) with respect to the suns solar rays will still receives more than 75 percent as much energy per unit surface area as it does when it is optimally aligned.

San Antonio, Texas, United States
Latitude: +29.42389 (29°25'26.004"N)
Longitude: -98.49333 (98°29'35.988"W)
Time zone: UTC-6 hours
Country: Texas, United States
Continent: Americas
Sub-region: Northern America
Altitude: ~210 m

Latitude 30° Tilt 50.7°

Season	Insolation on panel	% of winter insolation
Winter	5.6	100%
Spring, Autumn	6.0	107%
Summer	5.1	91%

For the Non Fixed Tilt Method
(require adjust the panel by the user twice a year)

Method 1: Quick and Easy (But Less Effective)
Take your latitude and add 15 degrees for the winter, or subtract 15 degrees for the summer.
For example: if your latitude is 40 degrees, the angle you want to tilt your panels in the winter is: 40 + 15 = 55 degrees.
In the summer, it would be: 40 - 15 = 25 degrees.

Method 2: The Better Way (Winter)
In the winter months, when there's less sun, take your latitude, multiply it by 0.9, and then add 29 degrees.

For example: if your latitude is 40 degrees, the angle you want to tilt your panels in the winter is: (40 * 0.9) + 29 = 65 degrees.
This is about 10 degrees steeper than the "quick and easy" way! It's also more effective, because you want your panels to be directly facing the sun at mid-day during those short winter days.

Method 3: The Better Way (Summer)
Take your latitude, multiply it by 0.9, and subtract 23.5 degrees.

For example: if your latitude is 40 degrees, your panels should be tilted at:
(40 * 0.9) - 23.5 = 12.5 degrees.