» Battery Storage Endorsement Course
» Solar Grid Connect Design And Install Course
» Stand Alone Power Systems Course
» Electric Vehicle Chargers Course
» Advanced Digital Meters Course
» CEC Accreditation
» Australia Wide Training Locations
» Quality Training by Industry Experts
WHAT IS A PANEL?

Welcome to the Panel Pocket Guide: a handy reference guide for solar installers. The pocket guide contains essential information that every solar system designer and installer needs to have on hand when working with panels on rooftops.

Solar energy comes from the sun and solar panels (also known as PV panels) are used to convert light from the sun which is composed of particles of energy called photons, into electricity that can be used to power electrical loads. In a country like Australia, where there is an abundance of sunlight the uptake of solar panels on residential and commercial properties is currently the largest in the world.

HOW DO SOLAR PANELS WORK?
Solar panels are comprised of several individual solar cells which are composed of layers of silicon, phosphorous (which provides the negative charge) and boron (which provides the positive charge). Solar panels absorb the photons and initiate an electric current. The resulting energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells which then pull these free electrons into a directional current. This entire process is known as the photovoltaic effect.

An average home has more than enough roof area for the necessary number of solar panels to produce enough solar electricity to supply all of its power needs with excess electricity generated going into the main power grid.

The solar array sends direct current (DC) electricity through the charge controller to the battery bank. The power is then drawn from the battery bank to the inverter, which converts the DC current into alternating current (AC) that can be used for non-DC appliances. Assisted by an inverter, solar panel arrays can be sized to meet the most demanding electrical load requirements. The AC current can be used to power loads in homes and commercial buildings.

DISCLAIMER The publisher has made every effort to ensure that the information in this guide was correct at the time of publication. The publisher does not assume, and hereby disclaims, any liability to any party for any loss, damage or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident or any other cause. Information current as of September 2018.
MODULE TYPES

There are various module types which are commercially available on the market today. The following is a non-exhaustive snapshot of commonly used modules.

60 Cell vs 72 Cell Module - standard 60 cell modules (referring to standard 6-inch cells) are most commonly used for residential and commercial installations. With dimensions of approximately 1.65m x 1m they are designed to have a sufficiently large collector area while still being easy to handle. 72 cell modules are most commonly used in large commercial, industrial and utility scale work. Though physically larger (approximately 1.95m x 1m) and more difficult to handle in the work environment (ground mount or large roof surfaces) and inherent reduction in balance-of-systems makes them an attractive option for larger jobs.

Mono v Poly - the difference between monocrystalline and poly or multicrystalline is the manufacturing process. Monocrystalline cells are formed by drawing up molten silicon starting from a seed crystal of uniform lattice structure silicon. As the silicon boule is drawn it cools with a lattice structure which follows the seed crystal. The single crystal boule is then cut into cells. Polycrystalline cells are usually formed by being pressed in a die or extruded. When this is done the lattice structure is not uniform, hence multicrystalline. Generally, monocrystalline cells are more efficient than multicrystalline cells.

N-Type vs P-Type - N-Type and P-Type refer to the type of bulk silicon used to make the cell. To set up an electric field within the cell, a P-N layer needs to be created. This is done by “doping” bulk silicon with elements such as boron for P-type and phosphorus for N-type. Most cells have a P-type bulk layer for the historical reason that they perform better in extra-terrestrial applications. However, as the industry has evolved most PV applications are terrestrial, which is better suited to N-type bulk silicon. N-type bulk silicon cells usually have a price premium associated with them due to differences in the manufacturing process.

Half Cell - half cell modules are a relatively new type of module. These modules simply take advantage of reduced resistivity loss by halving the current from each cell. They are basically two parallel modules of series-connected cells put into a single encapsulation. Performance can be boosted by 5-8W per module. A drawback however may be that the leads for these modules are in the centre of the module.

Double Glass Modules - double glass modules use a standard cell type encapsulated with glass on both the front and the rear of the module (as opposed to the standard Tedlar backsheet). These modules offer superior strength and as...
COMMERCIAL ENERGY EFFICIENCY SPECIALISTS

With over 10+ years experience, we provide complete energy efficiency solutions to businesses based on their individual requirements.

ENERGY AUDITS
SOLAR LIGHTING
PPA’S & FINANCE
SOLAR CARPARKS
METERING & MONITORING
LED LIGHTING UPGRADES
HVAC TREATMENTS & BMS
BATTERY BACKUP & STORAGE
SOLAR DESIGN & INSTALLATION

Call us to discuss your options

1300 237 652
www.beaconenergysolutions.com.au
they are frameless, they do not need to be earthed.

**Bifacial Modules** - these modules are also double glass modules, however they use a clear EVA (Ethylene-vinyl Acetate) and cells with a rear busbar instead of a rear conductor which covers the entirety of the cell. This allows light to not only enter the cell from the front but also from the rear, thereby increasing its overall yield.

## MODULE COSTS

Module costs are usually given using the metric “dollars per watt”. This is done so that a standard metric can be used regardless of the module size or technology. Currently, module pricing is ranging from $0.45/Watt for value focused standard 60 cell modules to $1.40/Watt for premium products.

Pricing is slated to stay keen for the remainder of the 2018-2019 FY especially with the easing in the Chinese solar market and manufacturers looking to differentiate themselves with new products.

Regardless of the price, value should also be placed on:

- the trade history of the manufacturer
- the level of support provided by the manufacturer (ideally that support is local)
- the warranty offered by the manufacturer and that the warranty process is simple and transparent
- the module is on the CEC approved list

In addition, it is important to validate that the module purchased has been brought into the country legally and uses a valid serial number system so that STCs can be claimed and traced (if STCs are applicable).

## MODULE SELECTION

Selecting a module can be a difficult supply chain decision. Most module manufacturers present a very similar value proposition and specification sheets provide little differentiation. The following list is meant to provide some guidance for selecting a specific manufacturer or specific module:

- what is the cost of the module?
- what is the performance and workmanship warranty of the module?
- is the warranty backed by a third party?
- is the warranty process simple and transparent?
- does the manufacturer perform electroluminescence testing on batch samples if not on every module?
- is the module PID Free?
- is the module tested for salt mist and ammonia corrosion?
- what is the power temperature coefficient (Pmax)?
- what is the front and back load capacity of the module?
- what is the trade history of the manufacturer?
- does the manufacturer have a diversified product line?
- does the manufacturer provide product support or value add services?
- does the manufacturer provide financing?
- does the manufacturer have a local presence?

Comparing answers to this question set for various modules and/or manufacturers may help to differentiate the field. If weightings were applied to the above question set, a quantitative evaluation could be made of each manufacturer/module in order to provide greater confidence in the decision-making process.
Achievers Energy is an AUSTRALIAN BASED COMPANY. Wholesaler and Distributor of Solar PV Products.

Achievers Energy Operates Its Wholesale Network in most of the STATES IN AUSTRALIA.

PANELS Wide Range of TIER - 1 Brands

INVERTERS

OUR SERVICES
- STC Trading
- Technical Support
- Installation & Grid Application Services
- PV System Designing
- Warranty Claim Assistance
- After Sales Support, Warranty Claim Assistance

Call us for Pricing 1300 224 483

NSW - 02 888 17127    QLD - 07 3532 9126
VIC - 03 9977 9346    SA - 03 9977 9347
PV modules absorb solar radiation directly from the sun or from sunlight reflected off clouds or the area surrounding the module. Pointing the PV module at the sunlight will maximise the output performance. The PV module is most efficient when the sun's rays are perpendicular to the module's surface.

From your previous solar training or high school science classes, in the southern hemisphere, that is Australia, the sun is in the northern sky, it rises in the east and sets in the west and is higher in the sky in summer and lower in winter.

A dual tracking mounting system is the ultimate solution to follow the sun and get maximum output but this is not a practical solution due to cost and engineering considerations. A fixed module will not always perform to its maximum efficiency but it is the easiest and cheapest option.

**AZIMUTH:**
Azimuth is the angle measured in a clockwise direction from north that the modules are facing. True north is the best option to point the PV modules but that is not always achievable owing to the fact that the builder built the roof you are mounting the modules on facing some other direction. In general, according to the CEC accreditation website (https://www.solaraccreditation.com.au/installers/compliance-and-standards/accreditation-guidelines.html) the difference on daily solar irradiation collection in Sydney between north, east & west is minimal in summer but substantial in winter (see table)

If a north facing array is not possible, then the argument continues whether an east or west facing array is better. With self-consumption being a major reason to install PV nowadays, consider when the customer will use the generated energy. For example, charging batteries to use at night...maybe east facing, using air-conditioning after a hot day...maybe west facing.

In the end, most designers/installers have little choice, the azimuth is decided where they can mount the whole array.

<table>
<thead>
<tr>
<th>Solar collection efficiency compared to NORTH (Sydney)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilt: 20deg</td>
</tr>
<tr>
<td>Summer</td>
</tr>
<tr>
<td>Winter</td>
</tr>
</tbody>
</table>

**TILT ANGLE:**
As mentioned earlier the ideal tilt angle for the PV module is perpendicular to the sun's rays. PV modules should be tilted at an angle approximately equal to the site's latitude. This will give the best average, taking into account the angle of the sun over the entire year.

For a grid-connected PV system on a domestic pitched roof, the roof pitch will be the resultant tilt angle. This is not ideal but the most practical and affordable. If using a tilt frame on a flat roof then aim for an angle closer to the site's latitude.

For off-grid systems, the tilt angle is critical. In winter, when the sun is lower in the sky, it is paramount that the PV have a larger tilt angle to get the most out of the winter sun. Typically in off-grid systems, ground mount or tilt frame systems are used to get tilt angles of latitude plus 10-15deg.
SHADING:
PV modules generate electrical power based on the amount of sunlight hitting the module, then any reduction of sunlight caused by shading will reduce the output.

When shading strikes the module, the bypass diodes kick in and the output of the module can be reduced by the shaded cells. The worst case scenario for shading is when a line of shade crosses across all columns of the cells in the module and the output is reduced to zero.

The output of an array with PV modules, connected in series to a string inverter, can be reduced dramatically by the shaded module/s. So if shading is going to be a problem, then consider micros or optimisers. Both micro inverters and power optimisers essentially allow every solar panel in a system to operate independently, so that overall system energy production is not overly affected by just one or two shaded panels.

Amorphous silicon solar cells are said to be better at handling shading than crystalline silicon solar panels, but generally speaking the relatively low overall efficiency of amorphous panels means that crystalline modules are generally a better choice. Roughly half as efficient means that you need twice the roof space for mounting for the equivalent output. Not a practical solution with limited roof space.

Initial positioning of the array to minimise shading is important as is ongoing maintenance. Trees grow and need to be trimmed in order to maintain a shade-free array.

THE WEATHER EFFECT ON SOLAR MODULES

When you think about it, we place PV modules in the harshest conditions because they need sunlight to work. In hourly/daily changing weather conditions, hot one minute, cold the next, wet, frosty, you name it—most PV modules just keep on generating. Nowadays high quality PV modules are very durable.

TEMPERATURE:
The sun is shining, the temperature is rising, the PV modules are in full sun, generating heaps of energy...right? Well, not quite! As the ambient temperature rises, the performance of the PV module reduces. This is just a fact of silicon PV modules.

As the PV modules heat up, the Isc increases slightly but the Voc drops more. Using the formula P = V x I, the larger drop of Voc causes the power to decrease.

Conversely, at a low ambient temperature, the performance of PV modules increases, as the Voc increases, (the Isc decreases slightly). This is why you use the lowest temperature of the location to calculate the maximum Voc.

So the ideal location for PV modules is clear, sunny days, with low ambient temperatures like alpine areas of Germany.

CLOUD:
Put simply, PV modules need sunlight to perform. More sun equals more generation. Cloud reduces the amount of sunlight reaching the PV modules so generation reduces accordingly.
WEATHER

RAIN:
With rain comes clouds, so expect a reduction of performance. However rain can be good for PV modules as well. Over time PV modules can accumulate dust, dirt and bird droppings which reduce overall performance. A good rain shower will clean the PV modules returning them to a better output.

It is important that PV modules are mounted at least 10deg tilt so the water will run off. Pooling of water on the surface of the PV modules may cause damage in the long term.

WIND:
Wind may have a positive effect on PV module performance. The cooling effect of wind will keep the ambient temperature down so performance increases.

Wind however, can cause problems, if the PV modules are not mounted correctly on the roof. PV modules mounted too close to the edges or overhanging the ridge line are subjected to increased wind load which may physically damage the PV modules.

HAIL:
Hail storms may damage the glass surface of the PV modules. PV modules are designed to withstand hail; typically quality PV modules can withstand 25mm-diameter hail at 23 m/s.

PV modules with hail damage (a damaged glass surface) may still work but will degrade the overall performance of the array if a string inverter is used. Eventually, water will impregnate the damaged surface and cause total module failure.

LIGHTNING:
Stating the obvious, a direct lightning strike on your PV array will cause extensive damage. In lightning prone areas consider using a direct strike lightning protection like they do in Germany. If using ground mount arrays and underground cable runs surge protection should be installed on each end to protect the PV modules as well as the inverter and equipment.

SNOW:
Snow on the face of PV modules acts similarly to shading. Using micro or optimisers instead of a string inverter may increase the overall performance of the array. The weight of the snow adds to the static weight of the array on the mounting system and the roof structure needs to be taken into account when designing the system.

SALT WATER SPRAY:
In coastal areas, sea spray (high salt concentration in the air) will influence the performance of PV modules. Sea spray will get in everywhere so select a PV module suitable for the intended environment. More regular cleaning will also maintain the output and longevity of the PV array.
Ever bought a new car and wondered why they give you the first service free? Because it enables them to ‘finetune’ any possible issues with the vehicle after you have driven the first 3000kms. Otherwise they might expose themselves legally to defects or accidents that could occur.

So why is it that a lot of solar installers think that they can walk away from the job and ignore any maintenance issues? Here is an outline on what our Renewable Energy Standards say.

**AS/NZ 5033 CLAUSES AND MAINTENANCE**

- documentation - a maintenance schedule and recommended maintenance required must be left with the customer - 5.7
- Appendix C outlines the maintenance that may be required;
  - a) bolts on tilt frames, mid and end clamps are in place and tight
  - b) vermin - has any cabling been disturbed or damaged?
  - c) do the isolators still work, IP rating not affected?
  - d) conduit and fittings - are these still in good order?
  - e) panels - are these clean, undamaged and working? (hail can be an issue)
  - f) verify the Voc and Isc and check it is what is expected
  - g) labels - are they still in place and legible?
  - h) have there been modifications to the building which would now inhibit the panels?
  - i) have trees grown which now shade the system?
  - j) are there fans or filters that need checking or cleaning?
  - k) string fuses - check terminals and verify they haven’t blown. Are they the right type and curve?
MAINTENANCE

WARRANTIES

l) MC4 connections – is there evidence of arcing?
m) ‘hot spots’? use an infra-red camera

• table C1 outlines the periods for this maintenance

AS/NZS 4777:1 CLAUSES AND MAINTENANCE

The ACT Government introduced a requirement for testing of the AS/NZS 4777.2 ‘Anti-Islanding’ function of the inverter. An accredited installer has to check this every five years and sign off on its functionality. Ausnet in Victoria also recommend this be done every year. If the DNSPs are concerned about this perhaps you should be as well.

• Appendix D suggests a maintenance Schedule
  a) verify 60-second start up and/or ramp up
  b) verify that the DNSP network parameters (if set) are still in place – see 3.4.4
  c) central protection, phase balancing and export limiting – is it working as required?
  d) verify two-second shutdown
  e) verify connections are sound and not damaged
  f) earth fault alarm, emails and messages – are these still current?
  g) check earthing including earth stakes – the inverter can affect this due to a DC current being injected onto the AC cabling
  h) LGCs - verify that the readings for the CER have been made and submitted
  i) check for polarised isolators and replace
  j) isolator terminals are the correct torque – use a torque screwdriver
  k) if using an RCD on the output of the inverter test it (the RCD has to be a particular type, not an AC type)

AS/NZS 4509 AND ASNZ 4086 CLAUSES AND MAINTENANCE

Batteries and generators and other turbines: now we really have our work cut out for ourselves. Whether on or off-grid, these add another dimension to the maintenance requirements. While too extensive to list, here is where you would find some of the information.

• Appendix A – 4509 Part 1
• Generators – follow the recommended procedures from the manufacturer
• Section 3 – 4082 Part 2

TIPS FOR INSTALLERS

• install off-site monitoring if possible and look at your customers' systems
• develop a procedure for maintenance and allow for it in your quotes
• consider maintenance as just part of your job and not some other person's responsibility
• with off-grid jobs this is particularly important - allow a six month maintenance visit
• your customers will appreciate your efforts and you are less likely to have problems later on eco
WARRANTIES

Have you wondered who covers the warranty for the equipment that you are installing? This thumbnail sketch outlines some of the issues for us as installers.

The most important thing to consider is to use quality equipment from a well-known supplier.

But as it’s been shown in the last eight years, even reputable suppliers have closed their doors, leaving installers to cover the cost of recalled or faulty equipment. If you have to replace 1000 isolators at your expense because the other suppliers/importers have disappeared, the likelihood is that your business is going to suffer.

THE SUPPLY ‘FOOD CHAIN’

1. equipment manufacturer, or OEM. They manufacture and possibly import products into Australia
2. importer – they may be the OEM but could also be buying product from overseas and bringing it into the country
3. wholesaler – these could be the traditional electrical wholesaler or a solar specific wholesaler
4. solar retailer – these are often businesses aggregating work and passing it on to electrical contractors. They are usually not electrical contractors themselves
5. electrical contractors/accredited designers and installers

PRODUCT AND PERFORMANCE WARRANTIES

Installers often think that the panels they are installing have a 25-year warranty. This may not be the case – they have a 25-year (or possibly longer) performance warranty. This means that the panel will reduce in a tiered manner over the 25-years (e.g. by the 25th year the panel might be producing 80% of its original stated output).

The other warranty provided is a product warranty. This is usually 10-15 years and covers faulty materials and workmanship on the part of the manufacturer.

There seems to be some tension between these two warranties; if a panel fails at 16 years it isn’t meeting its performance expectations. Australian consumer laws support the notion that these panels are probably rated at 25-years, despite what manufacturers might want you to think about their 10-15 year product warranty. These fall under the term ‘express warranties’.
INSTALLER WARRANTIES
While the product that you are installing might have stated warranties, your own work also implies some warranty as to quality, longevity and workmanship. State and territories may have statutory warranty periods despite what you might tell the customer.

EXCLUSIONS TO WARRANTIES
Generally, the following applies:

- non-compliant installation practices – placing the panels upside down (unless the manufacturer states you can) or perhaps walking on the panels
- handling during transport – you throw the panels on top of each other in the back of your ute
- negligence during storage – the panels fall over in your workshop
- removal from original installation – there is no warranty for a second re-location
- weather – for example, the panels being installed on the roof blow off in a storm (force majeure). Other examples are vandalism, accidental breakage or lightning

INSURANCE
There is a misconception about what public/product liability insurance covers – it is meant to protect in the event of claims for bodily injury (to others, not your workers or you!) and property damage. Whilst the CEC only requires a $5 million cover for Accreditation it would be advisable to look at $10-$20 million.

Professional indemnity insurance is essential for all installers; it protects you in the event of economic loss suffered by your customers due to incorrect advice, negligence, poor workmanship or errors made in the design and installation of solar systems. For example, you advise the customer that this battery system will support 10Kwh of load per night and it doesn’t. Or you suggest that they will save $2000 on their electricity bill and this doesn’t occur either (assume you were defective with your designs).

Goods in care/custody insurance – picking up gear from a solar retailer and installing on a sub-contract basis? You are probably liable for the equipment in your care and in the event they are damaged you might foot the bill for replacement. E.g. a traffic accident and all the panels are damaged.

REMEDIES
Read the small print! Will your inverter suppliers pay you to replace a faulty inverter or will it be at your expense? If the isolator wholesaler goes into voluntary liquidation “am I now liable for the replacement of all those isolators installed?” (probably!). If you import the product you will likely hold the warranty. As a rule of thumb, work up the supply chain for compensation/replacement, with the solar retailer having to organise this. If the retailer has gone into liquidation, then the importer/manufacturer is the next entity to contact. If they have ‘disappeared’ it is possible you will be left with the liability. So, in a nutshell:

- buy quality gear
- from a very reputable wholesaler (and keep your ear to the ground about problems that you hear about with replacements)
- if you hear alarm bells ringing you better listen to them
- only do best practice installs – no cutting corners or using cheap equipment
- keep up to date with relevant standards, products, guidelines
- see who is on the following approved retailer list and always check that the products that you are using are on the CEC Approved List.

Ecogeneration would like to thank David Tolliday from Holmesglen, Bill Gammon from SkillBuild, Chris Martell from GSES and Gerard McAllister from Assertive Marketing for their knowledge and time.
SECONDARY INJECTION AND POWER QUALITY TESTING

Our testing and commissioning team offers comprehensive testing services to the commercial and industrial solar installers.

With the changes to AS/NZS 4777:2015 the grid connected solar systems above 30kW must install grid protection relays and requires secondary injection testing to prove that the correct operation of the protection relay as per the parameters set by the DNSP.

Some DNSP’s also require power quality readings with the solar system connected and disconnected as part of their requirements to approve solar systems.

We offer the most COMPETITIVE testing service to the Solar Installers FAST

Book your next test with Dara, Call us Now

0478 398 344

or Email us at Sales@dara-switchboards.com.au
Begin your pathway to CEC Accreditation

With industry leading training, GSES offers Nationally Recognised Courses that will help keep you qualified and certified.

Grid-Connected PV Systems
Design & Install $2,295

Grid-Connected PV Systems with Battery Storage
Design & Install $2,295

Visit www.gses.com.au to become an accredited solar designer or installer

Unit 4/17-19 Green Street, Botany, NSW, Australia
www.gses.com.au | 02 9024 5312 | info@gses.com.au
RTO# 91461