Home battery storage systems:

Frequently Asked Questions

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Acknowledgements

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Front Cover – Photo courtesy of Reposit Power

Page 4 – Figure 1 courtesy of NSW Department of Planning and Environment

Page 7 – Figure 2 courtesy of SolarQuotes

Page 8 – Figure 3 courtesy of SolarQuotes

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What is a battery storage system?

A battery is a device that stores electrical energy. It can be charged with electricity from the grid, or from a generator such as a solar panel or wind turbine. The energy stored in the battery can then be used later on to power appliances and other electrical systems in homes and businesses.

How does a battery storage system work?

In a typical home with solar panels, part or all of your energy usage may be met by solar generation while the sun is shining. Any excess solar energy is exported to the grid. Shortfalls, most often experienced in the evening and overnight, are met by importing electricity from the grid.

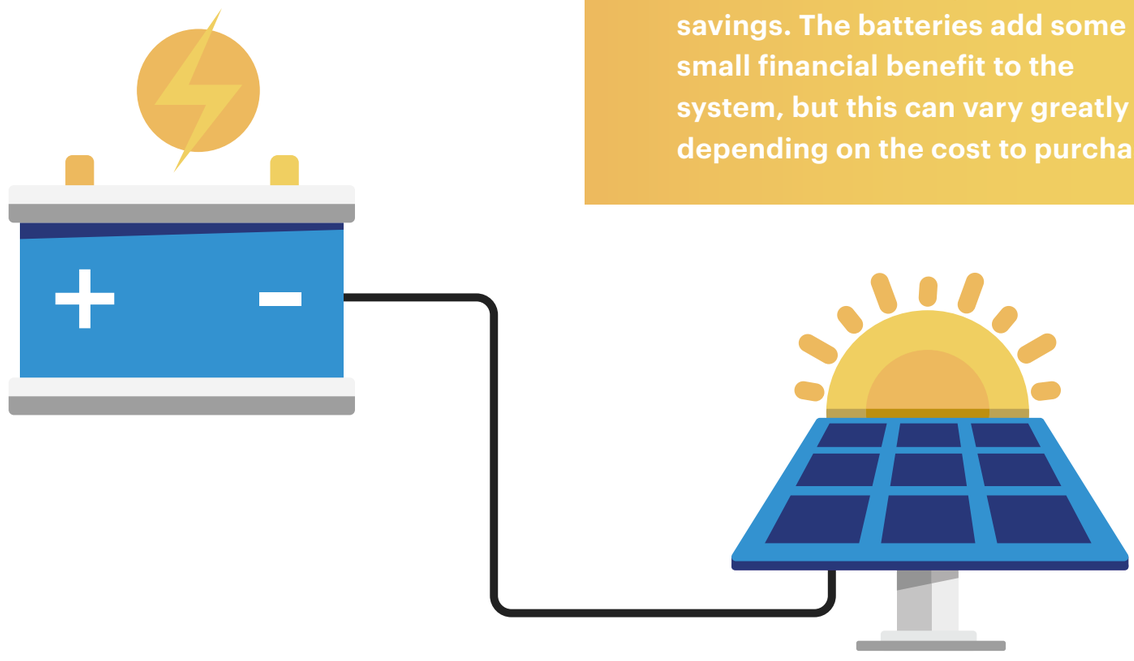
This is where a battery can help to save money. When you add a battery to a rooftop solar system, or install a battery and rooftop solar panels together in a new system, the excess solar energy not used at home during the day is used to charge the battery.

There are various battery storage products available that have a wide range of functionality and performance. Some batteries can be charged from grid electricity, during off peak times (overnight) for example on a time-of-use (TOU) tariff when electricity is cheaper than during the day.

The energy stored in a solar-battery system is used in the home whenever there is energy usage above the level produced by the solar panels. This battery energy can power house appliances before any energy is required to be imported from the grid.

Once the stored energy is depleted, grid power (or an alternative generator) will be needed to supply household energy requirements until solar generation is available the next day.

A stand-alone solar and battery system is used where the house or site has no connection to the grid at all. Typically, these systems comprise solar panels, inverters, a battery bank and a back-up petrol or diesel generator – primarily used to support the system during cloudy winter periods. The size of battery bank required for these systems, along with more sophisticated inverters, can mean these systems range in price from between $30,000 and $150,000.



Is it a good idea to get a battery?

This depends on what you are trying to achieve. Common project objectives are:

- Energy bill savings;
- Energy independence (from the grid, either total or partial);
- Higher supply reliability (in areas that face a higher level of power outages);
- Retaining more solar energy to be used on-site.

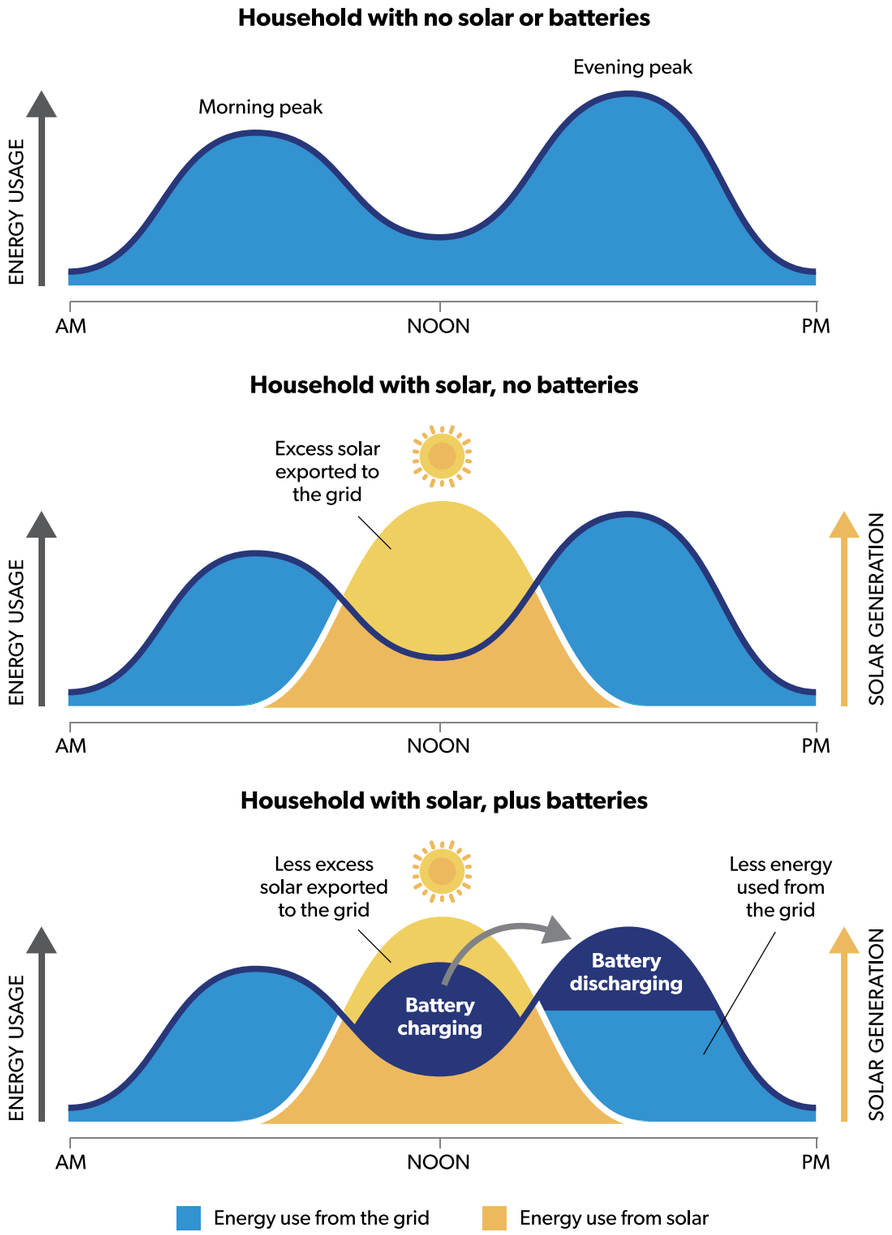
In a solar-battery system, it is actually the solar electricity generated by the panels, and then used immediately in the home, that delivers the majority of savings. The batteries add some small financial benefit to the system, but this can vary greatly depending on the cost to purchase.

Batteries could potentially make financial sense in the following circumstances:

1. You have higher than average electricity consumption;
2. You are on a time-of-use (ToU) tariff;
3. You are planning on installing a new solar system with your battery;
4. You live in a rural area where a new grid connection is expensive, so it makes sense to go off-grid. You would need to consider if an off-grid system is reliable enough for your year-round electricity needs, or if an additional backup source of electricity is required to meet all of your annual needs;
5. You have poor grid reliability (i.e. blackouts) in your area and particularly value battery back-up supply;
6. You have, or want to install, a large solar system but the local electricity network has imposed an export limit on your system, so some solar generation will go to waste without a battery;
7. A special program is available in your area, such as a Virtual Power Plant trial, including a battery subsidy, or bulk buy opportunity.

Is it a good idea to get a battery?

FIGURE 1: How solar, with and without batteries affects your home energy use



Are batteries a good investment right now?

Batteries are typically relatively expensive when compared to the energy bill savings they can deliver. There are a range of products and price points that offer varying functions.

Keep in mind the following "general rules of thumb " regarding battery economics:

- **New solar—**a new, correctly-sized, rooftop solar system without a battery currently pays for itself sooner than one with a battery.
- **Existing solar—**retrofitting a battery to existing solar may not make much economic sense right now, however this may change. Currently, the best cases for retrofits are for high-consumption houses with large solar systems.
- **Solar size—**bigger solar systems pay for themselves about one to two years quicker than smaller ones and are more valuable over time (as even if larger systems mean more solar is exported to the grid, the cost of generating solar electricity is now cheaper than the feed-in tariff rate). However, they do cost more to purchase.
- **New solar and battery—**in many cases a new solar system with a battery can currently pay for itself within 10 years.
- **Battery size—** the payback time is quicker for a small battery than a big one.
- **Financials—**payback times are likely to be better in 2021 than 2018, with payback periods likely to reduce by around three to four years for new solar and battery systems.
- **Tariff—**a time-of-use tariff is better than a flat-tariff for solar with or without a battery, often accelerating payback by one year.

Calculating the payback period

Grid-connected batteries are likely to become financially attractive to most Victorian homes around 2020, based on current expected battery price reductions. The payback time is worked out by dividing the total cost of the battery (or solar and battery system) by the annual savings on power bills.

The payback time should be less than the actual warranty on a system. At the moment the warranty on most batteries is around ten years, but the payback time can be longer. The life span of a battery is affected by a number of factors including number of charge and discharge cycles, depth of discharge, discharging timeframe and operational temperatures.

The performance guarantee on solar panels is around 25 years though, and payback is usually between four and 10 years, depending on consumption patterns and feed- in tariffs, which makes the investment on a grid-interactive solar system better value.

For more details on solar and battery payback times and energy bill savings, use the Alternative Technology Association's free online calculator at **www.ata.org.au/ata-solar-advice**

Does the government offer a rebate to install a home battery?

No. Unlike rooftop solar systems, there is no federal government scheme to encourage the mass uptake of home solar batteries. And there are currently no state government rebates for home solar batteries in Victoria. Moving forward, local councils or the state government may offer incentive programs for this growing sector.

Is my existing solar system "battery ready"?

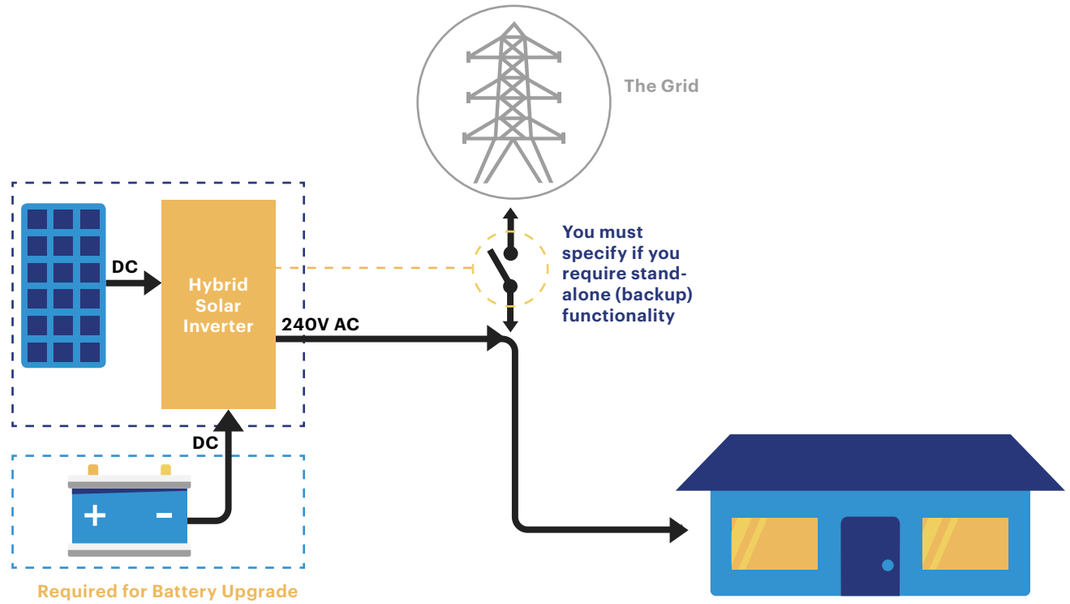
String inverters

The majority of existing solar PV systems in Australia have single, "string" inverters and are not fully "battery ready". Typically, the existing solar panels can be retained. However, most existing solar customers will either need to:

- Replace their existing grid-interactive inverter; OR,
- Add a second inverter that is dedicated to the battery (some battery systems come as an "all-in-one unit" with this second inverter built-in.)

Replacing the existing inverter and having a single inverter for the entire solar-battery system is known as "DC coupling". The battery is connected directly to the DC-output of the panels (albeit at different voltage).

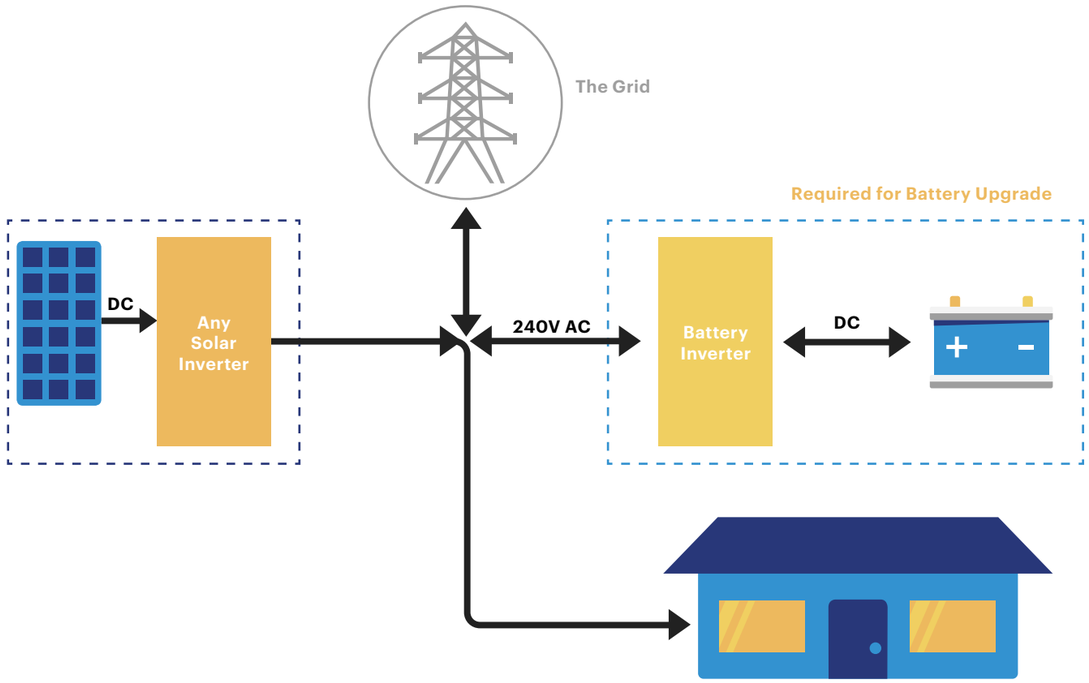
FIGURE 2: DC coupled battery



Including a second, battery-dedicated inverter in the system is known as "AC coupling". The battery and second inverter are connected to the AC wiring on the household side of the solar inverter (see Figure 3 on next page). AC coupling is easier when it comes to retro-fitting a battery to an existing solar system, however can be more expensive overall and does result in slightly more energy losses through the system (as the solar electricity is converted from DC to AC twice – once through the solar inverter and again through the battery inverter).

Is my existing solar system “battery ready”?

FIGURE 3: AC coupled battery



Micro-inverters

If your solar system has a micro-inverter under each panel, then you will need to install an AC coupled battery i.e. a battery with its own dedicated inverter. This option is relatively easy if you use a battery with an in-built inverter.

Some batteries integrate easily with the same brand micro-inverters. However, it is not absolutely necessary that the AC coupled battery is the same brand as the micro-inverters themselves.

New solar-battery system

If you are planning to install a solar system now, and a battery later, you may want to consider whether the more expensive “hybrid” inverter you install now could be obsolete by the time you purchase and install the battery. Inverter and battery technology is moving fast, and the current stock of hybrid inverters may be unable to support the functionality of newer battery technologies even in two or more years’ time.

Can I recharge my battery overnight from the grid on an off-peak tariff?

Yes – as long as the battery has the required functionality (typically smart software) to enable this.

Typically, only batteries configured in an AC coupled arrangement can facilitate charging from the grid. Due to the variability in daily and seasonal solar generation, and in household usage patterns, top-up charging from the grid on an off-peak (i.e. lower) tariff can make good economic sense.

Some smart software can even integrate battery charging from the grid with weather forecasts, so that the system can predict insufficient solar generation the following day and adjust the level of charging from the grid required accordingly.

It should be noted however that the functionality required to enable grid-charging does come at a cost – making these types of batteries more expensive than regular grid connected solar-battery systems.

What size battery do I need?

Choosing the right battery size for your needs will mostly depend on the size of your solar electricity system, how much energy you consume overnight and whether you want backup during a power outage.

To save the most on electricity bills it is generally best to buy a battery that you will regularly charge and discharge to the recommended level. You want to be able to store any excess solar electricity generated each day and ensure that the majority of that stored energy is used later on.

Battery over-sizing leads to a lot of stored energy that is not used – and therefore can be a wasted expense.

At the same time, it is wise not to over-use a battery, for example by fully charging and discharging two or three times a day. Doing this might shorten its lifespan. You can usually set this up in the Energy Management System or similar app that helps to optimise the system.

The best way to choose the right battery for your needs and budget is to get an independent assessment from an energy expert or accredited installer or supplier.

Upgrades and replacements

Some battery systems are modular, and you can increase your system capacity at a later date, for example, when your energy use increases or when funds become available. This is typically harder in a DC coupled arrangement. The ability of your existing battery to be upgraded needs to be confirmed with your installer prior to purchase.

What's the difference between lead-acid, lithium-ion and other types of batteries such as flow batteries?

Lead-acid

Until recently the most common chemistry used for home batteries – especially in off-grid locations – has been the 'flooded' lead-acid battery. It is similar to multiple car batteries strung together to provide more capacity. Their main advantages are proven reliability, safety and fairly low upfront cost. The main disadvantages are bulk and corrosion.

They also require regular maintenance, need to be kept upright to prevent leakage and must be kept in a ventilated environment. There are new variants that overcome some of these requirements, however, these new versions are not as cheap as standard flooded lead-acid batteries.

Lithium-ion

Grid-connected household batteries are increasingly focused on lithium-based chemistries, which have experienced a steady decrease in cost in recent years. Lithium-ion batteries are also widely used in mobile devices such as mobile phones or tablet computers, as well as the growing electric vehicle market.

These batteries are compact and light in comparison to their relative capacity. They can be efficiently charged and have comparatively long lifespans.

Not all lithium-ion batteries are the same. The two main varieties currently being sold are lithium NMC and lithium iron phosphate. NMC batteries have high energy densities but can overheat if discharged too quickly. Lithium iron phosphate batteries are a little larger but are considered safer.

Other Chemistries

The other main chemistry is 'flow' batteries, which use liquids to store energy. Their main advantages are safety, ease of maintenance and the ability to store the charge for long periods. The main disadvantages are greater bulk per capacity compared to lithium-ion as well as being relatively more expensive. The range of flow battery options are currently very limited for the domestic market.

A range of other chemistries is in various stages of development and commercialisation and could become available in the coming years.

Which type is suitable for my solar installation?

Generally speaking, the modern chemistries (e.g. lithium-ion) are more suitable for grid-connected solar systems. This is because of their higher power density, their ability to be more deeply discharged and to discharge the stored energy in a very short time period (e.g. two hours).

Lead-acid remains the favoured chemistry for off-grid systems as these batteries can be discharged over a longer period and cost less per unit of capacity installed. Modern chemistries such as lithium-ion are still generally too expensive for most off-grid systems which require much larger battery banks.

Will a battery ensure I have power during a black-out?

As with standard grid-connected solar systems, standard solar-battery and battery-only systems do not provide back-up power when the grid fails. For reasons of network safety and product capability, solar inverters must shut down when the voltage on the grid falls outside a certain range. This means the vast majority of solar households still experience a loss of power during a black-out.

However, some battery systems do provide back-up power during black-outs. For the same safety reasons, before supplying power the household must be disconnected (islanded) from the electricity grid. This involves the installation and use of an isolation switch as part of the system.

The isolation switch ensures that power does not flow to the grid during a black-out, thereby protecting any linesman who may be working on the local grid. The switch is positioned on the grid side of the solar inverter's connection to the switchboard and allows the system to be used as back-up during an outage.

Should you want a solar-battery system to be used for back-up power, you will need to specifically request this from your solar-battery supplier and pay the additional cost for the switch and its installation.

Do I need approval from the power distributor, (i.e. Ausnet, Powercor) to install a battery?

Your installer will manage the grid connection process for you. The process is often straightforward, although additional time or fees may apply when connecting larger systems.

To connect a solar or solar-battery system to the grid, your installer submits an application to your local electricity distributor. A rooftop solar system always requires application approval from the power distributor.

If you are installing a battery with solar, it will be managed by your installer as part of the same approval process. If a battery is retrofitted to an existing solar system, then a connection application is generally only needed if the total connected inverter capacity changes.

Check the exact requirements with your installer and/or network distributor.

There is always a chance that any electrician working on your house wiring will discover existing deficiencies. For example, the switchboard may be too small to accommodate the new switches required for your battery and may need to be re-wired or upgraded, or the site installation may contain asbestos and be dangerous to work on. Such activities would incur additional costs.

If I disconnect from the grid, will I still have to pay a daily service charge?

There are currently no ongoing fixed or variable (i.e. kWh or kW) charges for households that are disconnected from the grid.

Can I use rooftop solar and batteries to charge my electric car?

In theory, battery electric vehicles can be charged solely from your rooftop solar energy (direct or stored).

However, the battery packs of the current fleet of electric cars in Australia range from around 16kWh to 85kWh and more. This is on top of the electricity used in the house.

As an example, a Nissan Leaf, with 16kWh of energy storage, coupled with a typical Victorian home using 12 kWh per day, would require around 10kW of solar panels to generate the required energy on average throughout the year. If you wanted to completely supply this load in winter, around 30kW of panels would be required, and at least 60kWh of batteries. At current prices, this solar-battery system would be well over $100,000 in price.

Wahgunyah School of Arts, Wahgunyah

How safe are home battery storage systems?

Like most electrical equipment, batteries are generally safe as long as they are installed correctly. Considerations may include;

- Ensuring there is appropriate space around the battery unit;
- Positioning the battery away from any potential hazards;
- Correctly maintaining the battery.

The safety risks associated with actual cell chemistries differ depending on the chemistry. Discuss any potential risks with your installer so they can be mitigated.

Most home batteries can be safely installed outdoors. However, their life spans will be improved by a stable, cool temperature, so try not to locate them in direct sun or in an uninsulated, unshaded metal shed. It's also important to make sure that any enclosure is vermin-proofed, cannot be accessed by children and displays appropriate signs relating to safety, warnings and shutdown procedures.

Do not store heavy household equipment on top of a battery and keep the area clear of obstacles. Don't put flammable objects or those that could conduct electricity in or on the battery enclosure.

Standards Australia is currently working to finalise new standards to support the safe and efficient uptake of new battery technology in Australia. In any event, householders should satisfy themselves of any battery installation's safety by asking sellers and installers about how their products and installation conform to the interim guidelines and any international standards.

Photo courtesy of Solar North East Project

Solar panels and batteries are high value items so it is advisable to include their installation on your home insurance policy and check any insurance clauses and requirements for solar-battery related issues prior to installation.

What about their environmental impact?

Installing a grid-connected battery generally doesn't benefit the environment directly, but does help to develop economies of scale in battery manufacturing and installation.

In specific situations, batteries may have a direct environmental benefit if they assist an oversized solar system, avoid grid infrastructure construction or upgrades, or if they enable an off-grid lifestyle that helps the environment.

Embodied energy

Creating a battery requires quite a lot of input energy. The best current estimate is that manufacturing one kilowatt-hour (kWh) of lithium battery storage uses about 454 kWh of energy. Lead-acid batteries require less energy to create (321 kWh), but typically require more storage than lithium to deliver the same performance.

Recycling

Recycling schemes already exist for lead-acid batteries, so the figures quoted in this document assume some of the materials have come from low-energy recycled products. On the other hand, recycling is not included for solar systems or lithium batteries. Schemes are currently under development for these products.

While the figures quotes ain this document don't allow for energy consumed in the disposal of solar systems, it is expected that by the time a system sold today reaches the end of its life, there will be facilities available to recycle many components. This will reduce the energy consumed to create a new product.

Which batteries are Australian made?

Like most solar panels, very few batteries are manufactured in Australia. However, new products are constantly entering the market so it's worth checking with suppliers as to whether any individual battery is made locally.

How do I find a reputable solar battery retailer and installer?

Check that your solar retailer has Clean Energy Council Approved Solar Retailer accreditation where participants adhere to an industry Code of Conduct. The Code addresses issues of accountability, contractual obligations, sales and marketing practices and warranties.

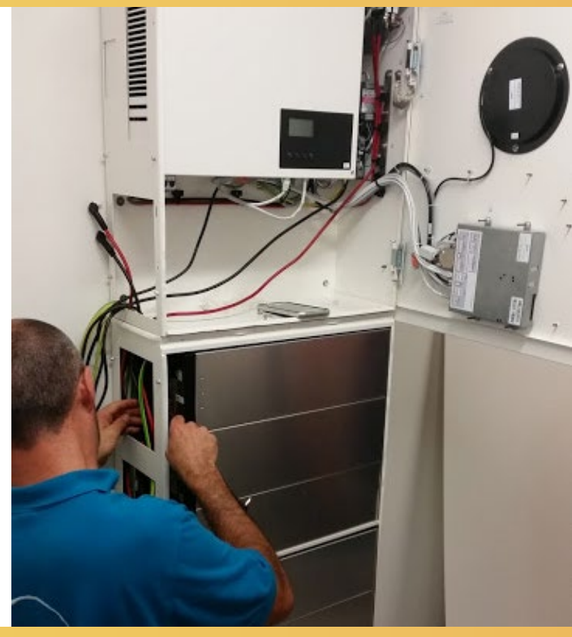
For more details, visit www.solaraccreditation.com.au/retailers/approved-solar-retailers

Also check that the installer/s are Clean Energy Council accredited. Grid-connected or stand-alone power systems with 240-volt wiring have to be installed by suitably qualified and Clean Energy Council accredited renewable energy installers. An accredited installer for a battery installation will hold either grid-connect installation accreditation with a battery endorsement or grid-connect installation accreditation plus stand-alone installation accreditation.

Contact the Clean Energy Council for a list of accredited retailers and installers in your area.

Where can I find more information and advice on installing batteries?

The Clean Energy Council has published a free guide to buying and installing a battery storage system for your home at **www.solaraccreditation.com.au/consumers/purchasing-battery-storage**



Tallangatta Library, Early Years & Community Centre, Tallangatta

Contacts and Further Information

Clean Energy Council:

www.cleanenergycouncil.org.au

Alternative Technology Association:

www.ata.org.au

The NSW Home Solar Battery Guide is a free, online reference for installing solar-battery systems. This comprehensive document was produced by the Alternative Technology Association and Total Environment Centre. Download a copy at **www.resourcesandenergy.nsw.gov.au/energy-consumers/sustainable-energy/home-solar-battery-guide**

Your local Council contacts:

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Photo courtesy Totally Renewable Yackandandah

Tips for Evaluating Battery Quotes

Grid-connected batteries for solar-battery systems are relatively new. None of the currently available products in the market have been around particularly long. When considering purchasing a grid-connected battery, either as part of a solar-battery system or on its own, have regard to the following tips:

- Get at least three quotes of roughly the same system size and functionality. That way you can compare "apples with apples".
- Make sure the installer is Clean Energy Council (CEC) Accredited (for both solar and battery installation) and that the company is a CEC Approved Solar Retailer;
- Given grid-connected batteries are relatively new, have a look on some web-based consumer forums to see feedback about specific products. Useful forums include:
    - Whirlpool: **http://forums.whirlpool.net.au/forum/?action=search**
    - ATA: **http://community.ata.org.au**
    - The Lithium Ion Battery Test Centre compares various chemistries and products available in the Australian market against claims made by manufacturers at **http://batterytestcentre.com.au/**
- Make sure you have thought about your requirements for the system such as;
    - What size do you need? What is this based on? (e.g. optimal economic size, achieving 90% grid independence, etc).
    - Do you want the battery to work as a back-up when the grid goes down?
    - Do you want to be able to charge the battery from the grid? Do you want the system to optimise how much energy to purchase from the grid by predicting tomorrow's solar generation?
    - Do you want to lower your power consumption below a specific threshold (e.g. 5 kilowatts?) This can be handy if you are on a demand tariff.
    - Do you want to be able to sell electricity from the battery back to the grid?
- Where will the battery be installed? Does this comply with the manufacturer's requirements and the appropriate Australian Standards?
- What is the monitoring system? How will you be able to access performance data from the battery? (e.g. smart phone app.) What type of data will be provided?
- Ask the supplier for customer references. Talk to previous customers about the process and how their projects performed?
- Check that the pricing is fixed or over a stated time period (particularly where part of a solar-battery system).
- Does the system require maintenance? If so, who will do this, when and how?
- Are parts readily available? Does the manufacturer have an Australian office?
- What are the performance guarantees and warranties for the system?
    - Are there specific exclusions or operational conditions (e.g. location, temperature range) for the warranty to remain valid?
    - What is the total number of cycles warranted for the battery?
    - How many years does this correspond to at your required cycles (and taking into account depth of discharge)?
    - Which warranties are the installer's responsibility and which are the manufacturers? (Typically the component warranties are the responsibility of the manufacturer, while the installation warranty resides with the installer or Australian supplier.)
    - What is the design life of the battery?
    - Given all batteries reduce in capacity over their lifespans, what will be the useable kWh at/near the end of its life?

Glossary

Alternating current (AC): An electric current in which the flow of electric charge periodically reverses direction.

Ampere-hour (Ah): A unit of electric current over time.

Battery electric vehicles: A vehicle for which an electric motor is the sole source of propulsion.

Battery utilisation: The average daily discharge of the battery (on an annual basis) as a percentage of its useable capacity.

Battery Management System (BMS): Enables each cell in a battery bank to be individually monitored when charging and discharging. Prevents overcharging and discharging below the minimum voltage point.

Battery Charge Controller (BCC): A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against over-voltage, which can reduce battery performance or lifespan, and may pose a safety risk.

Consumption tariff: Any tariff that involves the purchase of electricity by a consumer from the grid (as opposed to a feed-in tariff, where the customer is paid for electricity exported to the grid.) See also flat tariff, demand tariff, time-of-use tariff.

Battery cycles: One cycle involves the discharge and re-charge of a battery to a given depth of discharge. Battery warranties are often based on a specific number of cycles over the lifespan.

Demand tariff: Any tariff that involves the purchase of electricity being charged to a consumer on the basis of their maximum power demand (i.e. in kilowatts or kW) as opposed to their energy consumption (i.e. in kilowatt hours or kWh.).

Depth of discharge (DoD): DoD is a method of indicating a battery's state of charge (SoC). A battery completely discharged would have a 100% DoD. A battery half discharged would have a 50% DoD. Very few batteries are able to be discharged near or to 100% without affecting battery performance and lifespan.

Direct current (DC): An electric current in which the flow of electric charge is only in one direction.

Feed-in tariff: A tariff where a customer with on-site distributed generation (e.g. solar) is paid for electricity exported into the grid.

Flat tariff: A tariff where the customer pays a volumetric charge (i.e. per kilowatt hour) for each unit of electricity consumed (see also consumption tariff, demand tariff, time-of-use tariff).

Inverter: An electronic device that changes direct current (DC) to alternating current (AC).

Kilo-watt (kW): A measure of a unit of power (1,000 watts).

Kilo-watt hour (kWh): A measure of a unit of energy (1,000 watt-hours).

Nominal capacity versus useable capacity: Nominal capacity is the total storage capacity of the battery as designed and manufactured (expressed in kWh).

Useable capacity is the capacity of the battery taking into account its recommended maximum depth of discharge (DoD). This is a discharge limit at which batteries should be set, so as not to impact their performance and lifespan. Useable capacity is the more realistic characteristic for the consumer.

Time-of-Use Tariff (ToU): A tariff involving different volumetric (i.e. kilowatt hour) charges at different time intervals (see also consumption tariff, flat tariff, demand tariff).