NSW GOVERNMENT

NSW Home Solar Battery Guide

2020

Foreword

The Hon. Matt Kean MP
Minister for Energy and Environment

I'm pleased to release this updated NSW Home Solar Battery Guide, an important tool that helps our NSW Electricity Strategy to deliver better outcomes for energy consumers.

Rooftop solar panels are more affordable than ever and the people of NSW are capitalising on this clean energy opportunity. Around 500,000 households are already harnessing the power of the sun.

Battery storage allows people to bank their solar supply and use it any time—day or night. While batteries may not be suitable for everyone, people with rooftop solar should consider whether storage works for them.

The Australian Energy Market Operator anticipates more than 1,000 megawatts of batteries will be installed in NSW by 2035. This is partly due to progress in battery efficiency and affordability.

This guide seeks to help consumers answer two questions:

- Will battery storage save me money?
- How do I choose the right battery system?

The guide provides general advice and every care has been taken to provide accurate and up to date information about the rapidly evolving battery market. You should seek expert advice to decide what option is right for you.

NSW has an objective of net zero greenhouse gas emissions by 2050 and the actions of individual households and consumers will be crucial to helping meet this target. The NSW government aims to accelerate the transition to emerging clean energy sources. Part of that is empowering you to access clean energy in the best ways possible. This **NSW Home Solar Battery Guide** shows you how.

Contributors

The NSW Home Solar Battery Guide was originally published in 2017 with advice from the Total Environment Centre, in collaboration with then Alternative Technology Association (now Renew) and Zumio. This updated edition was developed with advice from ITP Renewables in consultation with industry stakeholders. The Department appreciates the valuable input provided by industry and other stakeholders in the development of this guide.

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Section 1

Your home solar battery guide

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The changing energy market

Australia's energy system is going through a transformation. More than 500,000 households in NSW have already installed rooftop solar systems, with many more expected to follow in coming years.

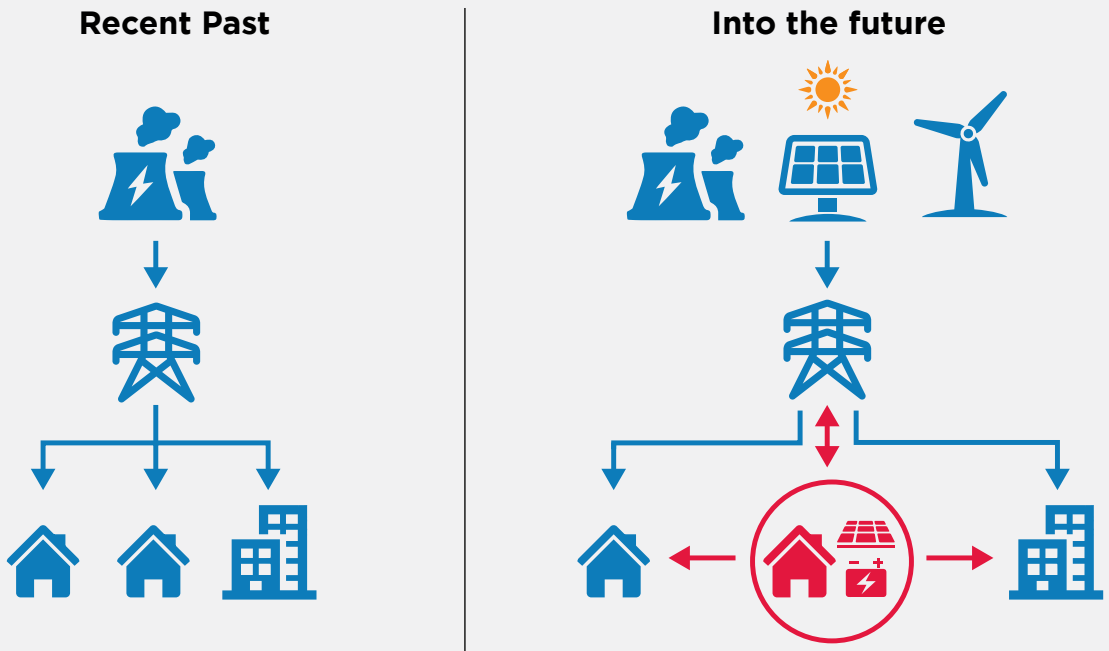
Home solar battery systems can store solar energy generated during the day and make it available when the sun isn't shining—potentially saving the household money. They deliver a clean, secure and reliable energy supply.

Battery storage systems for households are not new. For decades people have used them to support their use of the grid or to operate offgrid if they are in remote locations. These systems mainly relied on lead acid batteries. They were individually designed and often involved significant installation time and cost.

Increased demand and improvements in battery storage technologies, including lithium-ion, mean that today's systems can store much greater amounts of energy in a smaller volume and have an increased lifespan. While lithium-ion batteries are the market leading technology, there are other types available, and there are even variants within the lithium-ion family. Most importantly, their cost is rapidly reducing, making them more financially viable.

Home solar batteries are also an important link in the transformation of the grid. The old centralised model featuring the one-way flow of electricity from big generators to consumers is changing into a new model featuring two-way flows between 'prosumers' (producer-consumers) and the grid (see Figure 1 below). They can help reduce the need for expensive peaking generators when electricity demand is high.

Figure 1. The changing energy market[1]



In the old system energy flowed in one direction.

Energy flows in two directions, and the customer is at the centre of the energy flow.

What this guide covers

Battery storage systems are a substantial investment, so it is important to understand what value they provide and if you would benefit from one. Keep in mind that there are alternative options available to save energy and money. This guide will help you understand the below points when considering a home solar battery.

In many NSW locations and households a new solar battery system can pay for itself within the typical 10-year warranty period. However, most of these savings will usually come from the solar PV rather than the battery. Batteries are expected to provide greater value as battery costs reduce and tariffs change. Also they provide opportunities for households to generate additional revenue from their system through energy services such as virtual power plants.

Is getting a battery a good idea?

- Your motivations for considering a battery will help establish whether you would benefit from one.
- Understanding how and when your household uses electricity will help you decide whether a battery is right for you.
- There are a range of alternatives available to you, and depending on your circumstances, they may offer better value for money than a battery.

When do batteries make financial sense?

Individual circumstances, such as how much electricity you use in your home and when you use it, will determine whether a battery makes financial sense for you. Accredited suppliers can help you make this financial assessment.

- In most NSW locations and household types, a new solar battery system is expected to pay for itself within the typical 10 year warranty period.
- In most situations, retrofitted batteries will not yet pay for themselves within 10 years, but this may change as battery costs reduce, tariffs change and other benefits develop such as virtual power plants.
- Batteries can also have practical, non-financial benefits such as powering your home in a power outage or supporting the grid by exporting energy at peak times.
- Going offgrid only makes financial sense in a few select circumstances.

What are the critical things you need to know when buying a battery?

- Quality—choose a quality product and an accessible and licensed installer with a good reputation.
- Size—choosing an appropriately sized battery for your needs is critical to get the best economic return. The payback for smaller batteries, when purchased with a new solar system, is typically shorter than for large batteries (see page 34).
- Software—the energy management system is key to making the whole system work (see page 22).

Who is this guide for?

The NSW Home Solar Battery Guide helps households make informed decisions when considering buying and owning a battery system.

The guide will explore a range of topics including:

- installing new rooftop solar together with a battery
- adding a battery to an existing rooftop solar system
- installing a battery without solar
- using a battery to disconnect from the grid.

This guide is designed for home owners, and is not intended for business owners or tenants. It outlines things you may wish to consider when making financial decisions. However, the guide does not provide financial advice.

The guide does not cover going offgrid in detail because in most cases this is not a financially viable option.

The technical information and financial analysis in the guide are based on extensive modelling undertaken by ITP Renewables, using current information as at January 2020.

Extra resources

The NSW Home Solar Battery Guide page on the Energy Saver website provides extra resources, fact sheets and practical examples to further support the information in this guide.

energysaver.nsw.gov.au/solar-battery-systems

How to use this guide

Whether battery storage is right for you, and which kind, depends on what you want it to achieve. Your motivations will also affect how you navigate this guide and supporting material on the website. Refer to the below motivations and practical examples relevant to you when considering a home solar battery system.

Cut energy bills

'I want to save money by reducing the amount of power I import from the grid.'

With energy bills having risen significantly in recent years, it makes sense to look at ways to reduce costs. While a battery may reduce your bills, it does not mean that it will pay for itself within the warranty period.

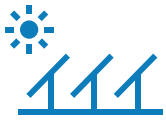
Guide focus areas

Understanding your energy use (page 12)

Easy things to do first (page 18)

Planning for a battery (page 32)

Will a battery save me money? (page 40)



Become more self-sufficient

'I want to have more control over my power supply.'

Many people want to buy a battery as insurance against potential future energy price rises. You may also wish to rely less on your electricity retailer or network.

Guide focus areas

Easy things to do first (page 18)

Planning for a battery (page 32)

Should I go offgrid? (page 36)

Access renewable energy

'I am concerned about climate change and want to support renewable energy.'

Any solar energy you generate will reduce emissions from fossil fuelled generation, whether you use it yourself or export it to the grid. Adding a battery may not necessarily further reduce emissions.

Guide focus areas

Easy things to do first (page 18)

How green is that battery (page 30)

Sell excess electricity

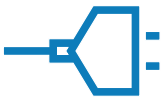
'I want to sell energy back to the grid.'

With a battery you may be able to earn money by exporting energy to the grid during peak periods.

Guide focus areas

Will a battery save me money? (page 40)

Managing your battery (page 53)



Power outage backup

'I want backup power in case of power outages.'

Most parts of the network in NSW have been very reliable over a long period. Not all batteries can operate independently if the network goes down.

Guide focus areas

Battery sizing (page 34)

Will a battery save me money? (page 40)

Should I go offgrid? (page 36)

Preferred choice

'I just want one!'

As an early adopter or a tech enthusiast, we recommend researching a range of topics from battery basics to designing and buying your home solar battery so you're informed of the potential considerations.

Guide focus areas

Battery basics (page 24)

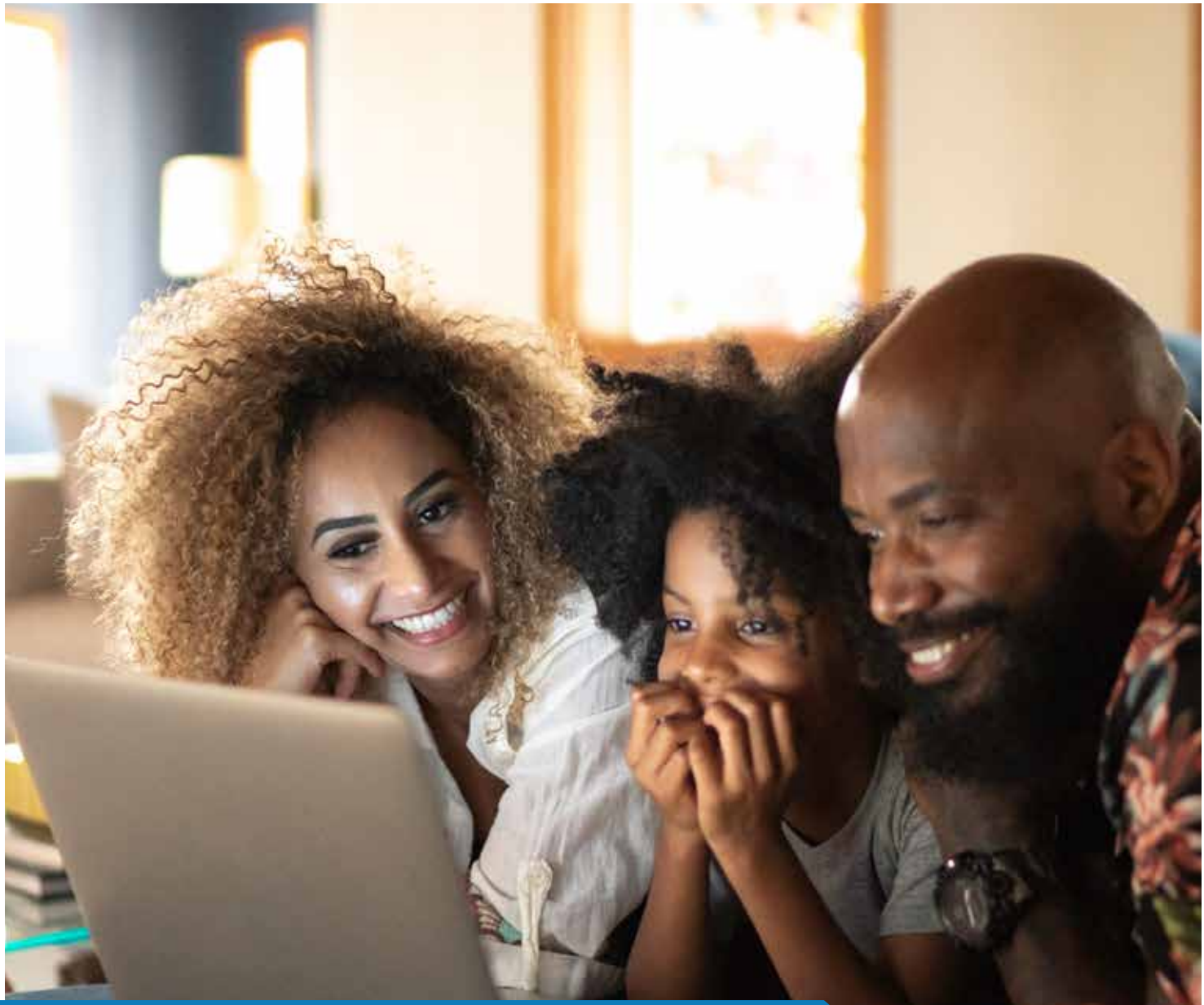
Planning for a battery (page 32)

Buying a solar battery (page 46)

Practical examples

The NSW Home Solar Battery Guide page on the Energy Saver website provides practical examples to help demonstrate how households, with varying scenarios, decide on the best solution for them.

energysaver.nsw.gov.au/solar-battery-systems



Section 2

Understanding your energy use

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Household energy use

When considering a battery, it is important to understand how much energy you use in your home and when you use it.

To correctly size and design your battery storage system, you need to understand how you are already using energy in your home.

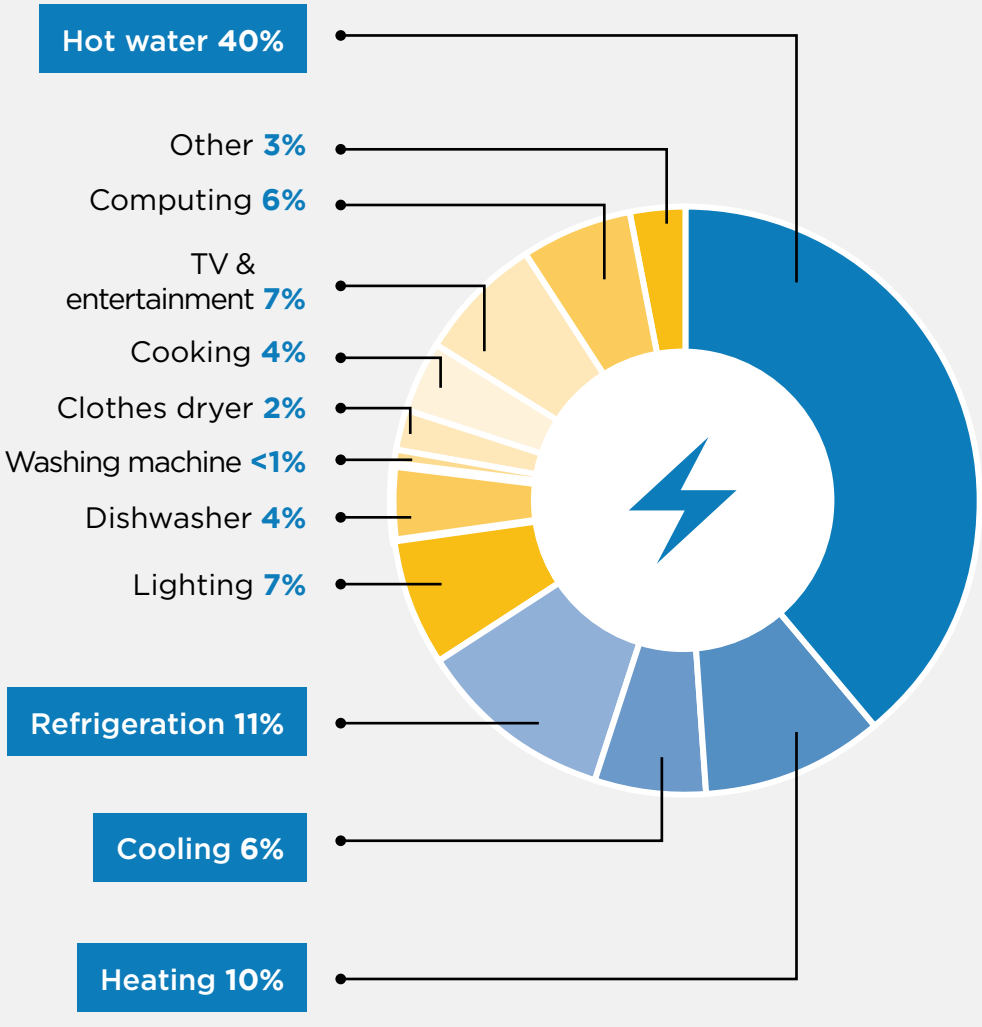
This is useful for two reasons:

1. to avoid using power when it is most expensive
2. to find the right battery size by knowing how much excess solar you have and when you use power.

The appliances using the most energy in average NSW homes are hot water systems, fridges and heating and cooling systems (see Figure 2 below). Most homes use the highest amount of energy in the early morning as well as late afternoon and evening (see Figure 3 on page 14).

This means households are not always using energy during daylight hours, when the solar panels are producing electricity.

Figure 2: Typical energy consumption for an average household in NSW[2]



Measuring energy

There are two units to measure energy. One is the power used at a given moment in kilowatts (kW), the other is the total energy used or produced in kilowatt hours (kWh). If your solar produces 5 kW of power for 4 hours, then the total energy produced is 20 kWh.

It works the same way for consumption. If your air conditioner uses 1.5 kW of power and you leave it on for 13 hours, it will have consumed about 20 kWh (1.5 kW multiplied by 13 hours) as shown in Figure 4 below.

Figure 3. Typical household energy usage pattern

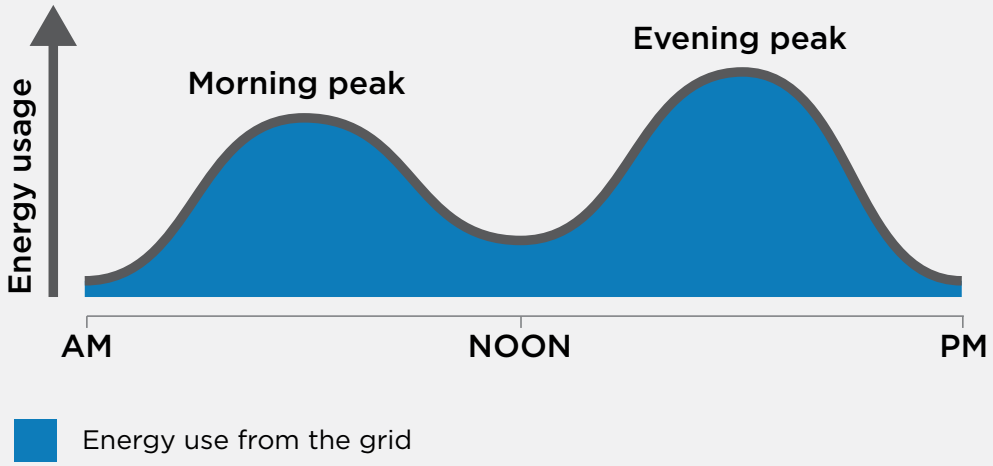
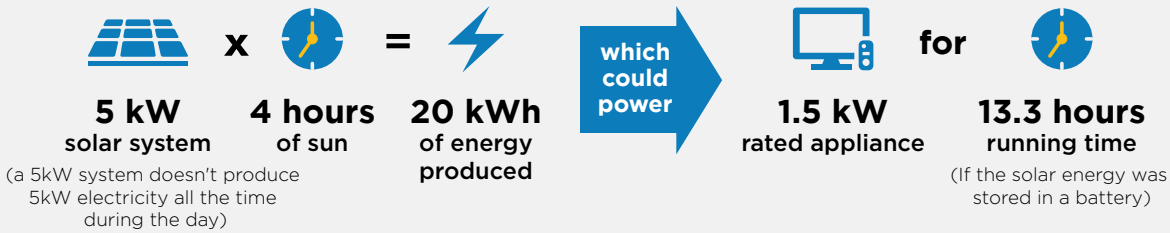


Figure 4. Guide for calculating usable power from solar power generation

The below figure provides a guide for calculating usable power from solar generation, based on an equivalent of 4 hours of sun and a 90% round-trip efficiency of the battery.



Find and understand your energy information

Before purchasing a battery, it is important to understand your energy consumption and energy costs, as well as alternative ways to use less energy.

There are several sources of information to help understand how you are currently using energy. These include:

Electricity bills

Compare your daily average consumption for each billing period. This will indicate whether your consumption is increasing or decreasing and will show you how your energy usage varies across different seasons. If your bill is based on estimated usage, ask your retailer for accurate values.

Read the 'Tariffs' box on the following page for more information about what makes up your bill.

Meter data

Data may be accessible via your meter depending on the kind of meter you have. Older meters are only read periodically, while newer meters generally provide more detail, for example half-hourly grid import and export data.

From December 2017, all new solar systems and new connections would be connected to 'smart' meters that send information about your energy usage back to the grid.

Your energy retailer and network provider keep smart meter data and are required to provide it to you within 10 business days upon request. More conveniently, many energy retailers now have online portals where you can log in and access your usage data.

Solar inverters

If you already have a solar system, a solar inverter collects data about energy generated by your solar panels and most display certain data on a small screen.

Many inverters are able to upload data in real time to an online web portal or smartphone app where you can access your usage data.

In-home displays

You can receive detailed data from in-home displays. Simple displays show data about one appliance, while more sophisticated ones are WiFi connected and can tell you how the whole home is performing on your smart device or computer.

Tariffs

A tariff is the rate you pay for grid electricity. It is usually composed of a fixed daily charge (in cents per day) and a usage charge (in cents per kWh). The usage charge can vary at different times of the day, days of the week or months or seasons of the year.

Most households in NSW are currently on flat (or nearly flat) tariffs. That is, you pay the same amount for electricity all day and night, plus the fixed daily charge.

Many solar and some other households are on a time of use tariff. This tariff charges more for peak periods and less for shoulder and offpeak periods (see Figure 5 below).

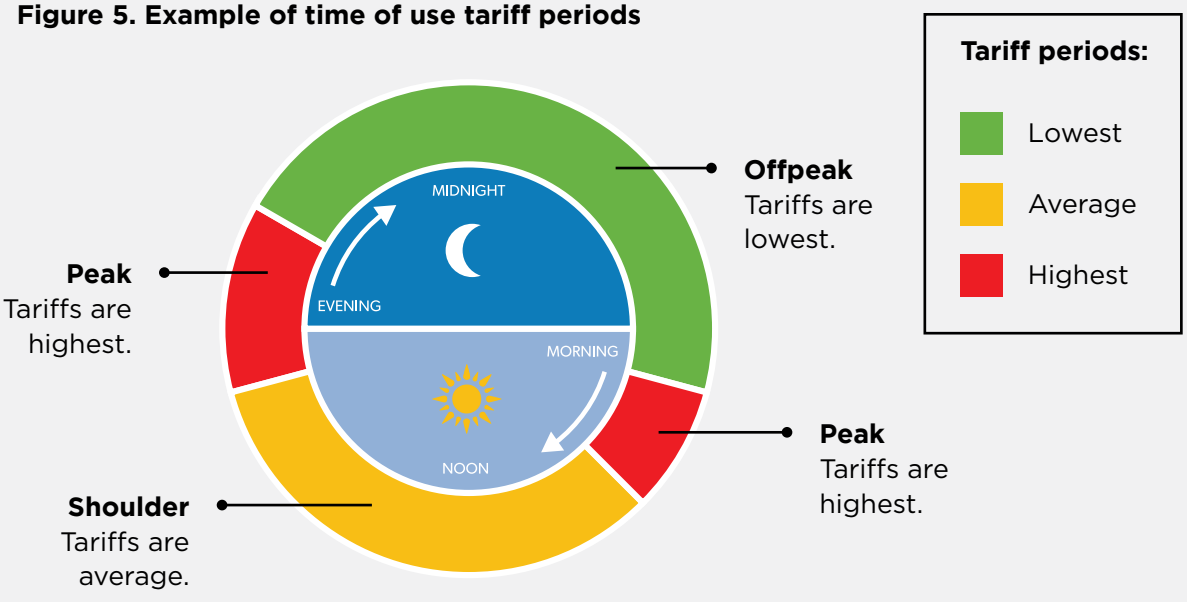
Retailers also offer demand-based tariffs to customers with a smart meter. This tariff structure includes a demand charge which is based on maximum power demand the customer puts on the network at any one time. Demand-based tariffs encourage customers to spread their electricity usage over time rather than all at once. To benefit from demand-based tariffs, you need to be vigilant in monitoring power usage to avoid spikes in demand.

From July 2019, retailers are required to make a default market offer to households to ensure that annual prices are capped, and price offers can be compared across different providers. The default market offer is set by the Australian Energy Regulator each year for each electricity distribution zone based on average usage.

In the future, more households may be encouraged to move to time of use and other new tariffs which better reflect the pressure on the network during peak periods.

A controlled load tariff refers to a separate tariff and meter with lower charges. This tariff can only be applied overnight by using special appliances such as hot water systems, some pool pumps and slab floor heating. Currently, home battery charging on controlled load tariffs is not available so if you charge your battery from the network it would be on a different tariff.

Figure 5. Example of time of use tariff periods



Easy things to do first

If you are mainly interested in a battery to save money on electricity bills, there are some simple steps you can follow to take control of your energy use and save money, even without a battery. In terms of value for money, there is a simple hierarchy.

1. Shop around for the best price

Competitive pricing and discounts

Find the most competitively priced retailer to help you save money each year and ask for discounts for direct debit or on-time payments. You should make sure you are on the most appropriate type of retail tariff to suit your needs. Visit energyswitch.service.nsw.gov.au to help find the most competitive offer.

2. Reduce your household consumption

Use less energy

Replace old light bulbs with LEDs, switch off appliances and lights when not in use, use less hot water, have shorter showers and wash clothes in cold water.

Upgrade your home insulation

Good building insulation including ceiling batts, gap sealing and window shading, may have a shorter payback period than either solar or batteries.

Purchase energy efficient appliances

Energy efficient appliances, with at least four stars on their Energy Rating label[3], may cost less over the life of the product, despite a higher upfront cost.

3. Make the most use of your existing solar energy

Change your habits

If you have existing solar, run appliances such as dishwashers and washing machines when there is sunlight. If your house is well insulated, pre-heat your house (in winter) or pre-cool your house (in summer) while your solar system is producing energy to reduce evening consumption from the grid.

Engage an expert

Arrange an electrician to rewire your hot water tank so it uses your own solar panels and when replacing an existing gas or electric storage hot water system, consider replacing with a heat pump hot water system.

4. Increase your rooftop solar power

Add more solar panels

Install a rooftop solar system or add more panels to your existing system to cover more of your consumption.

5. Installing a household battery

Is a battery the right solution?

If you have explored all of the tips mentioned, only then consider installing a household battery.

Additional tips

For more tips on how to fine-tune the energy used in your home and save money on your power bills visit:

energysaver.nsw.gov.au/households/fine-tune-your-home

Three easy alternatives to batteries

1 Heat pumps powered from solar

Heat pumps work like air conditioners in reverse, extracting heat from the atmosphere and using it to heat the water in the tank.

If you set the timer to run when the sun is shining, it's a win–win outcome for renewable energy and low bills.

Modern heat pumps are highly efficient, producing up to five times the energy required to run them. You have to pay for the cost of the heat pump unit, but it should save money in the long run.

2 Solar electric hot water

If you have an existing electric storage hot water system you can heat it directly (or as a priority) with electricity from your rooftop solar.

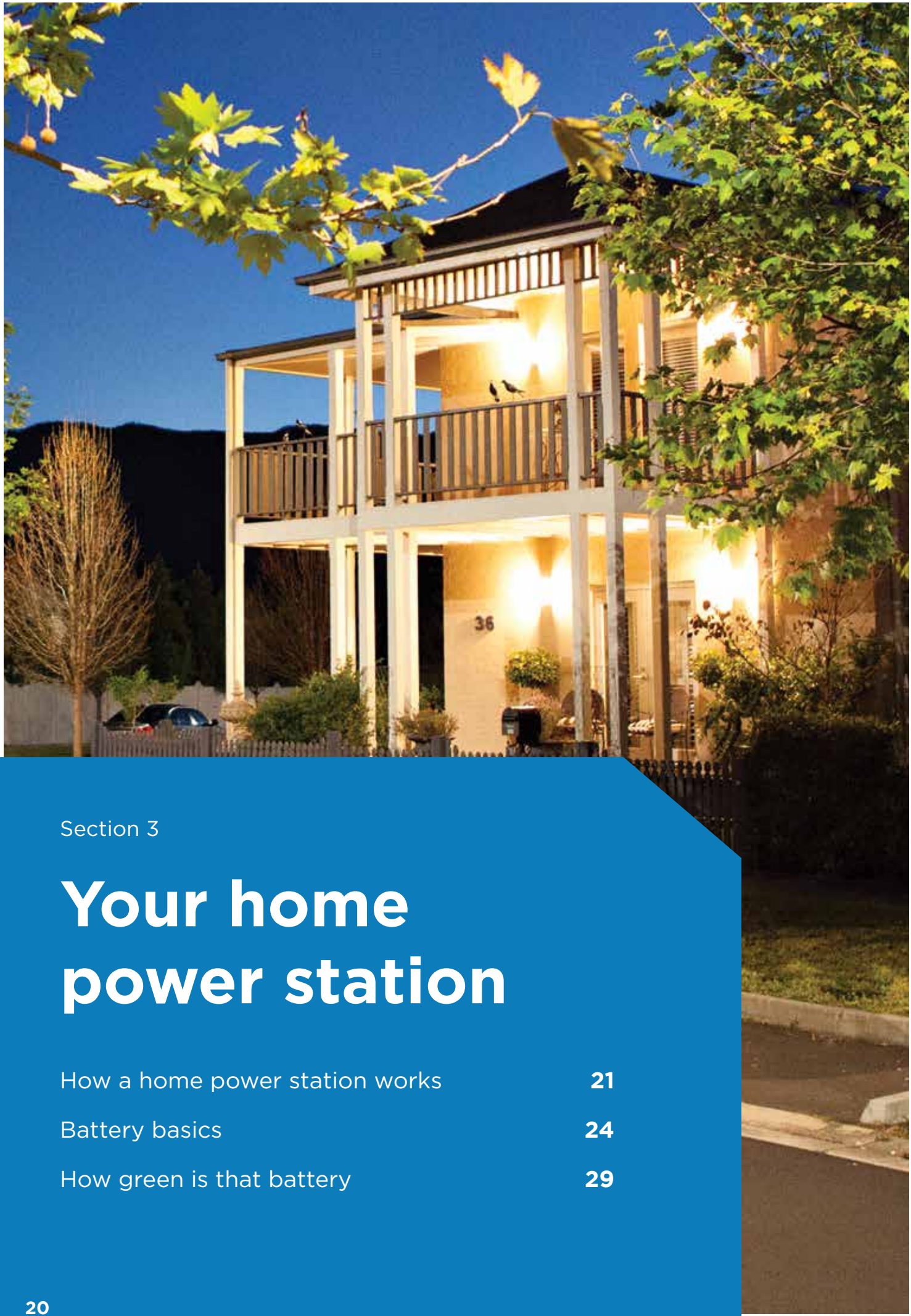
Doing this instead of using grid electricity could save around $300 per year (on a flat tariff). About half of the electricity for your hot water system would then come from your solar system, with the rest coming from the grid.

Using excess solar energy for hot water heating may be more cost effective than battery charging, however you may need to make changes to how the hot water heater is set up, particularly if it is already on a controlled load. A smart hot water heater may also be required.

3 Adding solar for early morning and evening

Adding more solar panels to an existing system or installing a larger new solar system may have a shorter payback period than buying a battery. This can be especially beneficial where the new panels' setup helps produce energy later in the afternoon or in the early morning.

You will need to receive professional advice about whether you can add more panels to your existing solar system or will need to install a whole new system, and whether this is beneficial to match your existing or planned energy consumption.



Section 3

Your home power station

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How a home power station works

A home solar battery system is a mini power station that produces and stores solar energy to provide power to your home and allow greater energy independence.

Solar panels on your roof generate energy while the sun is shining, and this is used in your home during the day. The unused solar electricity is stored in an energy storage device installed in your home (the battery). This battery can help power your home when the panels aren't producing electricity, such as during the evening, when grid electricity is usually most expensive, or on overcast days.

Any solar energy not used in your home or stored in your battery is exported to the grid. Without a battery, exports can represent a large share of the electricity generated from a rooftop solar system, especially for households which are not at home during the day.

Solar feed-in tariffs

If you have a solar system, any energy you export usually earns a feed-in tariff from your electricity retailer. In NSW, the Independent Pricing and Regulatory Tribunal has recommended voluntary feed-in tariffs in the range of 6 to 7.3 cents per kWh for 2020–2021.

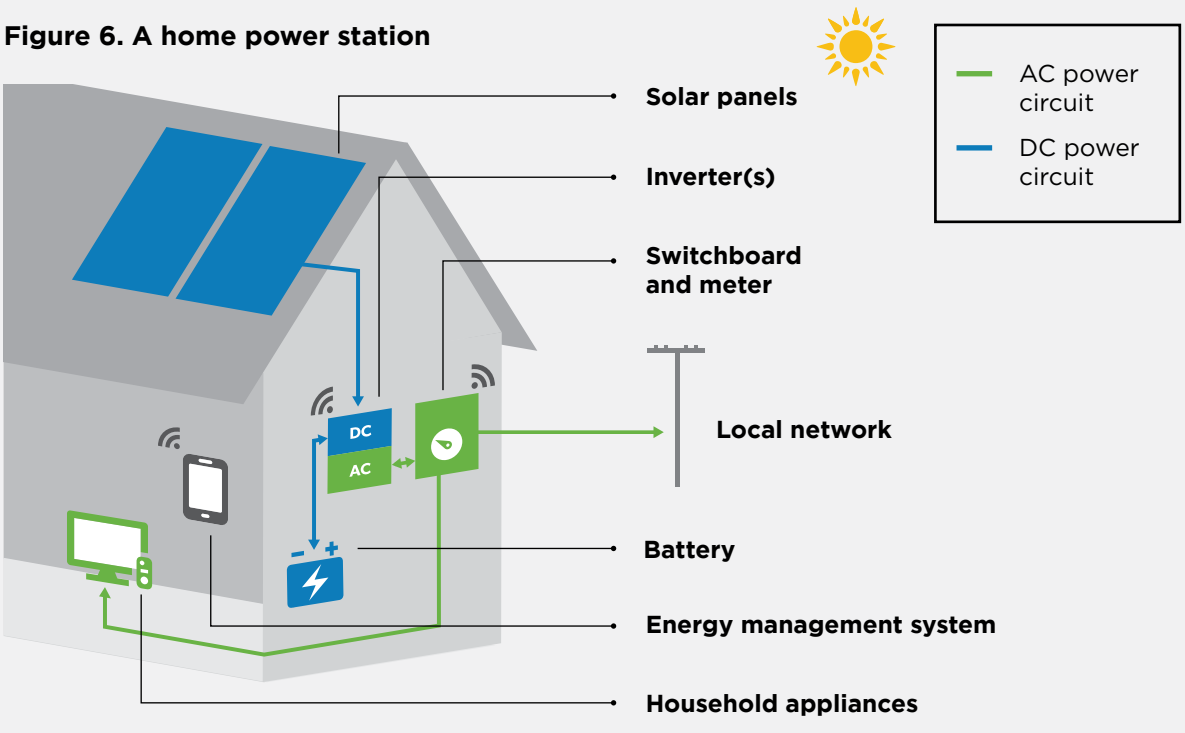
Using power from the grid generally costs more than that, so it makes sense for you to use as much of your own rooftop solar energy as possible, rather than exporting it to the grid.

How a home solar battery works

When you add a battery to a rooftop solar system (or install them together), the solar energy not used at home during the day is used to charge the battery. Figure 6 illustrates the setup of a home solar battery system. Figure 7 on page 23 shows the typical daily energy consumption for a NSW household without solar, with solar and with solar and batteries.

Some batteries can also be charged from grid electricity, for example during offpeak times on a time of use tariff when electricity is cheaper than during the day. Installing a battery will slightly increase total household energy usage as a battery consumes electricity in the process of storing it for later use.

Figure 6. A home power station



Solar panels

Solar panels convert sunlight into direct current (DC) electricity. Some batteries charge directly with DC electricity, while others need to be connected after the inverter.

Because they have no moving parts, good quality solar panels are usually reliable and can last up to 25 years without a significant loss of output.

Inverters

Inverters manage the flow of electricity, converting the electricity generated from the solar panels or stored in the battery into alternating current (AC), the type of electricity that powers your home.

It is beneficial to purchase a good quality inverter for higher efficiency and because their typical lifespan is around 10–15 years. Ambient temperature, unstable grid voltage, dust, heat, ventilation and vermin such as ants can affect the lifespan of the inverter.

There are two main types of inverters used in residential systems:

- **Stand alone inverters:** do not connect to the grid and are used in offgrid homes where there is no grid connection.
- **Grid-connected (or grid-tie) inverters:** these inverters may be solar only, battery-only or hybrid. A hybrid grid-connected inverter can change both solar and battery current from DC to AC. Some grid-connected inverters can also run independently from the grid during power outages, if they are designed for that. Inverters with this backup function are usually more expensive.

Energy management system

An energy management system (EMS) controls the different components of your home power station, including your battery. The EMS is usually software and/or an energy management device.

They are not the same as battery management systems (BMS). The BMS controls the internal safety of a battery while the EMS helps to integrate it with the other components of a home power station.

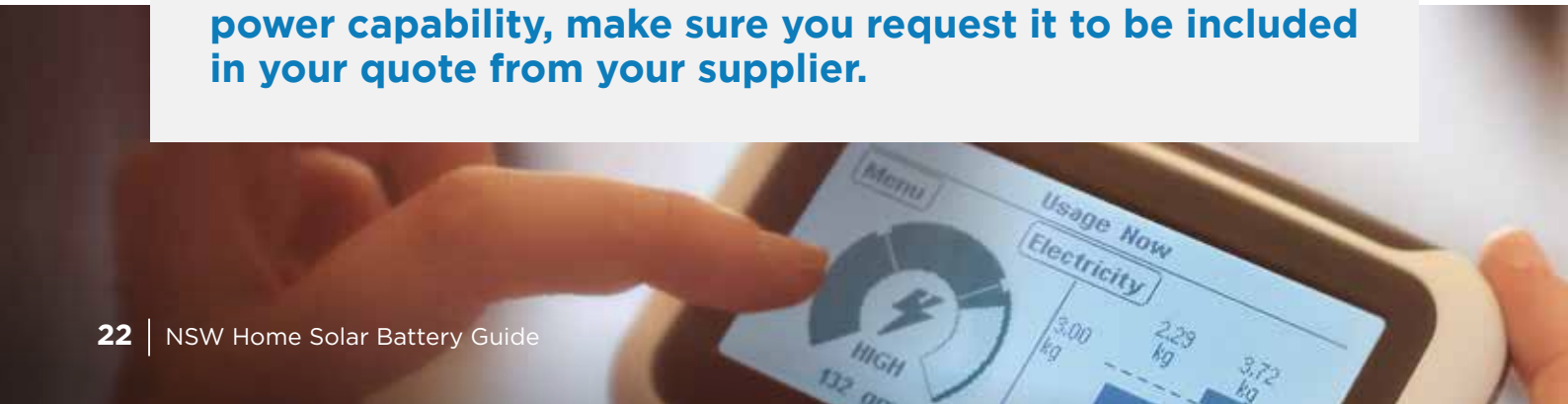
The EMS will decide when to:

- charge the battery from the solar system
- charge the battery from grid electricity
- discharge the battery to power home appliances
- export to the grid.

Some batteries come with an integrated EMS. If they don't, it is important to know how this functionality can be provided separately so you can achieve the best use of your battery. In general, brands offering an integrated system (solar, batteries, inverters and software) are likely to work better together, although you may pay more.

Some EMS may also enable intelligent battery control where both energy demand and generation are predicted and used to optimise electricity usage and costs. In some cases, a separate energy management device may be required to participate in a virtual power plant (VPP). See page 39 for more information.

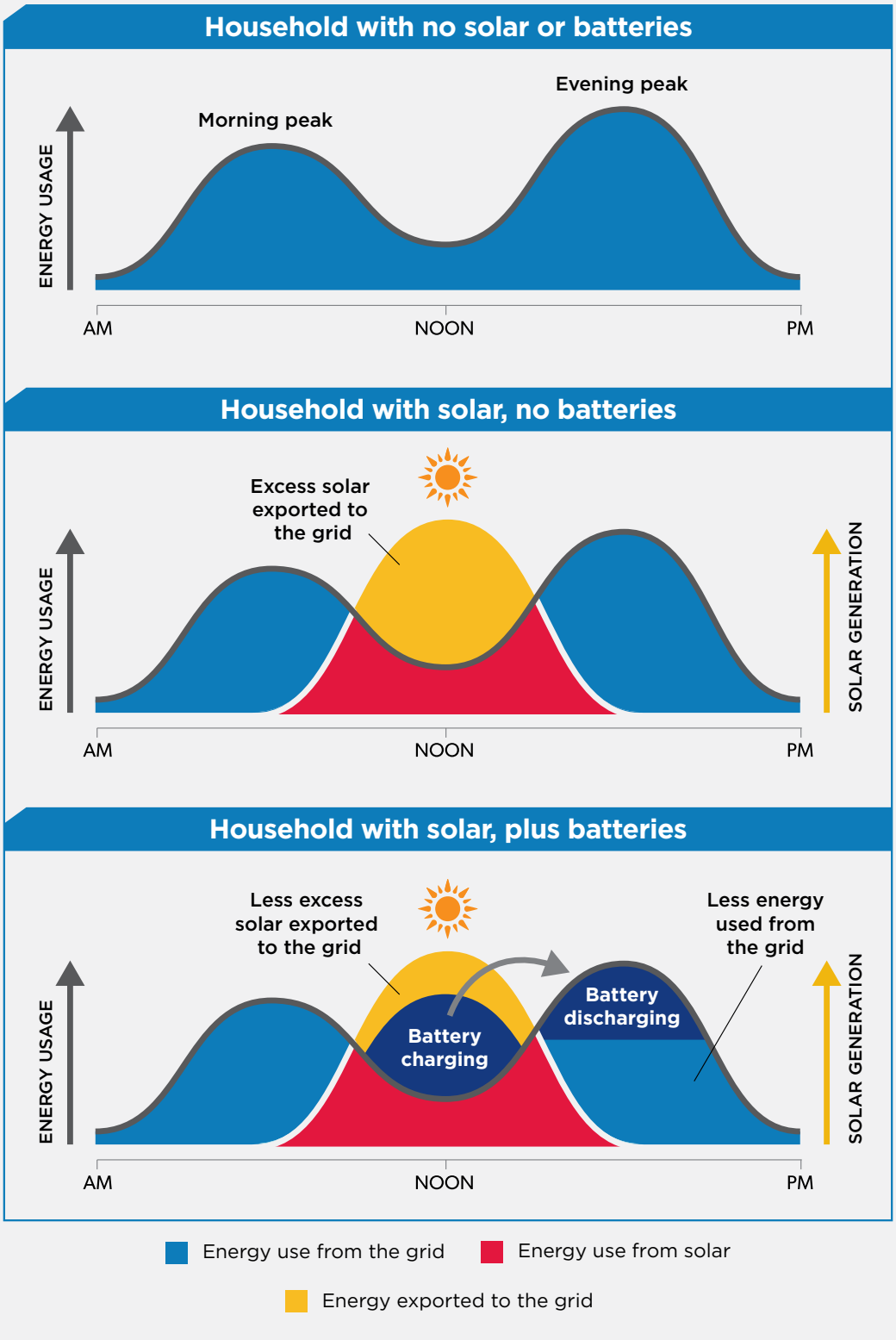
Most inverters currently being installed don't provide backup during a power outage. If you need backup power capability, make sure you request it to be included in your quote from your supplier.



How solar power and a battery affect your home energy

How solar power and a battery affect your home energy is demonstrated in Figure 7 below. This figure compares energy usage of a household with no solar or batteries, to a household with solar only and with both solar and battery.

Figure 7. How solar power and a battery affect your home energy



Battery basics

Before purchasing a battery, you should check with your supplier for any information about the battery that can affect how it should be used and what is covered in the warranty. This section details a few basic things you should be aware of.

Put simply, a battery is a box of chemicals. One type of chemical reaction stores energy (the charging cycle), while the reverse reaction produces energy (the discharging cycle). Different battery chemistries have different properties that affect how they perform.

The following information provides an introduction into the most important technical specifications you need to understand when considering buying a battery.

Chemistries

There are a range of chemistries currently available in the market.

- **Lithium-ion:** Network-connected household batteries are increasingly focused on lithium-based chemistries, which have seen 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.

  These batteries are small and light in comparison to their capacity. They can be efficiently charged and have relatively long lifespans.

  There are many variants within the lithium-ion family, the two main varieties currently being sold are lithium NMC (nickel manganese cobalt) and LFP (lithium ferrous phosphate).

  Lithium-ion technology generally displays high energy density (more energy stored in less space), high cycle life (lifespan) and excellent charge acceptance (allowing faster charging). Within the lithium-ion family, LFP technology is generally considered safer than NMC owing to better thermal stability, but overall quality is the key factor for battery safety.

- **Lead-acid:** Offgrid solar systems have until most recently used lead-acid batteries for solar storage. Lead-acid batteries are relatively simple, reliable, and have a low upfront cost. However, they are less suited for solar storage applications as they must be fully charged regularly, are slow to charge, are quite heavy, and have relatively low cycle life. They also require regular maintenance and must be kept in a ventilated environment.

- **Other technologies:** 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 lower energy density compared to lithium-ion as well as being relatively more expensive.

  Other chemistries such as advanced lead-acid batteries are in various stages of development and could increase their market share in future.

Lifespan and warranty

You want your battery to last as long as the warranty and hopefully well beyond it. A battery's lifespan will be influenced by several factors including the charge or discharge rate, the depth of discharge (DoD) employed in its everyday operation and the temperatures the battery is exposed to.

Some battery manufacturers' warranties are for a specific time period (e.g. 10 years), but there are other warranty types. These include for a specific number of cycles, where charging and then discharging the battery makes up one cycle, and energy throughput, which relates to a total amount of energy that is stored and delivered, across the battery's life.

Most lithium-ion battery warranties take the form of 'this battery is warranted to retain a percentage of its storage capacity after a certain number of years or cycles, whichever comes first'.

Some warranties may limit battery use to a number of cycle/s per day. In either case, the definition of a cycle is not always clear, but should be understood when comparing products.

Key factors that can void the warranty include excessive charge or discharge rates, exposure to high temperatures, and over-charge or discharge.

Useable capacity

This is the amount of a battery's total or rated capacity that is available for regular use without overly affecting its lifespan.

For example, a battery may have a rated capacity of 12 kWh, but its recommended useable capacity is only 10 kWh. If information is not available, you should assume that around 10% of the total capacity should not be used on a regular basis. This needs to be considered when comparing batteries.

It is important that you understand your warranty. To avoid uncertainty make sure the supplier has explained it to you in detail.

Depth of discharge

The depth of discharge is the recommended maximum discharge level of a battery. Some battery chemistries can handle being fully discharged on a regular basis; others can't and will degrade quickly if fully drained often. Generally, lithium-ion batteries of either main type (NMC and LFP) may be discharged to a relatively low level. Rough estimates for the recommended discharge level for lead acid, lithium-ion and flow batteries are shown in Figure 8 below. This should be considered when designing a system.

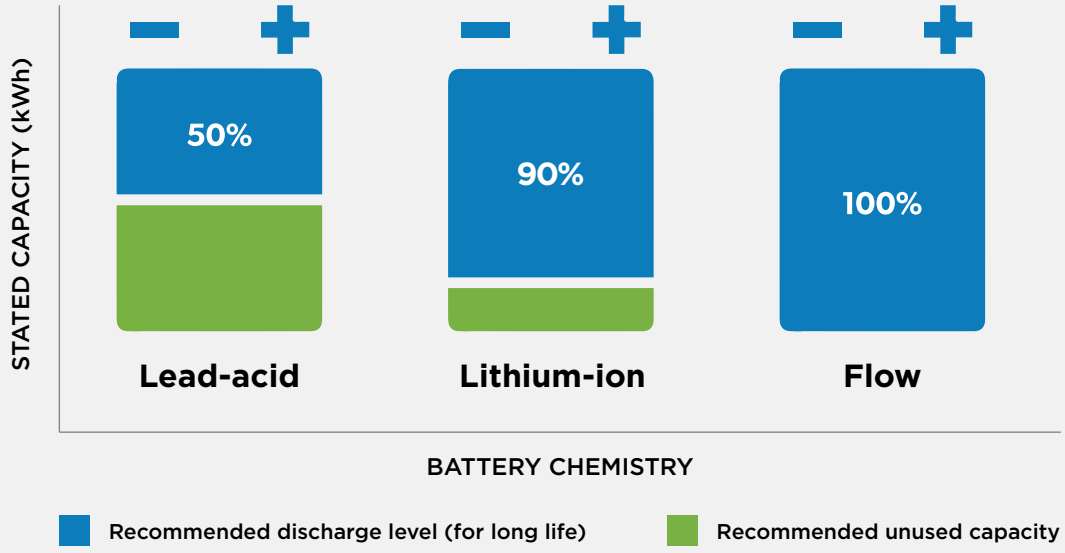
Charge and discharge rates

The maximum charge and discharge rates are the most power you can feed into a battery at once, or the most power you can get out of a battery at once. It is usually given in kilowatts (kW). Battery providers generally include it in the product specifications. The higher this rate, the more maximum power at once that can be accepted (charging the battery) or delivered (discharging the battery).

For example, a battery with a maximum discharge rate of 2 kW should be able to power appliances that use up to 2 kW of power at any one time, such as a fridge, computer, TV and some lights. However, it may not have enough power if the air-conditioning, electric stove or microwave are also running at the same time.

Most batteries have energy losses in the charging process; this is the roundtrip efficiency of the battery. For example, a 10kWh battery with a roundtrip efficiency of 90% will provide 9kWh of usable energy.

Figure 8. Recommended depth of discharge levels for different battery types



* Some lithium-ion manufacturers allow 100% discharge.

Most batteries are more efficient if you don't charge or discharge at the maximum rate. The energy management system may allow you to control these rates. This is an important consideration for households that wish to use a lot of energy at once.

For instance, a battery with a usable capacity of 10 kWh may have a maximum discharge rate of 5 kW. If discharged at 2 kW power, it can deliver the full 10 kWh of energy. But if discharged at 5 kW power for a short time it may only deliver a total of 9 kWh of energy. This is due to wiring and heat losses being higher at the maximum rate.

Choosing a lead-acid, lithium or other chemistry affects how much of the total capacity can be used.


Brown Residence
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10.7
14.8
716 Wh
ENPHASE
ENPHASE

Coupling—should batteries share the inverter with solar?

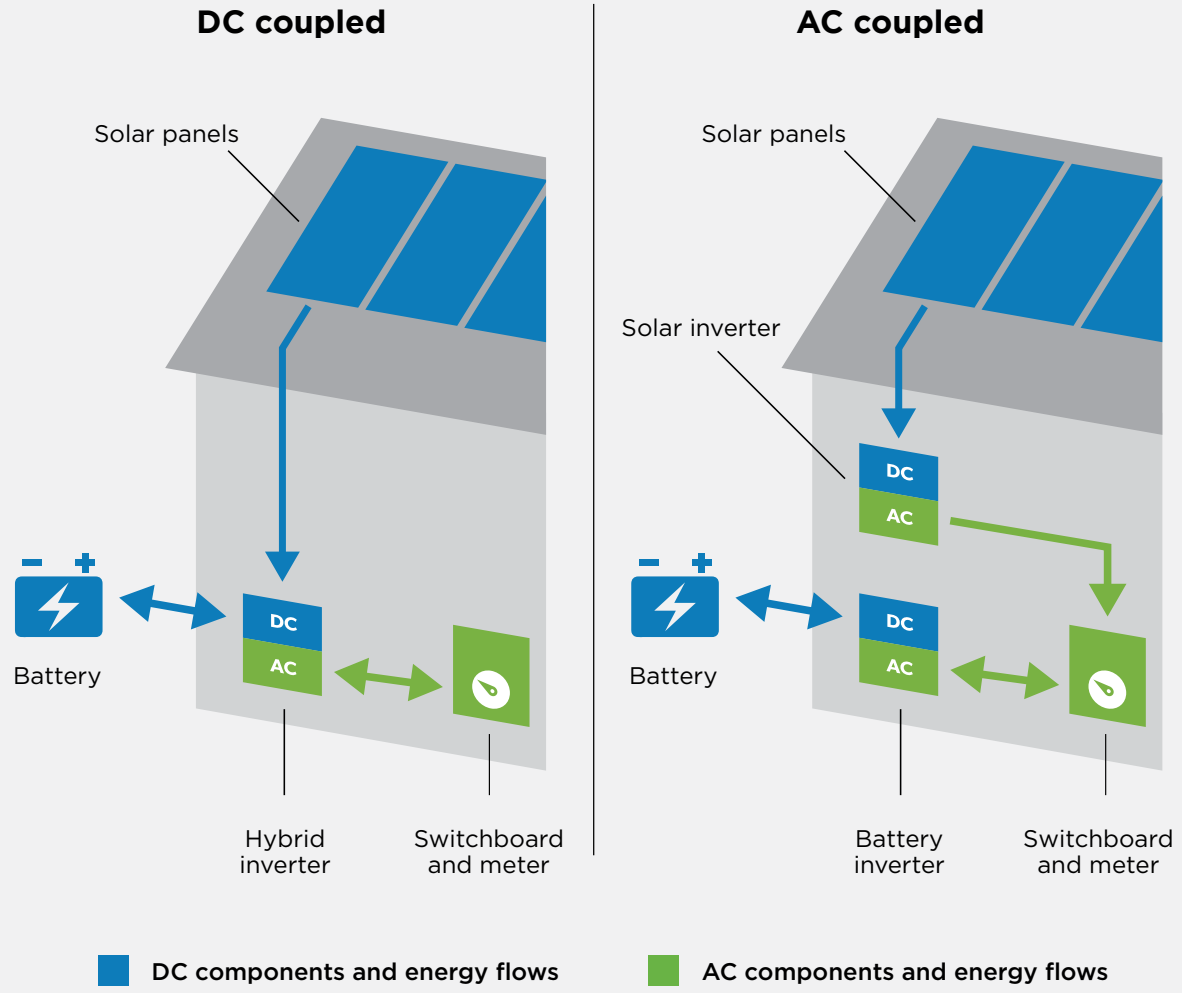
'Coupling' refers to the way batteries and solar panels are connected to the switchboard. In a direct current (DC) setup a battery is connected to the same inverter as the solar system. In an alternating current (AC) coupled setup, a battery inverter connects the battery to the meter box, separate from the solar inverter. The setups are illustrated in Figure 9 on the next page.

It is best to discuss options and costs with your installer. Here are a few reasons why you would choose one over the other.

- DC coupled batteries are slightly more efficient and are easier to get network connection approval because only one inverter is connected to the network. However, DC coupling can be tricky for existing solar systems, as it requires a hybrid inverter in place of the existing solar inverter. If your existing solar inverter is relatively new and working well you may not wish to replace it.
- AC coupled batteries are slightly less efficient, but AC coupling allows power from the battery to be used at the same time as solar power, and usually allows you to charge the battery from the grid, which is not always the case for DC coupled systems. An AC coupled battery can be installed without any changes to an existing solar system.
- Both AC and DC coupled batteries can be designed to have backup functionality during a power outage, but check the specifications of the products.

You should check with your supplier for the most appropriate set up for your circumstances.

Figure 9. Comparing AC and DC coupled battery systems



How green is that battery?

There are a number of things that you need to think about when considering the environmental sustainability of particular battery types and products.

Currently, there are no independent sources of information or advice that rank different products for their environmental performance or impact. Nor is there an industry product stewardship scheme for the whole supply chain and product lifecycle that would put the responsibility on makers and sellers to provide this information. Both of these are likely to happen in the near future.

In the meantime, here are some of the things to look for.

- **The materials and energy used in manufacturing and transportation ('embodied energy'):** Some battery raw materials are relatively cheap and plentiful (like lithium or lead), while others are rare and expensive (like cobalt). A solar system that includes a battery should offset the energy used to manufacture it in around two years[4].
- **The energy efficiency and lifespan of the system in use:** The longer a battery is warranted to last, and the more energy a battery is guaranteed to store within its warranty period, the better the use of resources to manufacture it.
- **Whether or not the battery helps to increase renewable and decrease fossil fuel generation:** Unlike solar, installing a battery doesn't automatically guarantee that you are creating more renewable energy. However, batteries may have a direct environmental benefit such as allowing you to install an oversized solar system, reducing the use of diesel generators in offgrid situations or reducing the amount of generation required in the grid when used at peak times.
- **End of lifecycle reuse, recycling or disposal:** Batteries are likely to constitute a significant source of e-waste in future. However, organisations like the Australian Battery Recycling Initiative, www.batteryrecycling.org.au are already working on a solution for waste disposal and recycling.

  Further, the battery industry and the Federal Government are currently working toward establishing a voluntary scheme for battery stewardship covering all types of batteries. The intention is for the scheme to be extended to home batteries. The scheme will seek the responsible management of battery products from design through to end of life by all parties involved in the battery supply chain. The start of the scheme is planned for mid 2020.

  In the meantime, some batteries (such as lead-acid) have ingredients that are easier to recycle than others. Batteries may also become reusable in new applications and installers could potentially offer used electric car batteries for your home power station.

  You could also ask your supplier if they have an 'end of life' policy, or something similar in relation to the disposal of batteries.

Buying GreenPower

You can make sure any grid electricity you use directly or to charge your battery has zero net emissions by purchasing 100% GreenPower through an electricity retailer. Most retailers offer a GreenPower product for all or part of your electricity consumption.

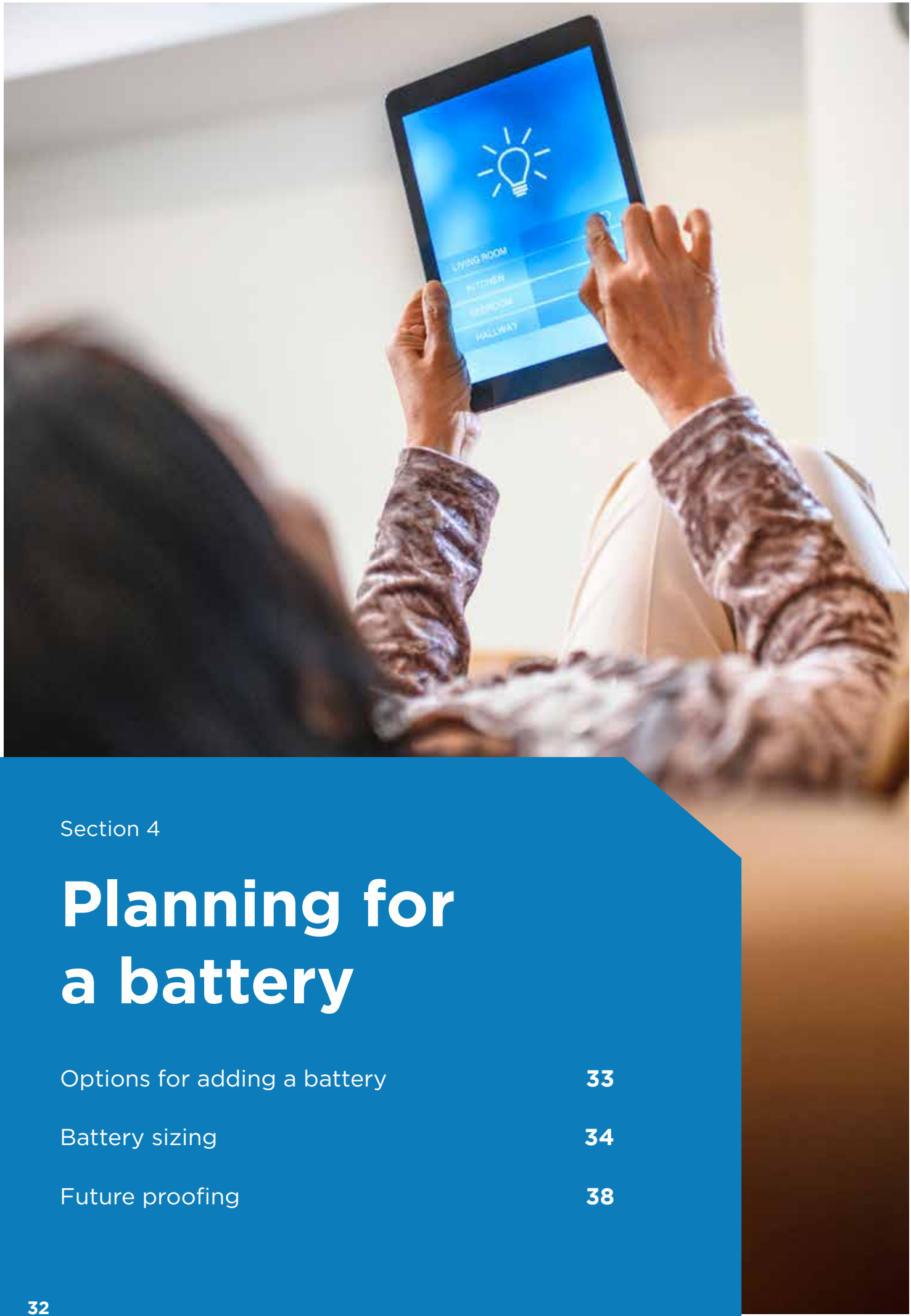
GreenPower is renewable energy sourced from accredited solar, wind, bioenergy and mini-hydro generators across the country.

GreenPower accredited electricity is additional to the national Renewable Energy Target and is strictly audited to verify that the retailers ensure that electricity generated from accredited renewable energy generators is fed into the grid on your behalf.

By purchasing GreenPower, you will be able to lower your emissions and to contribute to the growth of Australian renewables at the same time, whether you decide to invest in a battery or not.

To find out more visit **greenpower.gov.au**

GreenPower®
Accredited Renewable Energy



Section 4

Planning for a battery

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Future proofing 38

Options for adding a battery

In most instances, you will be adding a battery to a new or existing rooftop solar system, unless you are thinking of buying a battery to operate on its own.

New solar and new battery

Installing a new solar system with your new battery has both financial and practical advantages. The solar battery system usually has a shorter payback period than the other battery options. This is mainly because the solar system is what generates the financial savings. You can have a single hybrid inverter instead of two inverters and you can install a larger solar system with the extra power generated being stored and used later.

Addition of battery to existing solar

Adding a battery to existing solar, also called retrofitting, has a longer payback period than new solar and a new battery, often exceeding the warranty period. Based on the current cost of batteries this option may not pay for itself, but it will still improve your energy self-sufficiency.

It is important to determine whether your existing solar system is 'battery ready.' Usually you will need to install a dedicated battery inverter with your new battery. Most battery products on the Australian market are now being sold with an inverter, which may be integrated into the battery unit or installed separately.

Some providers might offer to replace the existing solar inverter with a single hybrid inverter which connects to both the solar and battery, but this is not possible in all cases.

Providers may also offer to connect the battery to the existing solar inverter, without needing a battery inverter, by fitting a dedicated DC to DC converter between the solar panels and the battery. This option will mean that the battery can only be charged from solar, and not from the grid.

New battery without solar

A new battery without solar may be suitable for households that want to charge a battery from the grid at offpeak rates and then use the energy in their home during peak periods.

In most cases, this option currently doesn't make financial sense, has the longest payback period and is unlikely to recover the cost of the battery. It also does not have the benefit of providing any renewable energy for the household to use.v

Battery sizing

Choosing the right battery storage size for your needs will depend on the size of your solar, how much energy you consume during peak periods, whether you want backup during a power outage and your financial considerations, including budget.

Choosing a battery

For bill-saving purposes, it is generally best to buy a battery that you will regularly charge and discharge to the recommended level. This requires excess solar during the day for charging, and demand outside of solar generation hours for discharging.

You must be careful to not 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 app.

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

To help you when you talk to an independent assessor, we have included some tips for battery sizing in the box below, and some example sizing for different households in Figure 10 on the next page.

Battery sizing considerations

If you do not already have solar you will need to size your solar system appropriately. Speak to an accredited installer to help with solar sizing. The below are examples of what you may want your battery for. These considerations may help you get a better idea of what battery size you might need.

To make the most of your solar

Calculate how much excess solar energy you will have during the day. This can be done by subtracting the energy consumed in your home during sunny hours from the amount of energy your solar system typically generates in a day.

Decide whether you want to store all your excess solar or just the amount of energy you would use during the evening peak.

To power your house overnight

Calculate your excess solar energy and your overnight energy use, for example by subtracting the average daily solar energy used in your home from your total average daily consumption.

Size your solar and battery so the battery can be fully charged by solar energy during the day and discharged to cover your electricity needs overnight.

To have backup for multi-day outages

Your battery should be big enough to cover several days of energy use, and you may need an on-site diesel generator in addition to battery storage.

Design your system like an offgrid setup, with a special inverter and isolation switch.

Plan for a larger system with higher costs and less efficient battery utilisation.

Practical examples

The below table includes practical examples of what battery size, investment and payback may be required for different situations. The first three lines show the person's motivation, their power use and whether they already have solar. In the lower section you can see what their decision might be, including new or extended solar, battery capacity and what that means in terms of costs and savings.

Figure 10. Practical examples of solar and battery sizes

	Example 1: Isabella	Example 2: Ali	Example 3: Wei	Example 4: Scott
Overview and motivations	Find simple ways to reduce her energy bill.	Reduce carbon footprint and be an early adopter of new technology.	Rely less on the grid and earn money from grid support.	Become more self-sufficient and have home office backup.
Daily consumption	10 kWh	10 kWh	25 kWh	20 kWh
Existing solar	2 kW	—	5 kW	4 kW
	Their investment			
New solar	Buys energy efficient appliances instead	4 kW	5 kW	—
New battery	—	2.4 kWh	13.5 kWh	13.5 kWh
System cost	$2,800	$9,000	$18,500	$13,500
Annual savings	$520	$870*	$1,500*	$530**
Payback	5 years	10 years	12 years	26 years

*The annual savings from the solar battery system are not evenly split between the solar and battery components of the system.
**Annual savings from solar storage is $130, while annual benefit from avoided power outages is assumed to be worth $400.

Additional practical examples

The NSW Home Solar Battery Guide page on the Energy Saver website provides the full practical examples summarised in the table above.

energysaver.nsw.gov.au/solar-battery-systems

Backup power capability

Standard solar and battery systems do not work when there is a power outage. For backup power your system needs an isolation switch. There is usually an additional cost for the isolation switch and its installation.

During an outage the switch disconnects your whole house from the grid. This is necessary to protect anyone fixing the grid from getting an electric shock from your battery.

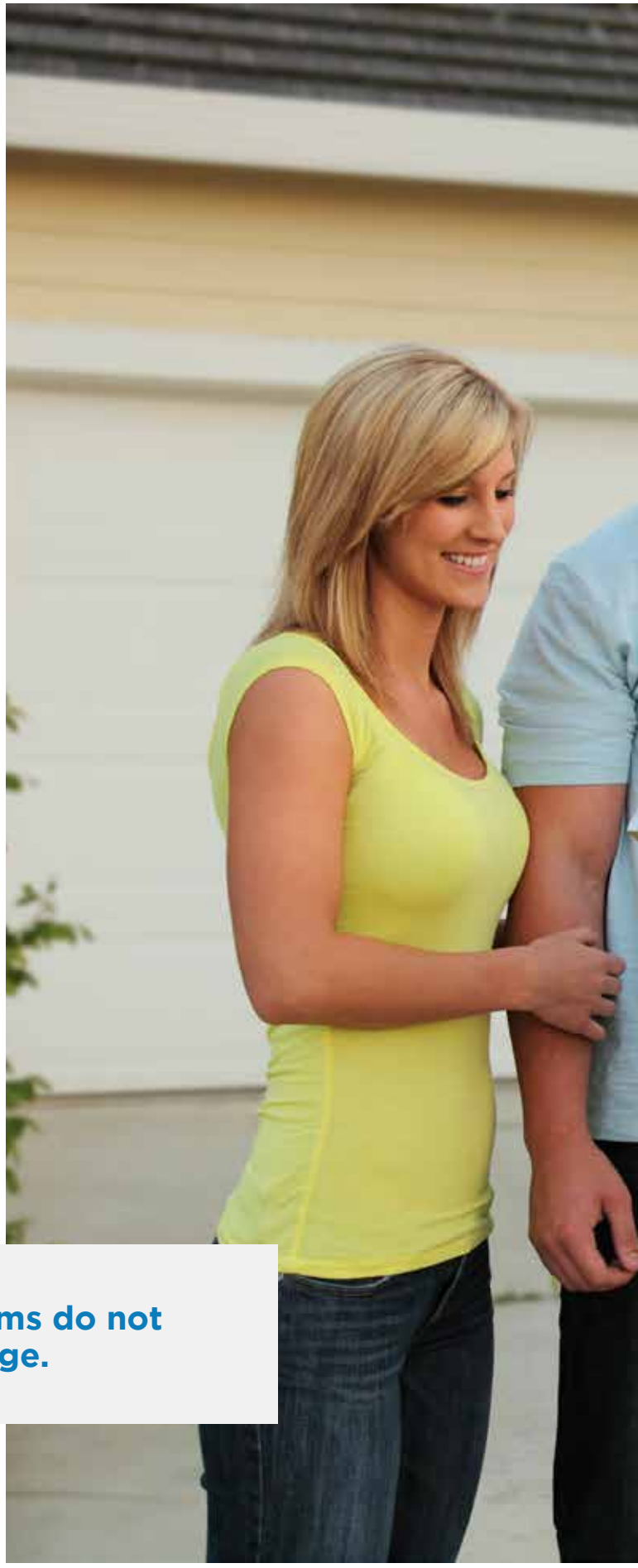
For most NSW households, power outages are rare so you may not need backup power capabilities.

Sizing for backup or going offgrid

The less reliant on the grid you wish to be, the larger the battery system you will need. Offgrid means not being connected to the local electricity grid at all. Completely offgrid houses need to generate and store electricity, with no reliance, or support, from the grid.

If you want backup for multiple days, or are considering going offgrid, then all of your consumption will need to be covered either directly by a rooftop solar system or other generator, or indirectly by using power which is generated earlier and stored in a battery.

While sizing for backup or going offgrid can give you control over your energy supply, the cost could be multiple times that of a grid-connected system.



Standard solar and battery systems do not work when there is a power outage.

Future proofing

In the fast-changing home battery market there is a range of factors to consider when trying to 'future proof' your investment decision.

Timing

If bill savings are your main motivation, the best way to future proof your investment would be to only buy a battery when you are confident you will get a payback within the warranty period. With prices expected to fall steadily, that could mean a wait of only a few years.

Solar now, battery later

You may wish to install solar now and add a battery later, when prices fall further. In this situation, many customers wonder how to ensure their system—particularly their inverter—is 'battery ready'. Here are some options.

- **Solar with solar inverter:** You might simply install solar with a solar inverter. When you decide to add a battery, you can either AC-couple the battery (via the battery's own inverter) or replace the solar inverter with a hybrid inverter that can accommodate a new battery.

  You should be aware that some installers may be unwilling to replace your old inverter to accommodate a new battery. In doing so they become responsible for ensuring the whole system meets the latest standards.

- **Solar with hybrid inverter:** Alternatively, you may install solar with a hybrid inverter, ready for the battery later on. However, there is a risk that by the time you install the battery the inverter may be obsolete or unnecessary.

Consider future tariff changes

Future tariff changes can impact the benefits a battery provides. For example, if your electricity tariff (the amount you pay for power from the grid) increases in the future, you are more likely to benefit from storing and using the electricity you produce.

Start small

Some batteries are designed to be modular. Having more storage is then simply a matter of adding more units. You will need to make sure that the inverter capacity matches your needs. Some modular batteries include an inverter in each module.

Sell your energy when market prices are high

As an alternative to selling your excess solar or stored battery energy into the grid for a fixed tariff, you can also buy software that allows you to sell your excess energy into the grid at times when energy market prices are high.

Some providers are currently offering this service. Please note, the software may have an additional cost, and the provider may make this service available only infrequently. Therefore, at the moment, this option should be considered as supplementary.

In the future, new electricity business models may emerge which include a wider range of offerings to households that can sell their excess energy back to the grid, or to other local households or businesses.

Virtual power plants

A virtual power plant (VPP) is created by a network of home solar panels and battery storage systems all working together to generate, store and feed energy back into the grid.

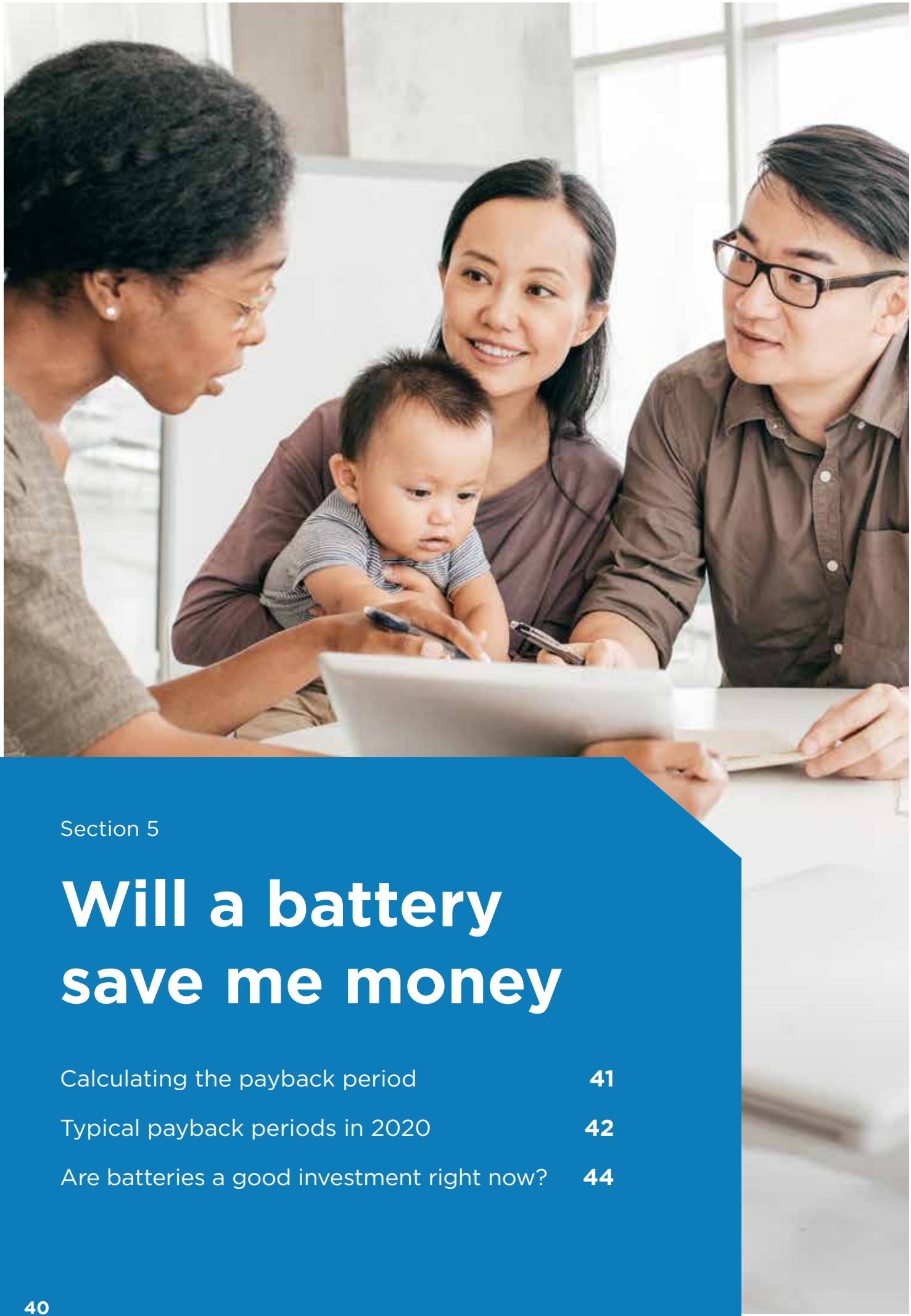
Energy from the home solar panels and battery systems linked to a VPP mainly provide electricity for the house where they are installed. However, energy generated or stored by the system, and not used by the household, can automatically be dispatched and sold back to the grid when needed most. This helps to reduce demand and pressure on the network.

VPPs are offered by some retailers and specialist providers. The benefits vary depending on the provider. Some offer a fixed payment back to the customer, a reduction in the cost of the battery or a payment every time the battery is being used as part of the VPP.

This technology is in early stages of uptake in Australia but is likely to increase in the coming years.

If you are interested in being part of a VPP and improving your return on investment:

- Check with your installer to see if your battery system is either capable or ready to be operated in a VPP.
- Sign up to a VPP initiative to complement your solar battery.



Section 5

Will a battery save me money

Calculating the payback period **41**

Typical payback periods in 2020 **42**

Are batteries a good investment right now? **44**

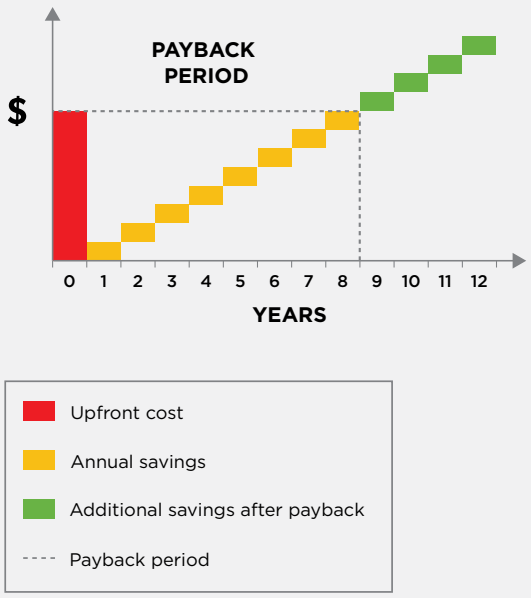
Calculating the payback period

The 'payback period' is the time it takes for a battery to pay for itself with savings in your energy bills. In some cases, a solar battery system may never achieve savings to pay for itself.

To estimate the payback period in years, simply divide the upfront system cost by the projected annual savings in your energy bills. If you have a warranty that is less than the payback period, the battery system may not pay for itself before the warranty expires.

Figure 11 below provides a simple example of how to estimate your payback period based on a system cost in year one, a yellow rectangle for each year of savings until the system has paid for itself and a green rectangle for each year of additional savings provided by the battery after the payback period. The dotted line indicates the point at which the battery has achieved enough savings to pay for itself. In this example the payback period is eight years.

Figure 11. Understanding the payback period



If the warranty period is 10 years, the example shown would suggest a relatively safe investment because the payback period is shorter than the warranty period. If the warranty was less than eight years in this example, you would be taking a risk by assuming the battery will be able to pay back its cost.

A number of online calculators exist that can help you work out the payback period once you have received one or more quotes. These are important because they can help you compare the different quotes. For example, you should try to understand what your 'annual savings' would be depending on if you will use the full battery capacity every day, or what part of the savings are due to the battery itself and what parts are due to installing solar panels.

For a more accurate payback period calculation, you would need to include a range of additional factors such as:

- actual level of discharge of the battery over the course of the year, taking into account energy use patterns and solar generation (where solar exists). This will always be less than the usable capacity multiplied by 365 days
- reduction of battery capacity over its lifespan
- potential future changes in retail electricity prices
- efficiency losses between solar, the battery and your appliances.

A list of detailed battery sizing and payback calculators can be found in the 'Where to go for more help' section on page 64 of this guide.

Typical payback periods in 2020

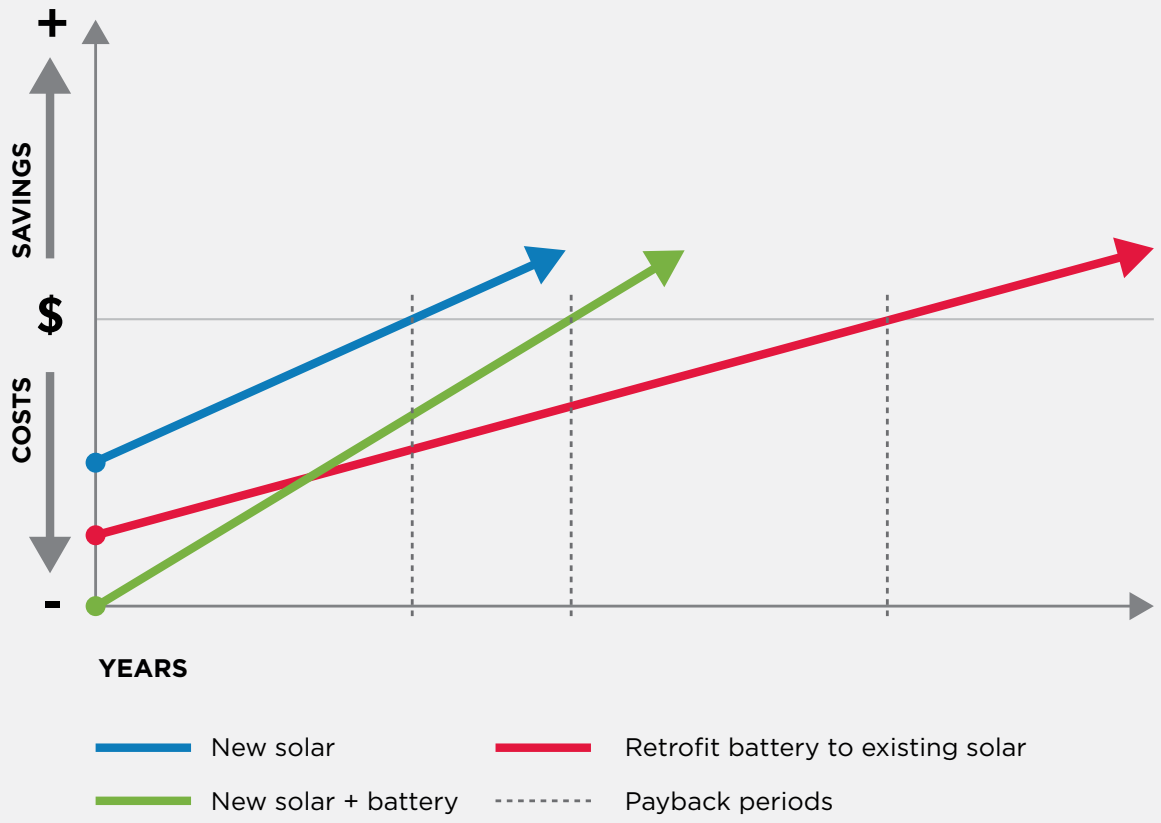
A new rooftop solar system, without a battery, usually has the shortest payback period. However, payback periods for batteries are getting shorter.

In many cases, installing a new solar system with a new battery can pay for itself within 10 years, especially for higher than average consumption households (over 16 kWh per day) on time of use tariffs. But this doesn't apply to below average consumption households.

The addition of a battery to existing solar, also called retrofitting, currently has the longest payback period, often exceeding the warranty period. While this option may not pay for itself, it still improves your energy self-sufficiency.

Figure 12 below shows the relative payback periods for different battery system options.

Figure 12. Relative payback periods in 2020 for different battery system options

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MC
GT
AC
+/-
MU
OFF
ON/C
CE

Are batteries a good investment right now?

It is important to know whether battery storage purchased today will deliver the financial benefit that you are looking for. There are some circumstances where a battery may already make financial sense[5].

High consumption

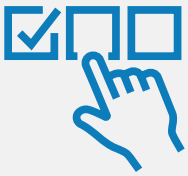
You have higher than average consumption during peak times, are on a time of use tariff, and are planning on installing a new solar system with your battery.

Location limitations

A new, rural grid connection would be expensive and going offgrid would be a cheaper alternative. This would still have reliability, customer protection and other implications.

Export limit

You have, or want to install, a large solar system but the local electricity network has imposed an export limit on your solar system, so some solar generation will go to waste without a battery.



Special programs

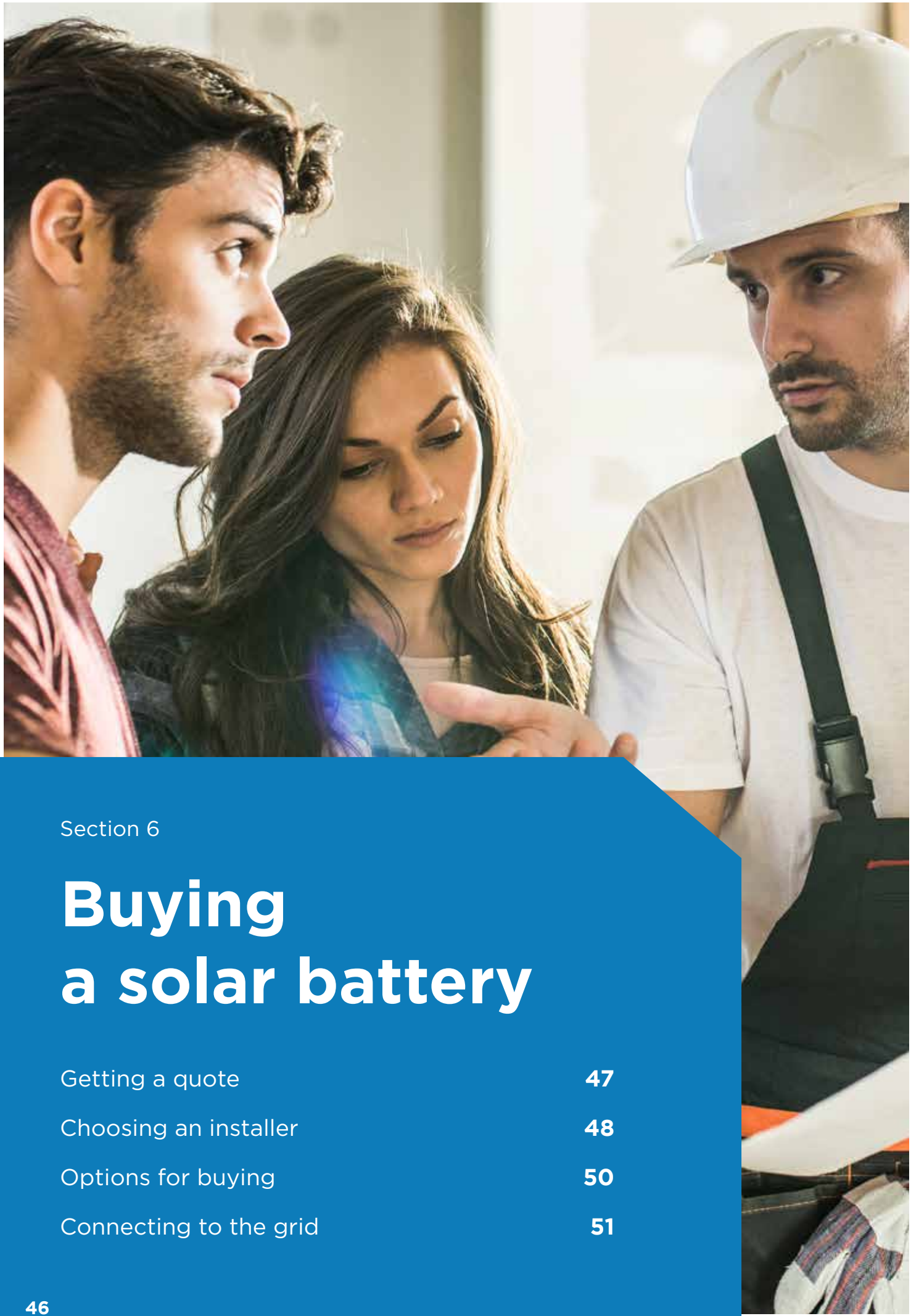
A special program is available in your area, such as a Virtual Power Plant trial, including a battery subsidy. Carefully check installer certification, warranties and customer support and read this guide for other useful information.

This list might expand within a few years to include most grid-connected households that export solar power to the grid. However, the optimum battery size for most of these households is likely to be relatively small.

Summary

- **New solar:** A new rooftop solar system without a battery currently pays for itself sooner than one with a battery.
- **New solar and battery:** In many cases a new solar system with a battery can pay for itself within 10 years. The solar component of a solar battery system will provide the majority of the savings.
- **Existing solar:** Currently, retrofitting a battery to existing solar doesn't make much financial sense, but that may change in the next few years. The best outcome for retrofits are for large-consumption houses with large solar systems.
- **Battery size:** The payback time is generally quicker for a small battery, when paired with a new solar system, as opposed to a large one.
- **Location:** Sunnier inland locations (e.g. Armidale, Broken Hill, Wagga Wagga) tend to pay back one year quicker than coastal locations.
- **Battery costs:** Battery costs are expected to continue to decline over the next few years, which will reduce payback times.
- **Tariffs:** Current time of use tariffs are better for battery payback than flat tariffs. However, future tariff trends are uncertain.

These messages are based on cost modelling undertaken for this guide in 2020 by ITP Renewables.



Section 6

Buying a solar battery

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Choosing an installer 48

Options for buying 50

Connecting to the grid 51

Getting a quote

If you have decided a solar battery system is right for you, we recommend you have your information and requirements ready and seek at least two quotes from reputable installers.

Installer information tips

Here is a list of things that may be useful for your installer to know to prepare a quote.

✔ **General**

- Meter type, location and single or three-phase power supply type (an installer can tell from what's in the meter box)
- Electricity bill information such as annual consumption, metering data, retailer name, tariff type and discounts
- Appliances that consume a lot of power and their age (e.g. hot water systems, refrigeration, pool pump and heating or cooling systems)
- Usage patterns such as when you use the most energy (daytime, evening, or a mix of both)

✔ **Solar**

- Approximate area of unshaded roof facing north, east and west
- Roof height and material (e.g. tile, colorbond)
- Approximate roof pitch
- Existing solar system size
- Preferred budget, system size, technology and/or brands

✔ **Battery**

- What you want a battery to do (e.g. maximise use of your solar or backup power)
- Preferred budget, system size, technology (chemistry) and/or brands
- Whether you have interest in selling excess solar or battery energy into the grid

Understanding the supplier market

The Clean Energy Council, an industry peak body, manages an accreditation scheme for solar and battery installers on a national level, including NSW. Accredited installers must comply with accreditation requirements, for example in how they provide you with a quote and the minimum warranty they need to provide for an installation. They must also ensure that your system meets industry best practice standards and all relevant Australian Standards. Only Clean Energy Council accredited installers can access the Australian Government's incentives for solar systems.

The main parties involved in the sale and installation of battery storage systems are the retailer, designer and installer. The roles of each are explained in the Clean Energy Council's Guide to Installing a Household Battery Storage System. Visit:

cleanenergycouncil.org.au/consumers/buying-battery-storage

These roles can be filled by one individual company or two or three entities may be involved if companies subcontract out their designs and/or installations.

Choosing an installer

Here are some factors to consider when choosing an installer:

- Is the installer accredited with the Clean Energy Council (CEC)?
- Is the solar retailer accredited with the CEC?
- Are they licensed to install this kind of system?
- What is their recent experience installing this particular product?
- What happens if the system needs to be fixed under warranty and their business is no longer operating?
- What maintenance is required? Who can do it?
- Are replacement parts readily available?
- How long have the manufacturers been in the industry, and do they have a local office?
- Which warranties are the installer's responsibility and which are the manufacturer's?

We recommend you schedule a consultation at your home. Be wary of any installers who claim to be able to provide a firm quote without visiting your home. Try to get at least two quotes, with different system sizes and brands, so you can choose according to your needs and budget. Take your time when making your decision.

What a quote should contain

When you get quotes back from installers, here is the information they should contain.

- ✔ **Installation compliance:** Confirmation the battery system will be installed in accordance with AS/NZS 5139:2019, Electrical installations—safety of battery systems for use with power conversion equipment. The installer should also include any additional items and costs required for the installation to meet the standard, for example fire-proof sheeting.
- ✔ **Battery specifications:** Including battery and inverter size (if separate), maximum charge and discharge rate and recommended depth of discharge.
- ✔ **Energy assessment:** A basic energy assessment of the premises, with recommendations for energy-use reduction.
- ✔ **Potential issues:** A note of what, if any, electrical issues may need to be addressed before the system can be connected.
- ✔ **Itemised prices:** A detailed list, with individual prices, of the system components you would be buying.
- ✔ **Additional costs:** Any additional costs for the installation (e.g. asbestos removal and switchboard or wiring replacement).
- ✔ **Solar system energy output:** An estimate of the energy output of the solar system, the expected self-sufficiency level and potential savings.
- ✔ **Emissions estimate:** An estimate of the CO_2 emissions reduction of the system.
- ✔ **Guarantees and warranties:** Including specific exclusions and conditions for them to stay valid (e.g. the battery location and temperature range) and what to do when something doesn't work.
- ✔ **Customer references:** If requested.
- ✔ **Energy management system:** Information about the energy management system and how it is accessible, for example via an online app on your smartphone.
- ✔ **Network connection paperwork:** Help with the network connection paperwork and the small-scale technology certificates application if also installing solar.
- ✔ **Additional information:** Including when it will be completed, whether the price is guaranteed until then, where the battery will be installed, compliance with the manufacturer's requirements and whether the battery can be relocated if you move house.

Options for buying

The most cost-effective way to buy a solar battery system, or a battery system, is usually to buy it outright. This is because you don't have to pay finance company fees and interest. Some alternative buying options are listed below.

Note that the information in this guide should not be taken as financial advice and has been prepared as general information only. You should consider all offers carefully and if needed, seek advice before investing.

Empowering Homes Program

The Empowering Homes program provides interest-free loans for solar battery systems to eligible NSW residents. Loans of up to $14,000 for a solar battery system, or up to $9,000 for adding a battery to an existing solar system, will be available to owner-occupiers with an annual household income of up to $180,000.

The program was launched in February 2020. It is initially running as a pilot for eligible postcodes to refine its design before rolling out across the state.
For more information please visit,
energysaver.nsw.gov.au/solar-battery-loan-offer

Lease

Some solar suppliers have leasing programs which they are now extending to solar battery systems. They own, install and maintain the system and you pay them a regular fee based on either a fixed monthly price or on the energy you use from the system. You should only explore this option if you are sure that the electricity bill savings will outweigh the lease repayments over time.

Finance

Some solar installers will offer finance, typically from an external funder. Separate finance is also available from financial institutions.

Watch out for cheap finance attached to an inflated system price, or direct debit fees that continue after you have repaid the loan.

Bulk buy

Occasionally, companies or organisations promote solar and/or batteries at lower prices for buying in bulk than would be available for individual sales. By signing up large numbers of customers in the same area in advance, the promoters may be able to get better deals from manufacturers and suppliers, which they can pass on to you. When assessing a bulk buy program, you may also choose to seek one or two quotes from other local installers so that you can compare offers.

Extra resources

The Clean Energy Council has a list of accredited installers.

cleanenergycouncil.org.au/consumers/buying-solar/find-an-installer

The Clean Energy Council also has a list of battery products which have been independently tested to meet industry best practice for electrical safety and quality standards.

cleanenergycouncil.org.au/industry/products/batteries/approved-batteries

There is currently a New Energy Tech Consumer Code being developed which offers consumers protection during the sale of new energy technology. The code will set a minimum standard of customer service for customers looking to buy new energy technologies. Customers should refer to **cleanenergycouncil.org.au/advocacy-initiatives/behind-the-meter-code** for further information on the status of the code.

Connecting to the grid

Your installer will manage the grid connection process for you. The process is often straightforward, although additional time or fees are sometimes incurred for connecting larger systems. In some cases, you may also need to replace your electricity meter.

Network connection approval

To connect a solar or solar battery system to the grid, your installer first submits an application to your local electricity network. Upon approval, the installer installs the system and supplies both you and the electricity network provider with a certificate of compliance for electrical work (CCEW).

For new or alterations to a solar or solar battery system, a connection application is to be submitted. If you are adding a battery to an existing inverter, the installer will need to submit a connection form to the network service provider. This is also the case for altering the panels with an existing inverter and removing equipment.

Distributed energy resources register

A distributed energy resources (DER) database was launched in December 2019 by the Australian Energy Market Operator to provide greater visibility over DER devices, such as solar and battery systems, to better manage the electricity grid.

The DER register contains information about your solar and battery system and its location in the network. Your installer is responsible for obtaining this information from you and providing it to the DER register.

Automatic connection approvals

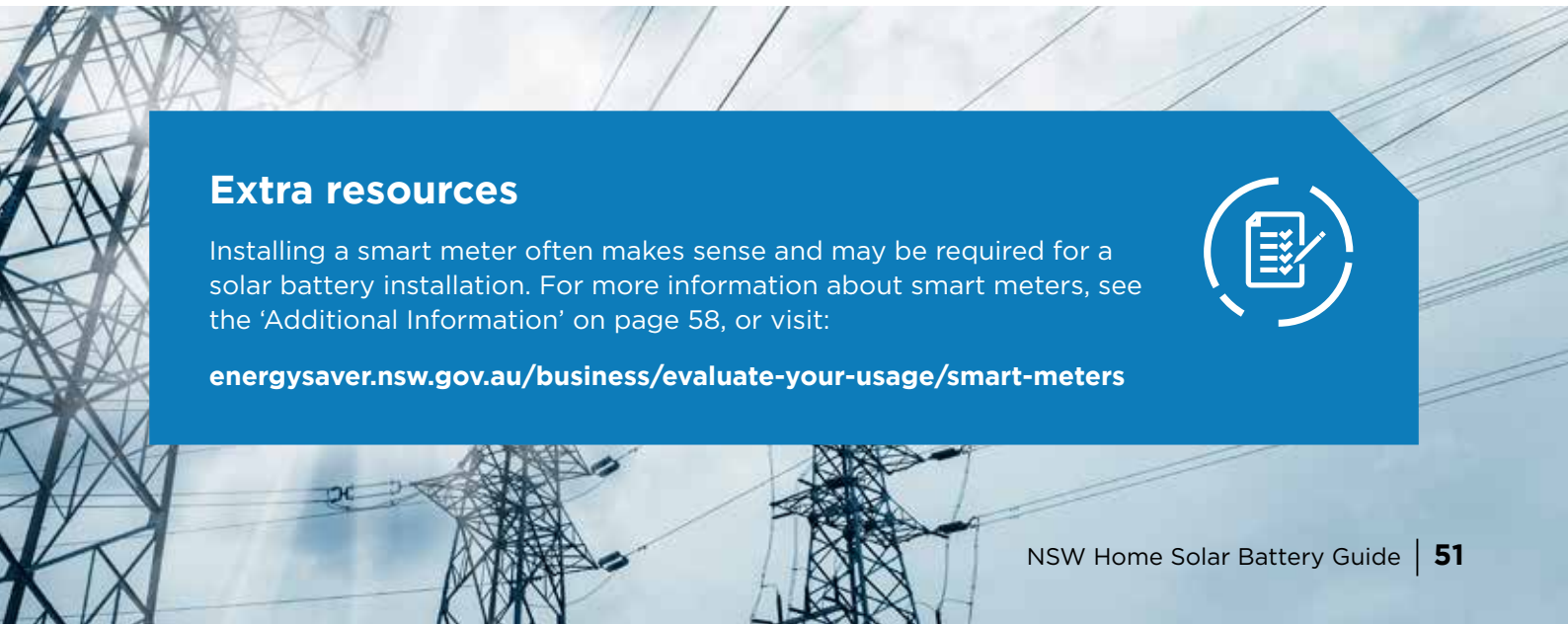
All NSW network providers offer automatic connection approvals for smaller systems. Where the total system inverter capacity is larger than 5 kW, individual assessments may be needed, and additional fees may apply.

Network providers may offer automatic approvals for solar battery systems with combined inverter capacities over 5 kW as long as export to the grid is limited to 5 kW. Check with your installer or network provider what the exact requirement is.

Remember, many older household electricity meters in NSW are not suitable for solar or batteries. Your installer may be able to arrange the installation of a new smart meter. It may be free through your electricity retailer or the cost should be included in your quote.

New meters and other costs

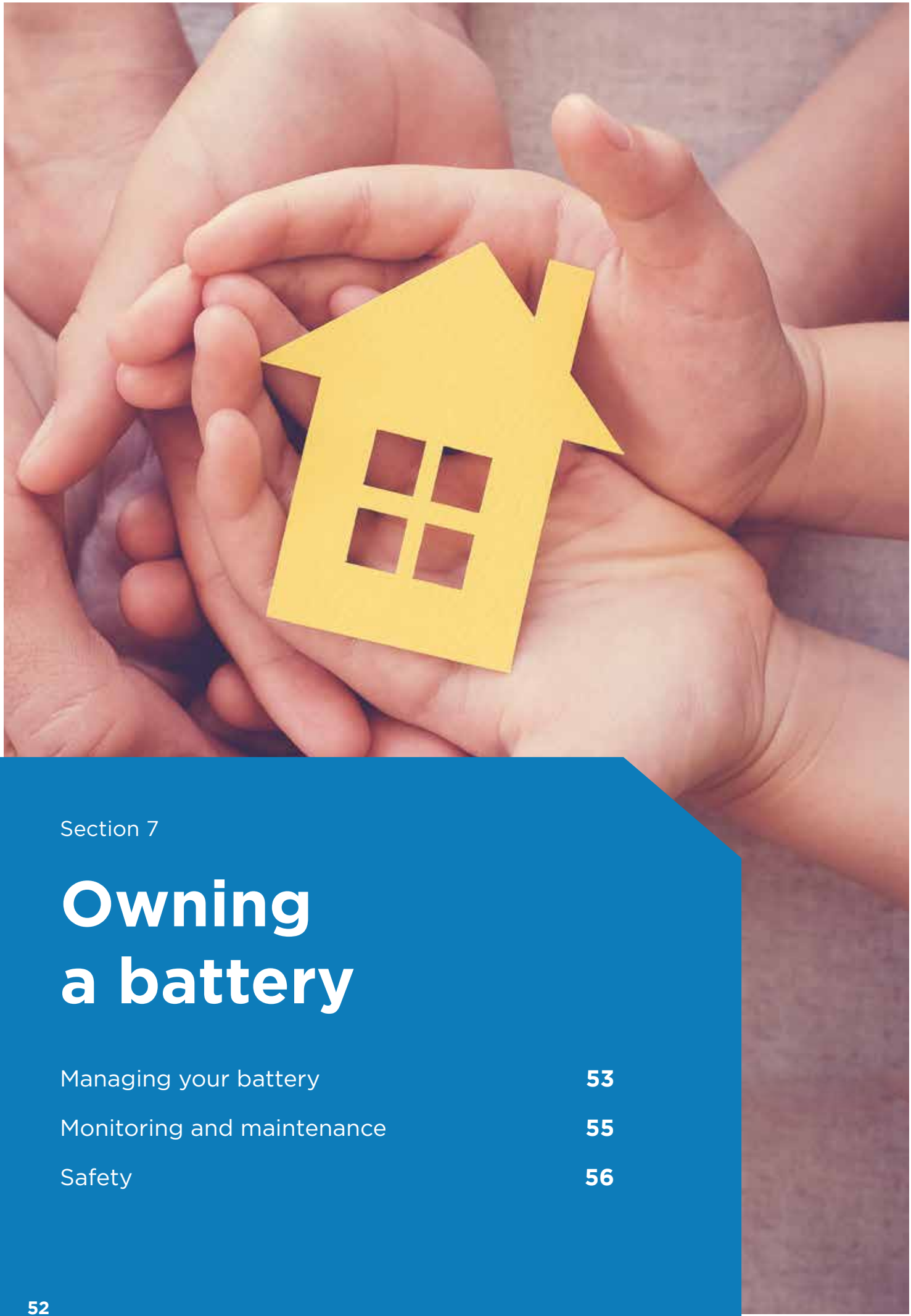
Any time an electrician is working on your house wiring, there is a chance they will discover existing issues. For example, the switchboard may be too small to accommodate the new switches required for your battery, or it may contain asbestos and be dangerous to work on, so it may need to be upgraded and re-wired. Such activities would incur additional costs.



Extra resources

Installing a smart meter often makes sense and may be required for a solar battery installation. For more information about smart meters, see the ‘Additional Information’ on page 58, or visit:

energysaver.nsw.gov.au/business/evaluate-your-usage/smart-meters



Section 7

Owning a battery

Managing your battery **53**

Monitoring and maintenance **55**

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Managing your battery

To get the most value out of your battery and manage it effectively, choose the battery management strategy which best meets your needs.

There are two main battery management strategies currently in use:

1. **solar buffer**—when you want to use as much of the electricity produced by your solar system as possible
2. **tariff optimisation**—when you want to minimise the cost you pay for electricity.

Your battery supplier should help you to decide which is best for your needs and help you with setup.

You may be offered an energy management system (EMS) to apply your battery management strategy. You will need to carefully consider the costs and benefits of the EMS over time.

Solar buffer

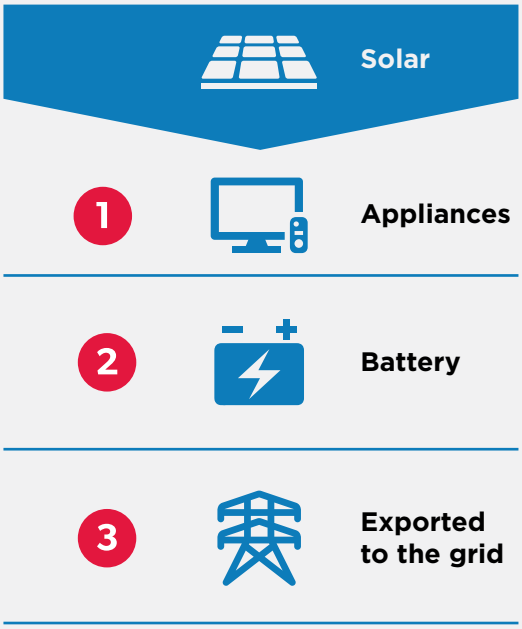
Solar buffer, commonly called PV self-consumption, is the most common battery management strategy. Under this strategy, the battery is charged from your solar panel rather than the grid.

Figure 13 below shows how this management strategy works. In the first instance, your solar generation is used to supply your household appliances, just like a solar system without a battery. Any excess solar is then used to charge the battery. Exports to the grid will only occur when the battery can't absorb the excess solar.

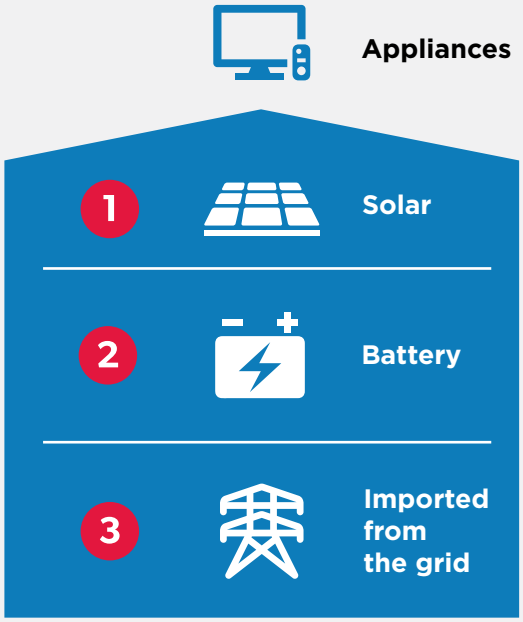
When your energy consumption is greater than what is being generated by solar, energy is discharged from your battery to avoid import from the grid.

Figure 13. How a solar buffer battery management strategy works

When you generate solar power, a solar buffer prioritises the order in which it is used.



When you use energy, a solar buffer prioritises where it comes from.



Tariff optimisation

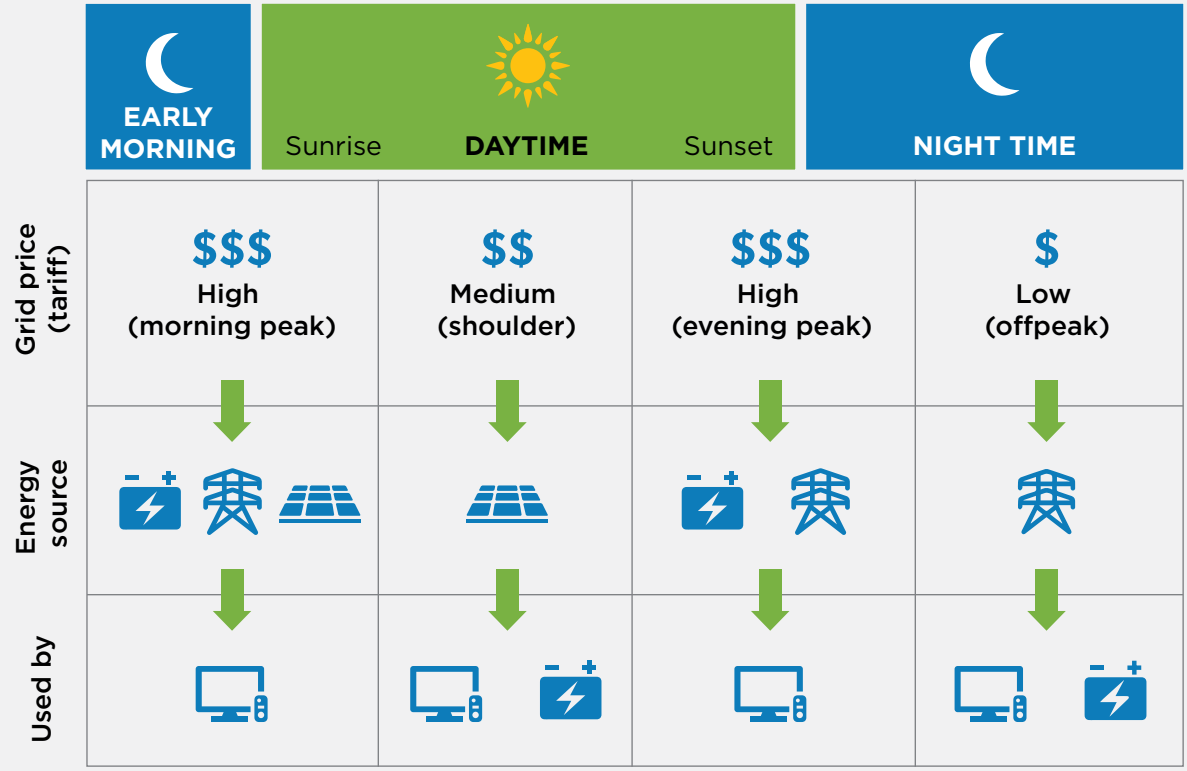
Tariff optimisation operates like solar buffer but has additional features that are useful when a time of use tariff applies (see page 17 for a reminder about how time of use tariffs work). Under this strategy the battery may sometimes charge from the grid overnight during the offpeak period.

Figure 14 below shows how this management strategy works. The EMS normally uses weather forecasting to estimate the day's solar generation and consumption. It then decides how much to charge the battery to minimise the amount of grid import that will be required during the peak period. It also tries to avoid charging the battery more than necessary, as this may result in excess solar exports to the grid during the day.

The strategy is as follows (weekdays only):

- **Morning** use is met from the partly charged battery when the morning peak tariff for electricity is expensive.
- **During the day** rooftop solar powers home appliances and charges the battery when there is excess solar energy.
- **In the evening** when the peak electricity tariff is expensive the battery discharges to power home appliances.
- **Overnight** the battery may charge from grid electricity, taking advantage of cheaper offpeak tariff price.

Figure 14. How a tariff optimisation battery management strategy works



Monitoring and maintenance

Most new batteries require minimal maintenance by owners[6]. They should come with instructions on any checks that need to be completed, such as keeping them clean and free from insect and animal infestation.

A periodic service by an accredited installer or other professional is usually recommended, this may have a cost associated with it. They can provide feedback on the system's performance and help you understand if there is anything more you can do to get the most out of your battery. They should also provide you with the manufacturers' manuals to help you identify when your system may be having problems.

If your system has failed or seems to be performing below expectations, contact your installer.

If your installer is not available, your next option is to contact your manufacturer. In cases where your installer or manufacturer cannot deliver the expected service within the warranty period, you should contact NSW Fair Trading.

As most solar systems and batteries are internet-connected devices, cyber security is another area of consideration. Most reputable brands may have arrangements in place to ensure products are cyber-secure through software updates. There is significant research currently being undertaken, including by the CSIRO in Australia, on this subject.

Your rights and protections

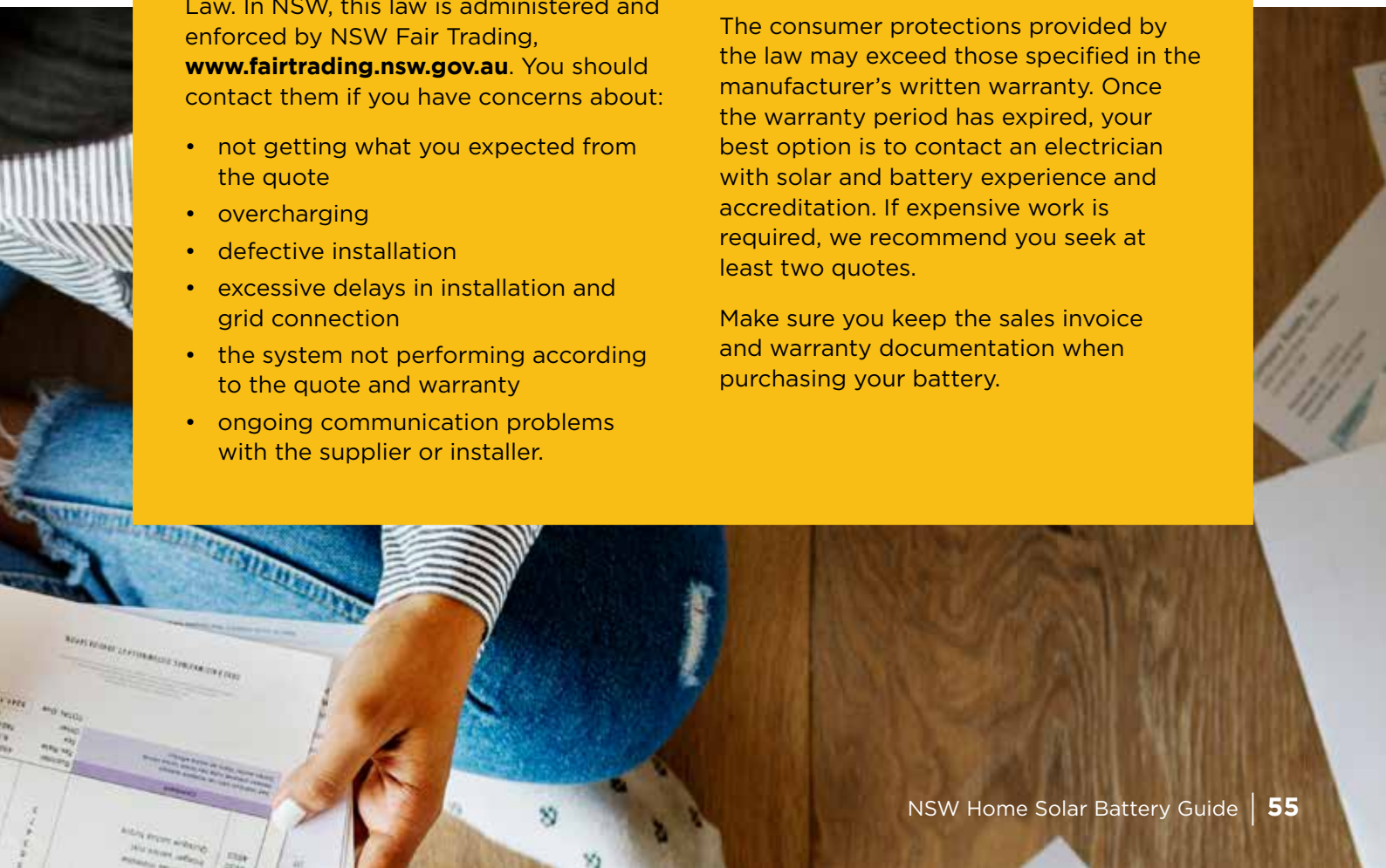
As with other consumer products sold in Australia, you are entitled to the full protection of the Australian Consumer Law. In NSW, this law is administered and enforced by NSW Fair Trading, **www.fairtrading.nsw.gov.au**. You should contact them if you have concerns about:

- not getting what you expected from the quote
- overcharging
- defective installation
- excessive delays in installation and grid connection
- the system not performing according to the quote and warranty
- ongoing communication problems with the supplier or installer.

If you have concerns about your electricity retailer, contact the Energy & Water Ombudsman NSW, **www.ewon.com.au**

The consumer protections provided by the law may exceed those specified in the manufacturer's written warranty. Once the warranty period has expired, your best option is to contact an electrician with solar and battery experience and accreditation. If expensive work is required, we recommend you seek at least two quotes.

Make sure you keep the sales invoice and warranty documentation when purchasing your battery.



Safety

The following section provides some simple tips to consider when it comes to battery safety. For major incidents, call emergency services immediately. In the case of a fire or flood, please let them know about the battery and its location.

Battery location tips

Most home batteries can be installed outdoors[7]. However, their lifespans and safety measures can be improved when:

- they are located in a stable, cool and insulated area that is not in direct sunlight
- the enclosure is vermin-proofed
- they cannot be accessed by children
- they are not installed in habitable rooms[8] for compliance with AS/NZS 5139:2019
- they are clear of obstacles
- they are clear of flammable objects or those that could conduct electricity in or on the battery enclosure
- heavy household equipment is not stored on top of a battery
- it displays appropriate signs relating to safety, warnings and shutdown procedures.

While most batteries are extra-low voltage, they still have the potential to cause serious, sometimes fatal, accidents. When installed correctly though, they are generally low risk. Safety signs are a requirement and care should be taken at all times.

In the unlikely event of a fault, some batteries can catch fire, and others can release flammable hydrogen gas, so they require proper ventilation[9]. These risks, while unlikely, may affect your home insurance. It is important to check with your insurer before installation.

Lithium batteries, the most common battery type, are generally fully sealed and during normal use do not release any gases and do not need ventilation. But the battery enclosure should include ventilation for temperature control, particularly in the event of a fire.

Standards and regulations

There are several Australian standards relating to battery design and installation within buildings. Most relate to traditional lead-acid technology and do not address lithium-based chemistries and network-connected solar battery installations.

In October 2019, Standards Australia published a new standard (AS/NZS 5139:2019) for the safety and installation of battery systems connected to power conversion equipment for the supply of AC and DC power. This standard includes lithium-ion technologies.

The new standard introduces a number of safety measures for battery installation in homes. One of the new key measures is, where a battery is installed against a wall with a habitable room on the other side, a non-combustible material such as a cement sheet is required between the wall and battery.

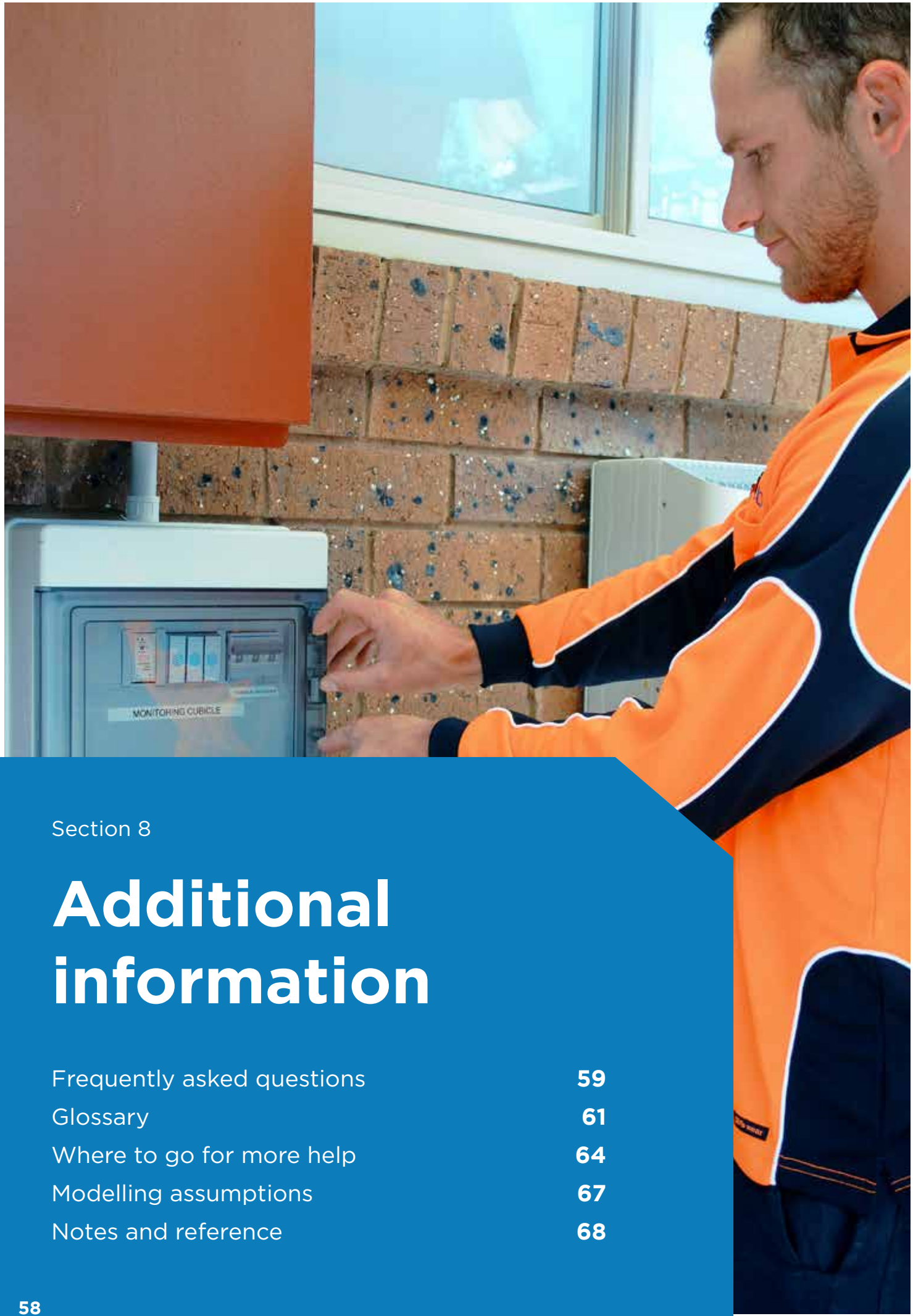
To ensure you are confident that your household meets the required standards, please ask your supplier and installer about how their products and installation conform. Battery storage standards continue to be refined and new standards are expected as the industry evolves.

The Clean Energy Council has developed a battery product safety guide based on industry best practices. The guide only applies to lithium-based battery storage equipment including battery modules, pre-assembled battery systems and pre-assembled integrated battery energy storage systems.

Visit **www.batterysafetyguide.com.au** to find out more.

For major incidents, call emergency services immediately.

Image courtesy of Solar Hub.



Section 8

Additional information

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Modelling assumptions	**67**
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Frequently asked questions

✔ **Can I get government support to install a home battery?**
The NSW Government's Empowering Homes program is providing access to interest-free loans to eligible homeowners so they can install a solar battery system. The program has initially been launch as a pilot in eligible postcodes. For more information visit energysaver.nsw.gov.au/solar-battery-loan-offer

✔ **Can I recharge overnight from the grid on my offpeak tariff?**
Overnight 'controlled load' offpeak power is installed in many properties on a separate circuit with a dedicated second meter. It is used to provide cheap power to hot water systems, some pool pumps and slab floor heating. None of the three electricity network providers in NSW currently allow overnight home battery charging on an offpeak controlled load circuit and tariff.

However, home batteries connected to the main circuit can be charged at offpeak rates for households on a time of use tariff. When this is done, households can partly offset the cost of their battery purchase by charging the battery at the offpeak rate and discharging it to meet consumption during the peak period.

✔ **I'm in an apartment with no solar; is a battery any use to me?**
You can install a battery (with strata approval) to offset peak period consumption on a time of use tariff. Currently, this is unlikely to be an economic option, even if you are on a time of use tariff. As an alternative, buying GreenPower is a very easy way for apartment owners to access renewable energy (see 'GreenPower' on page 31).

✔ **Will I benefit as a landlord?**
If you already have solar or are thinking of installing a home solar battery system, you have options to ensure that both you and your tenants get a financial benefit.[10] There are no direct financial benefits that are specific to installing batteries alone. However, adding a solar or solar battery system may make your property more attractive to tenants and increase its resale value.

✔ **Which batteries are Australian made?**
The majority of batteries are manufactured overseas, though there are some which are developed by Australian companies. In recent years, several battery assembly facilities have established themselves in South Australia.

✔ **Will I have to go on a time of use tariff if I install solar or a battery?**

This depends on what tariffs your retailer offers for your configuration, so be sure to check with them first. If you don't think the tariff you are currently on suits your needs, shop around. Visit Energy Switch, energyswitch.service.nsw.gov.au for more information.

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

There is currently no fixed network charge for households that are disconnected from the grid. However, disconnecting from the grid can incur fees and in most cases disconnecting is unlikely to save you money even without a daily service charge. If you or a future owner want to reconnect the property to the grid this will also incur a cost.

✔ **Can I use my rooftop solar energy to charge an electric car?**

In theory, battery electric vehicles can be charged solely from your rooftop solar energy, but with the battery packs of electric cars ranging from 16 to 85 kWh or more, you would need a relatively large solar system with lots of spare capacity to supply a full charge from solar. Your electric vehicle can be partially or fully charged from the grid to make up the difference.

✔ **I want to get an electric car eventually; can I use it to power my home too?**

Depending on the charger type used in the vehicle, some electric vehicle batteries can be used to supply power to the house when they are not being used or recharged. However, this is only offered by a limited number of electric vehicle manufacturers at present.

Image courtesy of Renew.

Glossary

AC	Alternating current—the form of electricity used in household circuits and on the grid
AEMO	Australian Energy Market Operator
AS4777	The Australian Standard relating to solar and battery inverters
AS/NZS 5139	The Australian Standard for safe installation of battery systems
BMS	Battery management system—software that regulates a battery's charging and discharging cycle and other functions
CEC	Clean Energy Council
Controlled load	Overnight 'controlled load' power is installed in many properties on a separate circuit with a dedicated second meter. It is used to provide cheap power to hot water systems, some pool pumps and slab floor heating. Often called offpeak power, it should not be confused with the offpeak rate on a time of use tariff, which is provided via the main circuit
Cycle life	The number of times a battery can be discharged before reaching end-of-life. Note that what constitutes a full discharge is often poorly defined
DC	Direct current—the form of electricity produced by solar panels and used in battery systems
DC to DC converter	Steps the battery voltage back up to a nominal voltage that meets the requirements of the existing grid-interactive inverter
DoD	Depth of discharge—the percentage of a battery's usable capacity that can be discharged from a battery without causing significant loss of storage capacity
EMS	Energy management system—software that interacts with the solar system, inverter, home appliances and the grid to optimise a battery's performance and value
Feed-in tariff	Payment from your retailer (usually in cents per kilowatt-hour) for your excess solar generation exported to the grid
Grid	The electricity system, with poles and wires in your street

Glossary

Hybrid	In relation to inverters, means a solar plus battery inverter (not an inverter that is both ongrid and offgrid capable, as some people use it)
Inverter	Device connecting your solar and/or battery system which converts DC (solar or battery) to AC (household) electricity. A hybrid or multimode inverter connects to both the DC solar panels and the battery
IP rating	Ingress protection rating—determines whether battery is suitable for indoor or outdoor installation; the higher the rating, the more weather resistant it is[11]
kW	Kilowatts—the instantaneous power output available to discharge
kWh	Kilowatt hours—the total energy available to discharge
Lithium-ion	The most common battery chemistry. The most common varieties are LNCM (lithium nickel cobalt manganese) and LiFePO4 (lithium ferrous phosphate)
Load profile	The energy usage pattern over a day or 24-hour period—it can be characterised based on when energy is used the most—e.g. peaky (energy use is up and down through different parts of the day) or flat (relatively consistent usage throughout the day)
Meter	The device in your switchboard or meter box that measures the amount of electricity being imported to or exported from your house. The main types are accumulation versus interval; gross versus net; and smart versus an older style. The optimum for a solar battery system is a smart meter, which will also be an interval and a net meter. A solar battery system needs to be connected to a smart meter before it can be connected to the grid.
Network	Your local distribution network service provider. In NSW this is either Ausgrid, Endeavour Energy or Essential Energy
Nominal capacity	The standard capacity designated by a battery manufacturer to identify a particular battery cell model—may be 10–20 per cent greater than the usable capacity
Payback period	The number of years it takes for the capital cost to be recovered through lower energy bills
PV	Photovoltaic solar panels

Retailer	The company responsible for selling you electricity (and perhaps gas); also responsible for paying any feed-in tariff for excess solar energy exported to the grid
Retrofitting	Installation of a battery where there is already an installed solar system. The term is generally used where something is added after the initial manufacturing or construction is complete
Roundtrip efficiency	The ratio of a battery cell's output during discharge to its input during charge
Solar electric hot water	Electric hot water system heated by rooftop PV via the main household circuit—as distinct from solar thermal or heat pump hot water
Switchboard	A box or board containing switches, fuses or circuit breakers for each electrical circuit in the home. This may be co-located with the meter in the meter box, or it may be separate, for example inside the home
Smart meter	A smart meter (also known as a digital meter or 'type 4' meter) is a device that digitally measures when and how much electricity is used at your home. A smart meter sends this information back to your energy retailer remotely, without your meter needing to be manually read by a meter reader
STCs	Small-scale technology certificates—rebates available under the federal Small-scale Renewable Energy Scheme for rooftop solar systems (but not for batteries)
Three phase power	Alternating current power supply using three instead of the usual single waveform, used to supply power to heavy loads such as electric vehicle fast charging, large power tools or industrial equipment
Tariff	The rates you are charged for electricity—usually flat (the same rate at any time) or time of use (with different rates for peak, shoulder and offpeak use) for households
UPS	Uninterruptable power supply, which has no lag time between a grid power outage and the battery starting up (unlike other backup power systems, which may have a short time lag

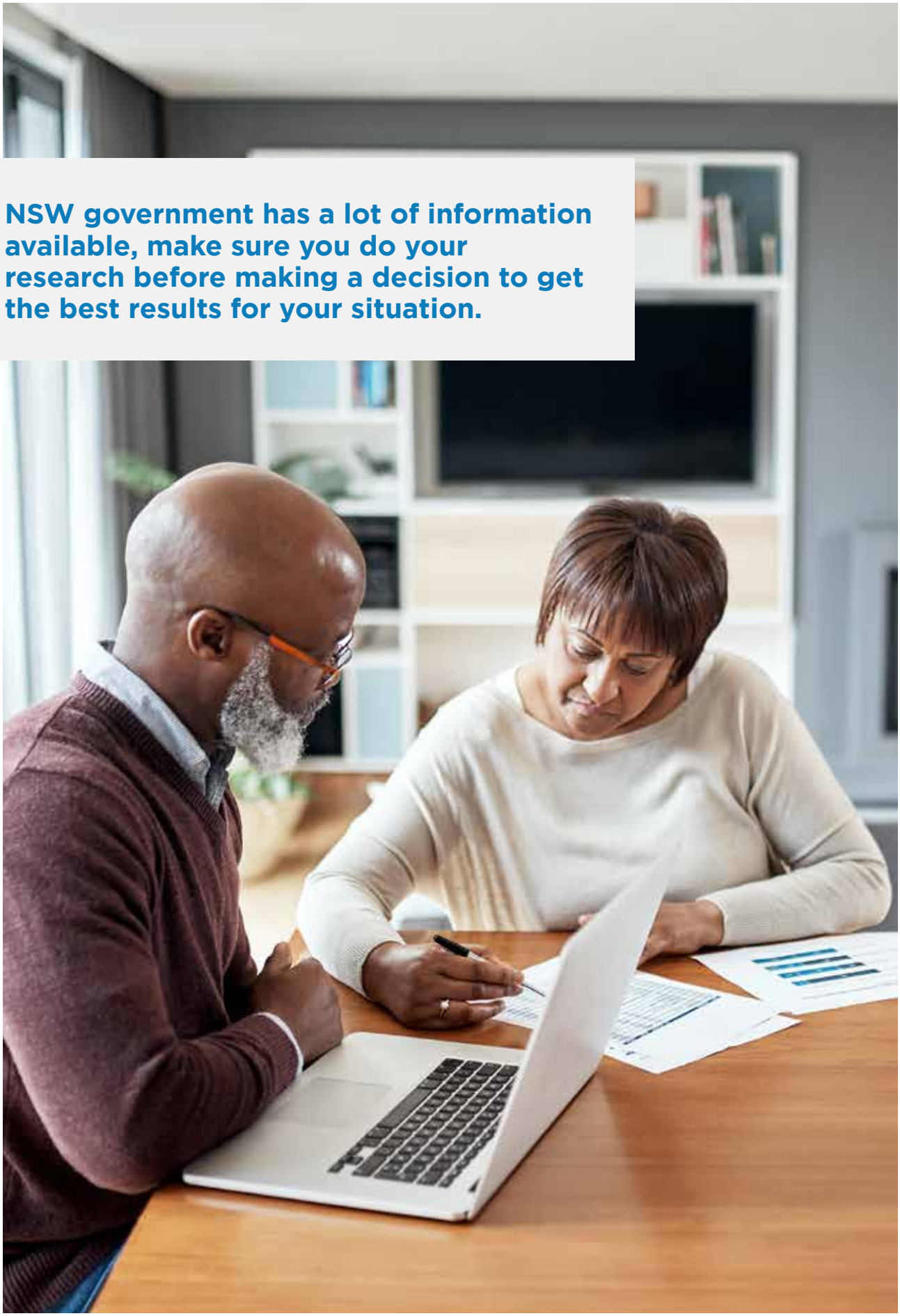
Where to go for more information

Australian battery comparison websites	**Canstar Blue customer satisfaction research** www.canstarblue.com.au/solar-power/list-of-solar-battery-retailers **National Distributed Energy Resource Register** www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/DER-Register-Implementation **Solar Quotes** www.solarquotes.com.au/solar-calculator
Battery technology information	**Educational website on all things battery** www.batteryuniversity.com
Business and industrial customers	**Energy Saver NSW for business** www.energysaver.nsw.gov.au/business
Connecting to the grid	**Endeavour Energy** www.endeavourenergy.com.au > residential and business > network connections **Ausgrid** www.ausgrid.com.au > connections > connecting embedded generation **Essential Energy** www.essentialenergy.com.au > our network > connecting to the network
Consumer complaints	**NSW Fair Trading** www.fairtrading.nsw.gov.au **Energy & Water Ombudsman NSW** www.ewon.com.au

Consumer guides and information	**Clean Energy Council website on buying battery storage** www.cleanenergycouncil.org.au/consumers/buying-battery-storage **Clean Energy Council Guide to Installing A Household Battery Storage System (2019)** assets.cleanenergycouncil.org.au/documents/consumers/battery-storage-guide-for-consumers.pdf **Choice How to buy the best solar battery storage** www.choice.com.au/home-improvement/energy-saving/solar/buying-guides/battery-storage-buying-guide#types
Installer accreditation	**Clean Energy Council accredited installer list** www.cleanenergycouncil.org.au/consumers/buying-solar/find-an-installer
Meters	**Energy NSW smart meters** energysaver.nsw.gov.au/households/understand-your-usage/smart-meters **Energy NSW factsheet and FAQs** energysaver.nsw.gov.au/media/1456/download
NSW Home Solar Battery Guide	**Energy NSW** energysaver.nsw.gov.au/solar-battery-systems
Offers and tips to help reduce your energy use	**Energy Saver NSW** energysaver.nsw.gov.au

Where to go for more information

Recycling and disposal	**Australian Battery Recycling Initiative** batteryrecycling.org.au/recycling/energy-storage-batteries **CSIRO lithium-ion battery recycling report** www.csiro.au/en/Research/EF/Areas/Grids-and-storage/Energy-storage/Battery-recycling
Safety	**Clean Energy Council** www.cleanenergycouncil.org.au/industry/products/batteries/battery-safety-guide
Sizing and pricing calculators	**Renew basic solar and battery advice calculator** www.renew.org.au/free-solar-and-battery-advice **Renew Sunulator solar feasibility calculator in MS Excel** www.renew.org.au/resources/sunulator **Solar Choice online battery calculator** www.solarchoice.net.au/blog/solar-pv-battery-storage-sizing-payback-calculator The NSW Government does not fact check or endorse these calculators.
Solar panels	**Energy Saver website about installation and connection of solar panels** energysaver.nsw.gov.au/households/solar-and-battery-power/installing-and-connecting-solar-panels
Tariff comparison	**Energy Made Easy** www.energymadeeasy.gov.au **Energy Switch** energyswitch.service.nsw.gov.au **IPART NSW solar feed-in tariff information** www.ipart.nsw.gov.au/Home/Industries/Energy/Reviews/Electricity/Solar-feed-in-tariffs-201920



NSW government has a lot of information available, make sure you do your research before making a decision to get the best results for your situation.

Modelling assumptions

ITP modelled the scenarios summarised in Figure 10 on page 35 of the guide and described in detail in the five practical examples. This work was conducted in January 2020 using ITP's knowledge of current market prices for electricity, solar PV and battery energy storage systems. Further assumptions are provided below.

- Network electricity tariffs are standard midrange flat or time-of-use offers for the selected locations.
- Solar panels were assumed to be north-facing and tilted at 20 degrees above horizontal. The system was assumed to be operating at a performance ratio of 80 per cent.
- HOMER Pro simulates solar generation for each interval based on horizontal irradiance data, the angle between the sun and the solar panels, and the performance ratio. For this modelling, irradiance data was downloaded from the Atmospheric Science Data Centre at NASA's Langley Research Center.

- An energy balance is conducted for each hour of the simulation by considering the prevailing load and solar generation, with the battery then charging or discharging so as to minimise grid import and export.
- Import and export tariffs are applied to the net load, depending on the prevailing tariff for that hour of the simulation.
- A small cost was assumed for the annual operation and maintenance. This cost was calculated as 0.5 per cent of the estimated capital cost.
- Component replacement was not modelled.
- Gird-connected battery systems were assumed to have a round-trip efficiency of 88 per cent. Offgrid battery systems were assumed to have a round trip efficiency of 80 per cent. The useable capacity was limited to 70 or 80 per cent of the initial nominal capacity (depending on the warranty conditions of the battery system assumed for the scenario). Degradation of the usable capacity was not modelled.

Notes and references

1. Clean Energy Regulator via www.cleanenergyregulator.gov.au
2. Energy consumption breakdown based on June 2017 analysis by the NSW Office of Environment and Heritage for a Western Sydney household using electricity for hot water heating and space heating.
3. See www.energyrating.gov.au
4. See www.renew.org.au/articles/energy-flows-how-green-is-my-solar
5. That is, the battery will pay for itself within the warranty period and will save money compared to network imports over the same period. However, solar-only may still provide a superior return on investment.
6. There are battery chemistries requiring regular maintenance such as weekly discharging, but this is often done automatically, and lithium-ion is not among them.
7. You can tell by checking the IP or ingress protection rating, which combines measurements for resistance to dust and moisture. It should be 55 or above, and preferably 67, for external installation. See www.batteryjunction.com/ip-rating-guide.html for more detail.
8. Habitable rooms include a bedroom, living, lounge and dining room. A full list of what is considered a habitable room can be found in the Building Code of Australia.
9. For more details, refer to manufacturers' recommendations and the Clean Energy Council battery installation guide.
10. Usually you can provide the energy to your tenants in return for a slightly higher weekly rent without a change in the metering. However, if you have more than one tenant the wiring and metering will need to be set up to ensure than all tenants receive the solar and battery energy. Or you may be able to sell the energy to them by changing the wiring and meters so there is a main or 'parent' meter for the entire premises and create an embedded network. If you look at this option you should contact the Australian Energy Regulator as you may need to obtain approval to operate as an 'exempt retailer': www.aer.gov.au/retail-markets/retail-exemptions. There may be taxation benefits, as solar and batteries are capital improvements that can be offset against rental income.
11. See www.batteryjunction.com/ip-rating-guide.html for more detail.

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dpie.nsw.gov.au

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