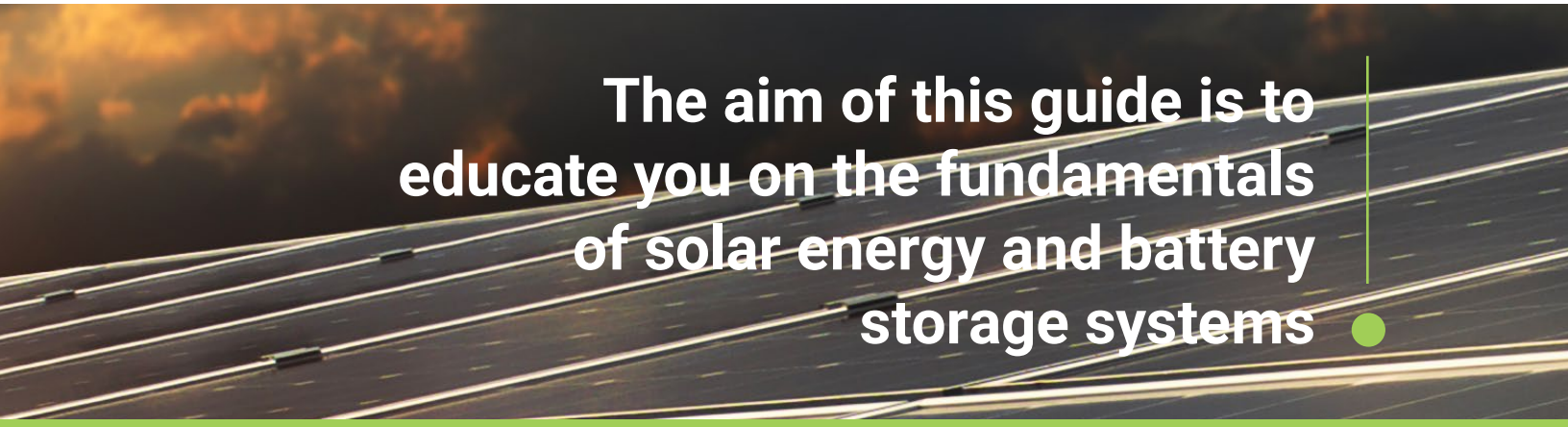
MY ENERGY GUIDE

SOLAR 101

Your journey to a cost efficient and sustainable future

Contents



The aim of this guide is to educate you on the fundamentals of solar energy and battery storage systems

Introduction

Australia has one of the highest per capita take up rates of solar anywhere in the world with 3 out of 10 properties having some form of system fitted[1].

But that still leaves 7 out of 10 to go; and the market shows no signs of slowing down especially given the recent electricity price increases and increasing consumer awareness of their household's carbon footprint[2].

The process of choosing a solar system and installer can be quite confusing and time consuming; complicated by numerous 'shady' solar companies and aggressive sales tactics. In fact, some of the most common reasons people give for not yet having installed solar is 'distrust of aggressive sales tactics', 'misleading advertising and unmatched expectations' and 'misinformation about solar system costs'.

The aim of this guide is to educate you on the fundamentals of solar energy and battery storage systems, and to enable you to hold your own with even the most battle-hardened solar salesperson!! But more importantly it should help to ensure you get the right system for your needs and at the right price.

The information presented in this guide is based on my personal experience. I have invested a significant amount of time and energy in the electrification of two homes and one business over the past few years. This includes a number of solar systems on differing roof types, battery storage, two EVs, numerous electric bikes, the retro fitting of some old gas appliances with electric and the early-stage development of software to truly make your home "smart". Hopefully some of the lessons I have learned can help you start your journey to a cost efficient and sustainable future.

1. Per https://www.energy.gov.au/households/solar-pv-and-batteries
2. AEMO forecasts an increase in household roof top solar to 65% by 2050. The AER announced electricity price increases up to 18% from 1 July 2022 (https://www.abc.net.au/news/2022-05-26/benchmark-power-prices-electricity-bills-to-soar-australia/101098128).

1 Key takeaways to help you on your journey

Solar will save you money and reduce your carbon footprint. If you own your own property then the installation of a solar system should be a 'no brainer' from both a financial and environmental perspective. The payback period on my system is 3.8 years, and it will save us approx. $85,000 over its life. The system will also save approx. 305 tonnes of CO2 emissions.

Ask around to find a trusted installer. Avoid random Google searches and social media adverts promising cheap looking prices when choosing an installer; chances are they are using poor quality equipment and/or will deliver a poor service and installation. Word of mouth referrals from your friends and colleagues are the safest bet to ensure a high-quality service.

Do some research. Once you have a quote or two via a trusted referral, then do some research online to ensure the components you are being quoted for are of a sufficient quality for the price. Some websites to help you are detailed on the following pages.

If you own your own property then the installation of a solar system should be a ‘no brainer’ from both a financial and environmental perspective

Size matters! If your budget can stretch, go for as big a system as your house can support. This will future proof you as you use more power over time e.g. as EVs, heat pumps and batteries become more prevalent. You never hear anyone say that they wish they installed a smaller system!

Do your homework on your retail plan. The difference between the right plan for you and a poor plan for you could be the difference between a monthly rebate to you from your retailer or you paying your retailer hundreds of dollars!! Shop around once you have 3-6 months of actual consumption and production data following the installation of your solar system. You will then be in good position to find out exactly the best plan for you as opposed to estimating in advance. Keep an eye on the My Energy Guide website for an online tool which will shortly be released that will help you with this.

2

Solar basics

A roof top solar systems works by converting the sun's energy into electrical energy for your home or business. Your home typically still remains connected to the grid.

If your home is using more power than your solar system is producing, then the difference is drawn from the grid (or your battery if you have one, more on that topic later). You only pay for the power drawn from the grid with the power generated from your solar system being free.

If your home is using less power than your solar system is producing then the difference is exported to the grid, and you should receive a rebate from your utility company for this.

Figure 1: Home using less than solar production and exporting to the grid

Figure 2: Home using more than solar production and importing from the grid

A typical solar system consists of two main components; the solar panels and the inverter. These are discussed in further details below.

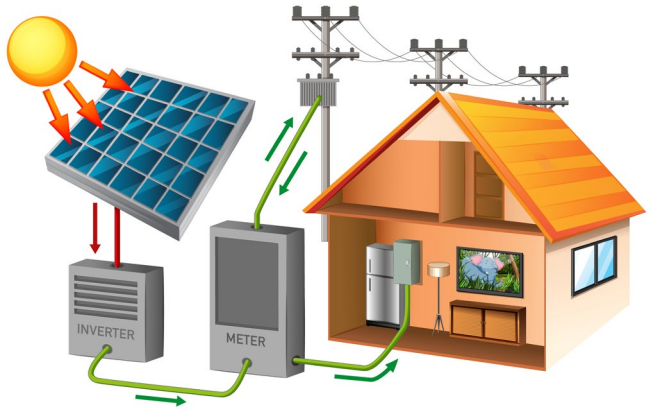
2.1 Solar panels

What type and brand of panel should I choose?

Type of panel

The three most common types of solar panel on the market are **monocrystalline** and **polycrystalline** thin film. There are a lot of articles on the internet discussing panel types if you want to learn more. Generally speaking, **monocrystalline** solar panels are highly efficient and have a less intrusive design, but they come at a higher price point than **polycrystalline** panels. **Thin film** solar panels are the cheapest, but have the lowest efficiency rating and therefore generally require a lot of space to meet your energy needs; they generally aren't used for residential systems, more commercial systems.

If you can afford the investment then generally **monocrystalline** is the way to go. But overall, the general consensus amongst industry experts is that the brand of solar panels and the solar installer you choose can be more important than which type of solar panel you install.



Brand

This can be a bit overwhelming at first as there are literally hundreds of brands out there. But you can quickly narrow your selection down by considering a few key topics such as: the warranty period most suitable for your circumstances (e.g. how long you may reside in your property), the panel efficiency, if the manufacturer has a 'tier 1' rating and whether the panel manufacturer has local market support in Australia.

Warranty periods can range from 10-12 years for a budget panel up to 40 years for a high-quality premium panel like SunPower.

The efficiency of the panels correlates as to how much of the sun's energy that the panel can convert to electricity. The vast majority of quality panels on the market are now between 19-21% efficient i.e. they can convert between 19% and 21% of the sun's energy to electrical energy.

Bloomberg New Energy Finance ('BNEF') has developed a tiering system for solar panels to create a transparent differentiation between the hundreds of manufacturers on the market. With Tier 1 being the best and Tier 3 the bottom. Unfortunately, this list isn't available unless you pay a fee to Bloomberg! However, sites like Solar Analytica present a freely available list of Tier 1 panel brands that should correspond closely to the BNEF list.

The team from Solar Quotes have also done a great job summarising the best solar panel manufacturers. As to have the team from Clean Energy Reviews.

Takeaway – once you have a quote for a solar system compare the panels to Solar Analytica, Solar Quotes and Clean Energy Reviews, or other more well-respected sources, to ensure what the salesperson is telling you reflects reality.

Budget / Value

JinKO Solar
CanadianSolar
Trinasolar
SUNTECH

Premium

SUNPOWER
Q CELLS
tindo solar
solaredge

2.2 What size system is right for me?

Generally, most households, who aren't hindered by space, opt for a 6.6 kW system or a 10-13 kW system. Part of the driver for this is that a standard 5 kW inverter (more on inverters later) can typically handle a 6.6 kW of panels. So, if you want to go higher than 6.6 kW you will need a second inverter (or a larger than standard inverter). The cost of a second inverter may not justify a 7 or 8 kW system hence the majority of people who opt for a system larger than 6.6 kW end up with a 10-13 kW system.

System power generation generally tops out at 80%-85% of the size of the system e.g. a 6.6 kW system will produce a maximum of ~ 5 kW of power and a 10 kW system a maximum of ~ 8 kW of power. If your house does not operate any high-power items like an EV, heat pump, air conditioning or underfloor heating then a 6.6 kW system may suffice. But if you have any high-power items, or are thinking of acquiring them in the future, then you should go for a larger system – ideally as large as your roof can take! It is possible to add additional panels and inverters at a later date but doing so will likely cost you more money than installing up front in one go. I have yet to meet someone who wishes they installed less panels, but I have met plenty of people who wish that they installed more!

See the appendix for a list of the power consumption of typical household appliances which may help you decide on the best sized system for your circumstances.

Takeaway – if you can afford the outlay then install as big a system as your house can support upfront and in one go. This will future proof you and result in maximum cost savings with the greater electrification of transport and household appliances, and help to maximise home battery storage potential.

2.3 What is the best configuration for my roof?

North-facing solar panels will generate the most energy overall (~ 15% more than east/west and 30% more than south) given that the sun rises in east and sets in the west on a northerly trajectory. Therefore, the working assumption has always been that for solar to be worthwhile you need good northerly roof exposure.

But northerly panels will produce less in the morning and late afternoon compared to east and west-facing panels. Most working households will likely consume more energy in the morning and late afternoon so an east/west array should not be a deterrent to getting solar, and in fact it could actually be more beneficial for self-consumption and therefore maximum cost savings.

I have fitted solar to two houses with the majority of panels being east/west on both and it has worked extremely well.

Takeaway – if you house can support it, and you use power during the morning and late afternoon, then consider splitting the system between east, west and north facing aspects. In you don't have a north facing aspect, then only being able to use the east/west aspects should not be a deterrent.

3 What is an inverter?

The job of a solar inverter is to convert the direct current ('DC') from the solar panels into alternating current ('AC') used in your home and the grid (refer to the appendix for more detail on DC vs AC). The inverter also generally acts as the overall monitoring system for your solar giving you detailed statistics, through a mobile app, on how much power your solar system is generating, how much power your home is using and how much power is being sent to or drawn from the grid.

Inverters which support 11 kW of panels; complete with 'smart' EV charger. Tip - try and install your inverters out of direct sunlight as much as possible, either under cover or on the south side of your home.

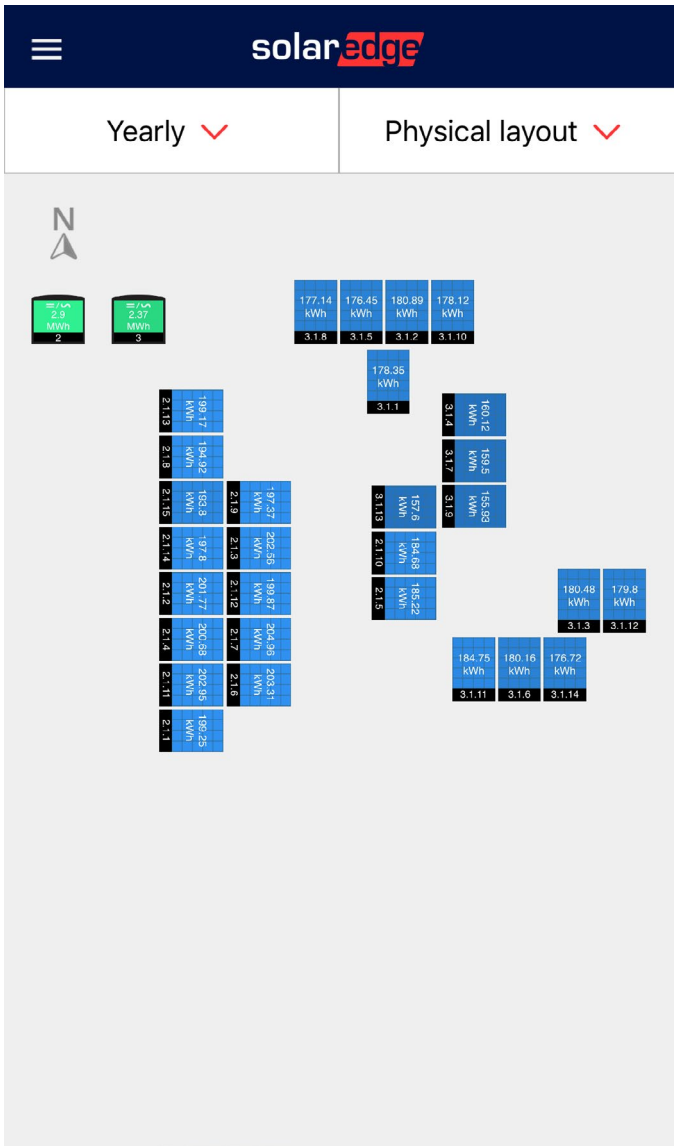
3.1 Types of inverter

There are two main types of inverter; a **string inverter** and **microinverters**. String inverters sit on the wall of your house where as micro-inverters sit under each solar panel. String inverters make up the vast majority of the solar installations as they are more cost efficient than micro-inverters and easier to maintain and access. As discussed earlier generally one standard home string inverter can support up to 6.6 kW of solar panels (although larger inverters are starting to hit the market).

However, the downside of string inverters is that if one panel in the 'string' is under performing due to shade or dirt then all panels are reduced to the lower level of performance. This is not an issue for micro-inverters. Think of the comparison to your old Christmas tree lights – if one light goes out, they all go out (string inverter) vs new modern LED lights – if one goes out the rest stay on (microinverter). So, if your roof is prone to shade then you may want to consider microinverters.

An alternative, and likely cheaper, solution to micro-inverters is to add 'optimisers' to a string inverter. This has the same effect as a micro-inverters, i.e. if one panel in the string is under performing, then other panels will not be impacted. I use a SolarEdge inverter combined with SolarEdge's optimisation system; SolarEdge is one of the few companies in the market to offer both inverters and optimisers.

Takeaway – If you are on a budget and your roof has no shading then a simple string inverter should suffice. However, if your budget can stretch, or your house is prone to shading, then you should consider micro-inverters or optimisers.



Screenshot from SolarEdge app, where you can monitor the performance of each individual panel with the installation of their optimisers. This is not possible with a standart string inverter.

3.2 What brand inverter is best?

String inverters typically range from $1,000-2,500, with the more budget brands like GoodWe and Sungrow being at the bottom of the range and more premium brands like SolarEdge. Enphase and Fronius being at the top end of the range. I have personally gone with SolarEdge for the systems I have installed but I have heard and read good things about GoodWe and Sungrow if you are on more of a budget.

Ensure that whatever inverter you choose has Wi-Fi connectivity and a good mobile app from which you can monitor the performance of your system and the consumption of power from solar and the grid.

The team from Solar Quotes have also done a great job summarising the inverter manufacturers. As to have the team from Clean Energy Reviews.

As a minimum you should check that the inverter you are thinking of buying has been approved by the Clean Energy Council so you can be sure it meets stringent safety requirements and also qualifies for a STC rebate.

Takeaway – Once you have a quote for a solar system compare the inverter in your quote to a third party source like Solar Quotes or Clean Energy Reviews, or other more well respected sources, to ensure what the salesperson is telling you reflects reality.

Budget / Value

GOODWE
SUNGROW

Premium

solaredge
Fronius
SMA
ENPHASE

3.3 Is my inverter battery ready?

Firstly, your home, and the grid, run off alternating current or AC power. Solar panels generate direct current or DC power and batteries only store DC power.

I have heard countless people say that their solar salesperson has told them that the inverter they are buying is "battery ready". This is a bit of a furphy as, for example, the Tesla Powerwall and any "AC coupled" battery should work with any standard inverter.

However, "DC coupled" batteries (e.g. SolarEdge, LG, BYD, Sungrow) will only work with a "hybrid inverter". A hybrid inverter manages your solar panels like traditional inverters, by converting DC power from the panels to AC power for the home and grid, but it can also send DC power from the panels into the battery, and change DC power from the battery to AC power for your home. For DC coupled batteries, the alternative to purchasing a hybrid inverter upfront is the addition of specific "battery inverter" at a later date when you add your battery.

Takeaway – unless you have a specific brand battery in mind, and that brand is a DC coupled battery, then don't worry about whether your system is "battery ready".

3.4 Single phase vs three phase?

A common question you will be asked is whether your house is "single-phase" power or "three-phase" power. Most homes will likely be single-phase. Having three-phase power gives you the ability to draw higher power loads than single-phase power. The cost to upgrade your house from single-phase to three-phase is approximately $2,000-3,000. However, it should not be required for the vast majority of solar and battery installations; it is more driven by the appliances you have and use. Your trusted solar installer will confirm this for you.

You can get single-phase and three-phase inverters. If you have three-phase power then unfortunately it's not as simple as a choosing a three-phase inverter. For example, if you want your solar to operate with battery back-up in the event of a grid outage then even if you have three-phase power you may still need a single-phase inverter in order to do this. I have three-phase power to my home but I operate single-phase inverters together with a Tesla Powerwall.

Takeaway – single phase-power and single-phase inverters should suffice for most people, even those with three-phase or who are considering an upgrade to three-phase power in the future. However, once you have found a solar installer then you should discuss this point further based on your exact system requirements.

4 Solar cost vs benefit

Cost

I paid $13,000 for an 11 kW system using higher-end components with panel optimisers. I also paid $5,500 for a 4.8 kW system using similar higher-end components. I have similar reference points from friends. So, for a more premium system expect to pay in the region of $1,100 to $1,300 per kW of capacity. For more budget systems prices tend to be in the region of $800 per kW of capacity (or 25-40% less). These prices are after the STC rebate and include panels, inverters and installation (refer to the appendix for more details on STCs).

Be very wary of unsolicited social media or Google adverts claiming 6.6 kW systems for $3,000. If the price is too good to be true then it generally is. You will likely either receive poor quality components and/or poor workmanship and support.

Cost benefit

During the sales process you will be presented with various pieces of analysis as to what the solar system will save you. This process has a number of assumptions and is inherently difficult to predict. However, the payback period should be somewhere in the region of 3-6 years depending on the cost of your system, how much energy you consume and at what time of day you consume such energy. So, for most households, after 3-6 years you will recover the cost of the system then for the remaining life of the system all energy generated is free!!

Below are the statistics from my system. Note I get paid 9 cents for every kWh that I feed back into the grid which is about standard these days.

UPFRONT COST:

$13,000

PAYBACK PERIOD:

3.8 years

$ SAVINGS:

3 YEARS	$10,200
5 YEARS	$17,000
10 YEARS	$34,000
25 YEARS	$85,000

IRR:

26.1%

CO_2 SAVINGS

3 YEARS	36.7 TONNES
5 YEARS	61.1 TONNES
10 YEARS	122.2 TONNES
25 YEARS	305.6 TONNES

Carbon benefit

The NSW grid is powered 70-85% by fossil fuels[3]. QLD is even worse and VIC is only marginally better[3]. So, if you consume power from the grid, no matter what tariff you are on, it is predominantly fossil fuel generated power!! The carbon saving from installing a home solar system can be significant. See above for the carbon saving of my system:

Takeaway – the installation of solar should make perfect financial sense. This is especially true given the recent announced electricity reference price increases. Installing solar also has the added benefit of significantly reducing your household's carbon footprint.

(3) Per AEMO dashboard https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/data-nem/data-dashboard-nem

5

Choosing the right installer

Unfortunately, too many people have had a negative experience when dealing with a solar company, either during the sales cycle and the installation or the after-market support. Choosing a good quality, well respected installer is crucial.

Avoid random Google searches and social media adverts when choosing a solar installer. Whatever you do, do not type the words "Cheap Solar" into Google!! You will be flooded by offers promising high-quality components for bargain basement prices. Chances are you will not have a good experience. Such installers hook you in with cheap offers often promising tier 1 equipment but then they swap out the promised equipment for cheaper and less reliable equipment, or up-sell to you after they have you hooked. And this is then often combined with a poor job on the installation which can lead to extra costs and safety hazards down the track.

Like most well respected tradespeople, the top solar installers will rarely have to rely on direct marketing or aggressive sales tactics to generate business – word of mouth will do it for them. My best advice is to therefore use your friends and colleagues who have solar in the first instance. If that doesn't yield any results then make sure you read online reviews from a reliable and independent source. As a bare minimum you should also check whether the installer you are working with is approved by the Clean Energy Council; you can check here.

Takeaway – avoid random Google and social media adverts when choosing an installer; chances are they are using poor quality equipment and/or will deliver a poor service and installation. Word of mouth referrals from your friends and colleagues are the safest bet to ensure a high-quality service.

6

Other solar considerations

I had personally never heard of possum or bird proofing a solar system until it was too late! A possum built a nest under our panels which caused some resulting damage, which in turn brought down half our panels for four weeks and cost us $600 to repair.

It turns out possums and birds nesting under panels is a fairly common problem. If your budget can stretch then ask your solar installer about fitting solar mesh to possum and bird proof your system. The cost to retrofit such protection is $1,000-2,000 but it should be significantly cheaper if you get it installed at the time that the panels are fitted.

Image of possum nest under our solar panels. The damage caused us to lose 50% of our output for 4 weeks and $600 in repair work.

With solar mesh fitted to stop possum and birds nesting under our panels. This can cost $1,000-$2,000 to retrofit at a later date, plus the costs to repair any damage from nesting. So if your budget can stretch it's probably a worthwhile addition to have fitted at the time of the solar installation.

7

Who is the best retailer for me?

This is where things really get challenging! Not only are there many different retailers but each retailer offers many different plans. What plans are available to you are also dependant on which underlying network you are connected to e.g. Ausgrid or AusNet.

Over the years I have tried numerous different online comparison sites but have generally found them either: not very helpful, plain wrong or too bias toward whoever is paying them kick-backs!!

This led me to building my own model to work out exactly the best retailer and plan for our specific circumstances.

It can be very hard to work out exactly the right plan in advance of any actual and meaningful actual data. By all means shop around once your solar is installed, based on what tools and data you have available at that point in time (e.g. the proposal from your solar installer, comparison websites etc.)

3-6 months after the installation of your system it is likely worthwhile re-visiting whether you are on the most economical plan. You will have actual data to base this on as opposed to high-level assumptions and forecasts. At this time, you can calculate exactly what your bill would have been based on different plans.

Keep an eye on the My Energy Guide website for an online tool which will shortly be released that will help you with this.

3-6 months post installation

Be aware of demand charges

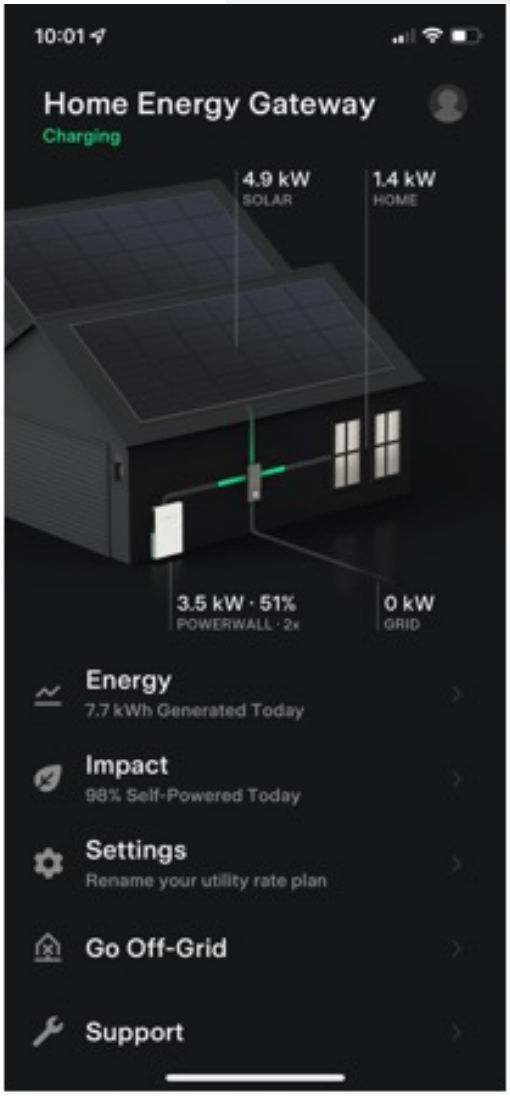
If you changed to a smart meter as part of the solar installation process, then be wary of a "demand charge" creeping into your billing. A tariff with "demand charges" can result in slightly cheaper rates but then you are subject to a separate charge based on your maximum power draw for a 30-minute period. This caught me completely off-guard and due to the relatively little amount that we draw from the grid it had impact of more than doubling our last bill and taking our effective rate to >60 cents per kwh. If a demand charge isn't right for you then contact your retailer to have it removed. Ausgrid's guidelines state that it can be removed one month after the installation of a smart meter.

Takeaway - get 3-6 months of actual consumption and production data following the installation of your solar system. You will then be in good position to find out exactly the best plan for you. Keep an eye on the My Energy Guide website for a tool to help you.

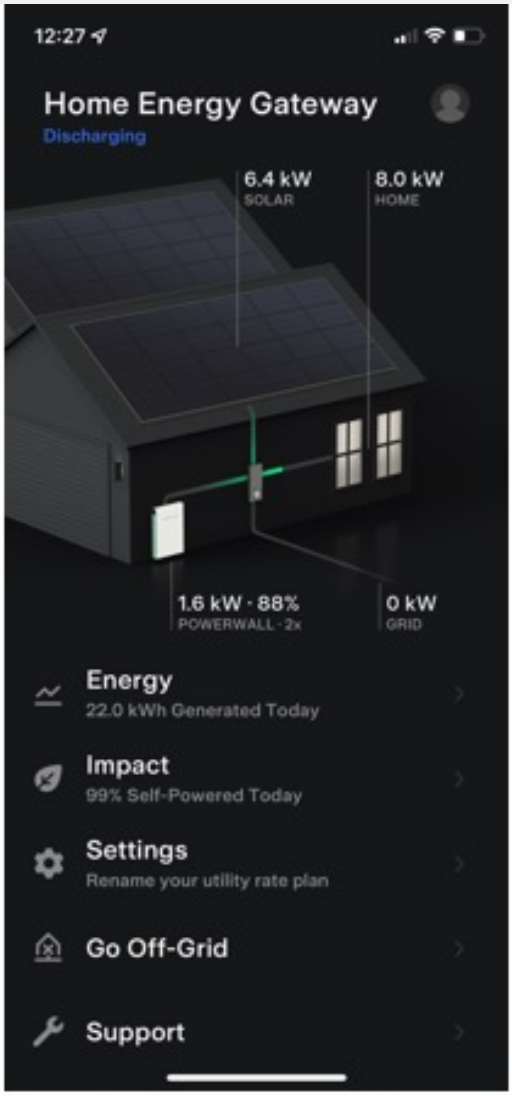
8 How does a home battery work?

A home battery system lets you capture excess solar from your roof to use at a later time when the sun isn't shining or the power demand of your home is greater than the supply from your roof.

The solar from your roof first goes to powering your home, then any excess goes into your battery, then when the battery is full any excess goes to the grid. If your home is using more power than your solar system is generating then it first draws power from the battery, and it only draws from the grid once the battery charge is depleted (see image 2).



Home using less than solar generation with excess going to the battery.



Home using more than solar generation with excess drawing from the battery.

Should I get a home battery?

Whereas the installation of a solar system is a no brainer whatever your motivating factor, the answer as to whether you should invest in a battery depends. What motivates you and your household? If it's access to the latest cutting-edge technology, reducing your impact on the environment or your home is prone to blackouts then you should absolutely consider complementing your solar system with battery storage. However, if the key deciding factor for you is financial return then the decision is not so clear.

Based on 23 months of actual data the payback period on my Tesla Powerwall 2 is 9.4 years. The cost of a single battery was $14,000 and it will take me 9.4 years to recover this cost through savings based on today's power prices. The warranty of the battery is ten years; however, I am expecting it will last for a number of years beyond this and I will therefore get a positive overall return on my investment. If the battery lasts for 15 years, then I will be cash positive by approx. $8,500 (which is about the same as I would get by leaving the $14,000 in a term deposit for 15 years). You may be able to reduce this payback period by joining a Virtual Power Plant ('VPP') whereby you get financial incentives for giving your utility company remote access to discharge your battery into the grid at times of high demand.

But in summary, if a return on your investment is a key deciding factor, then unfortunately the economics are unlikely to yet stack up for most people.

However, if you can accept the payback period then you will not be disappointed with the investment in a battery. I do not know a single person who has invested in a battery and later regretted it!! It's a great feeling cooking your dinner, watching TV or heating or cooling your home from the energy from the sun's rays as opposed to drawing power from the grid which is still primarily powered by coal and will be for the foreseeable future.

Takeaway – the economics of battery ownership are unlikely to currently stack up for most people. However, if your budget can stretch you won't be disappointed with the outcome. It is hard to see battery prices reducing in the short to medium term given global supply chain constraints and high-inflation.

UPFRONT COST:

$14,000

PAYBACK PERIOD:

9.4 years

$ SAVINGS:

3 YEARS	$4,500
5 YEARS	$7,500
10 YEARS	$15,000
15 YEARS	$22,500

IRR:

6.5%

I've considered the economics and I would love a battery, so what next?

There are a number of things to consider when choosing the right battery; too many to fit into this guide. Watch this space for my separate 101 Home Battery Guide.

Can I add a battery at a later date?

Do not worry, or get misled by solar salespeople, about ensuring your system is "battery ready". Any battery should fairly easily be able to be added to any solar system at a later date.

9

How does solar interplay with an EV

If you have an EV then solar is a no-brainer, and vice versa! In fact, up to 70% of EV owners in Australia have solar with the majority of the remaining residing in a property that isn't eligible for solar e.g. apartment or rented accommodation.

Combining an EV with solar is a great way to maximise self-consumption which is the best way to maximise financial savings and also your impact to the environment.

We have a Nissan Leaf and it is hands down one of the best investments we have ever made. It comfortably fits our family complete with pram, surfboards and bikes. We are now 14,000 kms in and we have not paid a cent for this, or emitted any CO2, as this charging has been almost exclusively from our roof using a 'smart' charger that only charges the car with excess solar.

Our Nissan Leaf (BEV) and electric bikes. All exclusively charged from solar energy. The Nissan Leaf is currently the only BEV in the Australian market that allows Vehicle to Home or Grid discharge ('V2H2G'), whereby excess power from your car can be used to power your home or sold back to the grid. However, at the time of writing, the hardware required for V2H2G has still not landed in Australia, it's currently two years late and counting. Estimated retail price for the hardware to enable V2H2G is ~ $10,000.

10

The smart home

Once you have a solar system then chances are you will start thinking about the best ways to maximise the power generated from it. The start of this journey may simply be to use the washing machine or dishwasher during the day instead of the evening.

However, as you add more and more high-powered items to your house, e.g. an EV, air conditioning, under floor heating, heat pump etc, then trying to balance consumption with solar generation can become quite the juggling act!! For example, to avoid going into the grid I am happy for my car to temporarily stop charging while I make lunch, but then turn on again once the oven and microwave have gone off. Not only does this save me money but it also reduces pressure on the grid and helps with the transition away from fossil fuels. Currently, this can be quite a manual process depending on the number of higher-powered items that you have.

Turning your home into a true smart home is a passion of mine. Currently it is possible to do so, even with a complex household, but it requires expensive hardware and installation by a professional electrician. I believe that there is a path to a software driven solution, that is brand agnostic, and as simple to use as the other apps on your phone. However, we are likely a few years away from such a solution existing – watch this space!!

Appendix 1
Glossary

AC - Alternating Current (AC) is an electric current which periodically reverses direction and changes its magnitude continuously with time. The Australian grid is AC and the majority of household appliances operate off of AC.

AEMO – Australian Energy Market Operator.

AER – Australian Energy Regulator-

DC - Direct Current (DC) is the one-directional flow of electric charge, i.e. it does not alternate direction like AC. The electrical energy generated by solar panels is DC, as is the energy stored in batteries. Inverters change the current from DC to AC so the energy can be used by household appliances.

BEV – Battery Electric Vehicle.

IRR – Internal Rate of Return. The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. IRR is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis.

STC – Small-scale Technology Certificates. Often, referred to as the solar 'rebate'. However, this isn't so much a form of government rebate, it is the carbon benefit of your solar system being sold on to organisations to help emit the carbon that they generate. The scheme is being wound down by 2030, and the amount that your STCs are worth is decreasing each year between now and then.

VPP – Virtual Power Plant. A virtual power plant (VPP) is a cloud-based distributed power plant that aggregates the capacities of distributed energy resources (DER), like home batteries, for the purposes of enhancing power generation. It allows your electricity retailer to draw the power from your battery a certain number of times a year and when demand on the grid is high.

Appendix 2
Power vs energy

Power and energy are closely related but are not quite the same. Think of power as the effort of work performed and energy as the time over which such power is applied. Power is typically measured in watts or kilowatts (kW) and energy in watts per second or kilowatts per hour (kWh).

To boil water in an electric kettle will need 2kW of power applied to the water for approx. three minutes. This will use 0.1 kWh of energy being 2 kW multiplied by 3 minutes/60 minutes. Your electricity retailer will charge you based on energy used, e.g. 30 cents per kWh.

Current, voltage and power

I'm sure you have heard of electrical current and voltage. Current is measured in amps. Think of it like the flow of water through a tap but instead it's the flow of electrons. Think of voltage like the pressure of water flowing through a pipe. Power is defined as current multiplied by voltage.

The Australian grid is at 230v. Therefore, the power that any given device uses is dictated by the current that it draws. Devices used from standard Australian plug sockets are limited to 10 amps of current, therefore meaning the maximum power that an item plugged into a standard plug socket can draw is 10 amps x 230v being 2.3 kW. This typically represents items like a kettle, toaster and washing machine.

Have you noticed how items like air conditioning, heat pumps, ovens and EV chargers do not have a standard plug socket? That's because they draw more than 10 amps of current and are therefore wired on separate circuits by a professional electrician.

The maximum power an item can draw if your house is on single phase power is approx. 6-7 kW. If you have three phase power this could rise to as high as 20 kW.

Appendix 3

Illustrative power draw of some typical household appliances

Item	Illustrative power draw	Cost to run per hour from grid(1)
Kettle	2.3 kW	$0.70
Toaster	1.5 kW	$0.45
Microwave	1.2 kW	$0.36
Modern washing machine 30 deg	0.2 kW	$0.06
Modern washing machine 60 deg	1.8 kW	$0.54
Modern tumble dryer with heat pump	0.8 kW	$0.24
Condenser tumble dryer	2.0 kW	$0.60
Fridge	0.1 kW	$0.03
TV	0.2 kW	$0.06
50 LED lights	0.4 kW	$0.12
50 Halogen lights	5 kW	$1.50
Air conditioning	4.0 kW	$1.20
Heat pump swimming pool	4.0 kW	$1.20
Filter swimming pool	0.8 kW	$0.24
EV Charger (single phase)	6.0 kW	$1.80
Modern dishwasher	0.8 kW	$0.24
Underfloor heating	2.0 kW	$0.60
Tesla Powerwall 2(2)	7.0 kW	N/a

(1) Based on a rate of 30 cents per kWh

(2) Can charge/dis-charge at up to 7.0 kW but it will charger at a lower power than this depending on excess solar available.

If you have a 6.6 kW solar system the maximum power that it will generate on a clear and sunny day will be ~5 kW. This is enough to cover most standard household appliances but not to cover multiple appliances used at once or higher power appliances like air conditioning, swimming pools or EV chargers. However, a 10 kW system will give you ~8 kW of power enabling you to run a high powered item like a swimming or air conditioning and give you some residual power for household appliances. Power generation will also be reduced on cloudy and wet days so a bigger system will make you less susceptible to using the grid during such days.

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