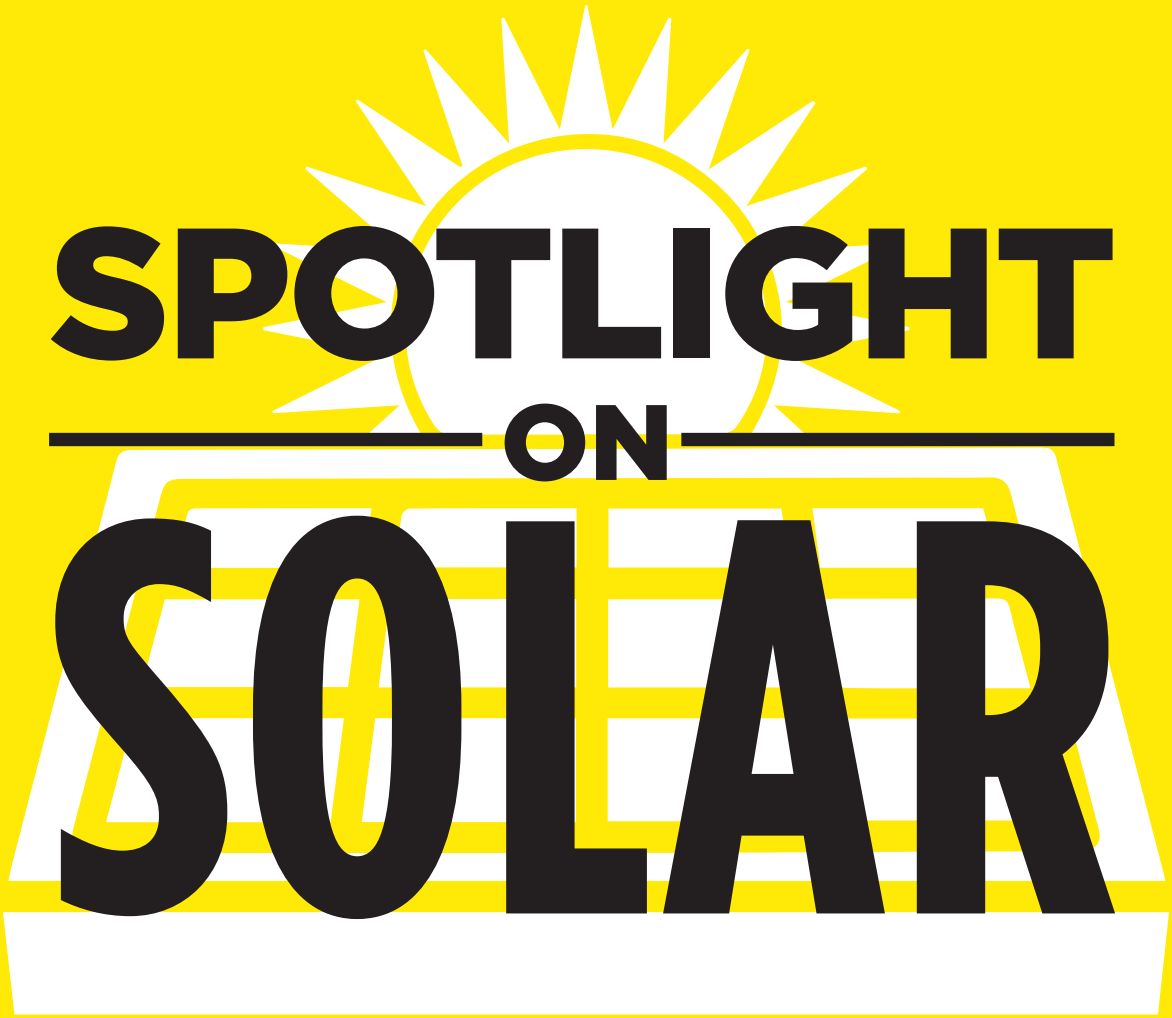


SPOTLIGHT ON SOLAR

YOUR INDEPENDENT GUIDE TO RESIDENTIAL SOLAR PV SYSTEMS

Eastland Network

Welcome

This is your independent guide to residential solar PV systems. It provides impartial, expert advice to help you decide whether solar is right for you. It also gives you the information you need to ask solar PV suppliers all the right questions.

In 2016 Eastland Network began a long-term trial at nine local homes to gather "real world data" about solar technology here in Tairāwhiti. It was also to understand the impacts that solar installations will have on our region's electricity network.

Who we are

Eastland Network is the electricity lines company for Gisborne, Wairoa and the East Coast. We are part of Eastland Group.

Together we're exploring the exciting potential of the rapidly changing energy sector, and how Tairāwhiti could be powered into the future.

We've established a regionwide network of electric vehicle chargers, delivered a home energy guide to help our community be more energy-efficient, and now we are reporting back on this long-term solar research trial.

eastlandnetwork.nz

Eastland
Network

About this guide

Part One. Solar power in the home

This part is a very brief explanation of solar power and how it's used in the home.

Part Two. Eastland Network solar trial

Read the highlights from Eastland Network's own solar trial to find out what you need to know before you get started.

Part Three. Solar PV at my place

Here, you'll get an idea of how well-suited your home is for a solar PV system and what things you might need to consider.

Part Four: Learnings from the Eastland Network solar PV trial

What can you learn from the solar trial?
What has Eastland Network learnt from the solar trial?
Is solar PV worth it, cost-wise?
Are batteries worth the expense?
Is solar financially beneficial?

Part Five: Choosing the right solar PV system

Tips and tricks to help you compare equipment, technology costs, and installers.

SO, YOU'VE DECIDED TO INSTALL SOLAR?

Part Six: Before you begin

In this part, you'll find a run-through of the documentation and regulations required before you sign up for solar.

Part Seven: Keep your system running

Find out how to maintain and operate your system so it performs at its best.

Part One: Solar power in the home

What is solar power?

Solar power is the process of capturing the sun's energy and turning it into a useable form of energy, like electricity, hot water or heating.

How solar is used

In most Kiwi homes, solar power is used in three ways:

1. Passive solar heating – this is where a house is designed to make full use of solar energy (the collection, storage and distribution of it), by maximising the sun's heat in winter and minimising it in the summer.

2. Solar water heating – this is the process of using solar energy to heat water, via a flat panel or evacuated tube, that's stored in a solar hot water (SHW) cylinder. Because these systems need direct radiation from the sun, they work best on cloudless, sunny days.

3. This is where solar energy is converted into electricity for use in the home. Unlike solar water heating, these systems can generate power on cloudy days, too. If your home is grid-tied, this system will reduce the amount of electricity being imported and used from the grid during the day by your household.

This guide specifically looks at solar Photovoltaic (PV) systems.

Grid-connected and off-the-grid systems

Homes with solar power will either be completely off the grid, running on a stand-alone system with no connection to the national grid, or will be grid-connected (or grid-tied) so that the home can still use power from the grid when it's required (for example, at night). If you do not have batteries as part of your solar system, chances are, you will still need to be connected to the grid.

Grid-tied systems also allow you to sell any unused power back to the grid.

Exporting solar power to the national grid

In a grid-connected solar PV system, there will be times when your system generates more power than what your home can use. When this happens, that excess generation is exported to the grid. The price of exported generation is different from retailer to retailer, but currently sits around 6-8 c/kWh. If you've been keeping an eye on your power bills, you'll probably have noticed this is a lot lower than the average variable price that you pay your retailer, which is currently between 30–35c/kWh in our region. That's because the exported solar generation price (sometimes called 'feed-in tariff') is only for electricity generation, and doesn't include other charges like transmission, distribution and metering.

Note that, over time, the 30-35 c/kWh variable price you pay may reduce. This may happen if electricity lines companies (like Eastland Network) change their pricing structure to one that is fixed and/or capacity based, rather than variable, to better reflect the fixed cost nature of distribution.

When does solar power work?

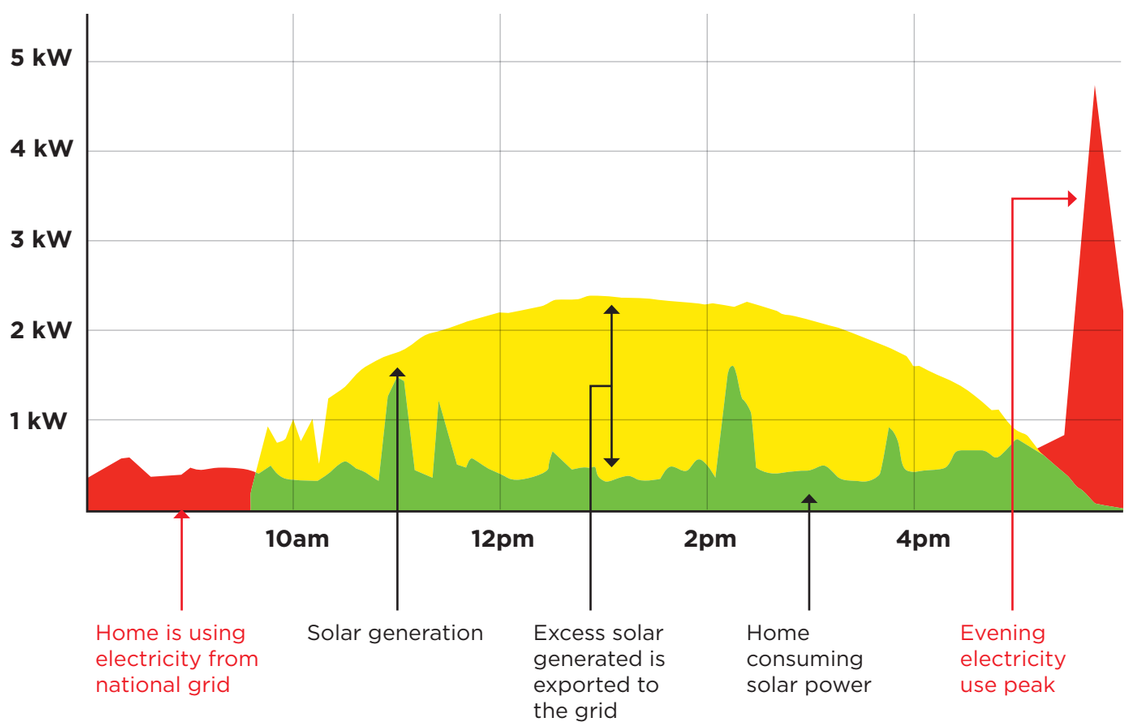
The chart below is taken from one of the homes on the Eastland Network solar trial. It shows an average day's electricity generation and consumption.

The yellow area shows the amount of solar power generated, throughout the day. Typically, the most solar generation happens between 10am – 4pm. Outside of sunshine hours, a home will need to use grid supplied electricity at home. Or install batteries to store unused solar energy throughout the day.

The red area is when the home is using grid-supplied electricity. As you can see below, the times when the home uses the most energy is towards the end of the day – when everyone gets home from work or school and uses electrical appliances, cooks dinner and turns on heat pumps or air conditioning.

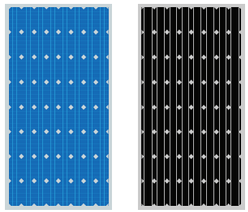
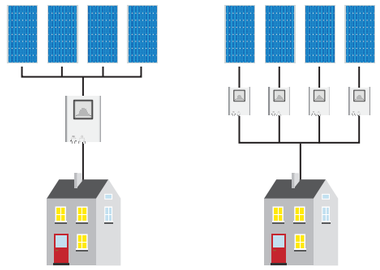
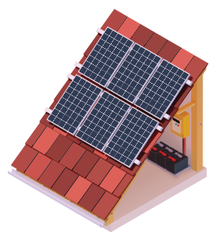
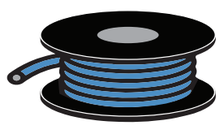
The green area indicates the solar electricity that is immediately consumed by the home. Every home has a 'base load' of electricity throughout the day. This made up of appliances like fridges, freezers, appliances left on standby, pool filters etc.

Solar electricity that is not immediately consumed by the home, is instantly exported back to the grid. Homes will receive payment for this generation from their retailer (as previously mentioned).

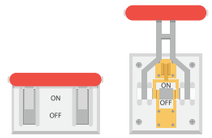


What are the parts of a solar PV system?

To capture the sun's light and convert it to electrical energy that can be used by your home (and even onsold to the national grid), solar PV systems require some fairly technical equipment. Let's take a look at the parts that make up most standard home solar PV systems.

EQUIPMENT	DESCRIPTION	APPEARANCE
Solar PV modules (solar panels)	Solar panels made from a semiconductor material (like silicon) convert sunlight into direct current (DC) electricity. Panels are usually made from either poly-crystalline silicon (left) or mono-crystalline silicon (right). When multiple panels are connected via cabling, they're called a solar array.	
Solar Inverter(s)	These convert a solar panel's direct current (DC) into 230V alternating current (AC), so that it can then be used in a standard grid-connected home. String inverters (left) convert the output of multiple solar panels connected in a series or "string". Usually, one inverter is needed for a house and is installed near the switchboard. Micro-inverters (right) convert the output of 1 or 2 solar panels and are installed behind the panel on the roof.	
Framing	Framing attaches the solar panels to your roof. It typically consists of aluminium rails, stainless steel clamps and "L feet" for mounting the solar panels on the roof.	
Cabling	For string inverters, solar panels are connected to the DC cable leads on the back of the solar panels, and DC cabling is then run through the roof or wall space. When micro-inverters are used, they're connected to the DC cable lead on the back of each solar panel and linked together by AC cables that run through a junction box, through the roof or wall space down to the main switchboard.	

QUICK TIP: Many monitoring systems don't track your household's energy usage so it's a good idea to consider investing in a electricity monitoring device. That way you can monitor how much of your household load is being supplied by your solar PV system, and adjust your electricity usage to maximise the benefit.

EQUIPMENT	DESCRIPTION	APPEARANCE
Switches	An AC supply switch will be installed in the home's main switchboard, as well as AC and DC isolators at the inverter.	
Control and Monitoring System	String inverters usually come with a panel display to provide basic information and system control, and a web-based monitoring system. Micro-inverters come with a central hub device that's plugged into a power point and connected to the internet.	
Import / Export Meter	Anyone on a grid-tied system will need an import/export meter to be installed (under NZ Electricity Industry Regulations). This records electricity imported from the grid and electricity exported back to the grid. Your power company (retailer) will arrange the meter installation, usually at a cost of around $100-150.	

QUICK TIP: Make sure you have the right inverter for your home both now, and in 25 years' time. Are there any trees nearby that will grow and shade your home? Or potential building developments nearby? A string inverter installation will only perform as well as its weakest panel. So, if one of the panels is shaded, the performance of ALL solar panels is reduced. On a micro-inverter installation, each panel performs individually, so only the shaded panel is compromised. Micro inverters are generally more expensive.

Part Two: Eastland Network solar trial

About the trial

Eastland Network's solar PV trial began in November 2016. The trial ran for several years, analysing data from nine Gisborne-based homes with rooftop solar PV systems.

The purpose of the trial was to gather "real world data" about solar technology, to help us assess the impacts that solar installations may have on our region's electricity network. Just as importantly, we also wanted to help consumers understand more about solar, so they could make an informed decision about whether it could be a good option for them.

The trial involved three solar installers. Each supplied three of the solar PV systems. The systems were sized to the individual customer's load and there were differences in the particular solar PV module and inverter technologies between each of the installers.

The below table shows key information about each of the trial sites.

Energy consumption has been estimated by combining half hourly import and export meter data from the households' electricity retailers, and the solar generation data from the solar PV systems. However, some gaps in electricity meter or solar data due to communications problems has meant that it was not always possible to estimate the annual consumption in all cases.

Table 1:
Trial participants - annual electricity usage vs key energy appliances in the home

		Annual Consumption(kWh)			Hot Water						Space Heating					Cooling		Appliances						Other Loads				Occupancy		
Site No.	No. of Phases	12m prior to Trial	2017 (Estimated)	2018 (Estimated)	Electric (Cylinder)	2nd Electric Cyl.	Hot Water Timer	Hot Water Diverter	HW Heat Pump	Gas	Elec. Heat Pump	2-3 Heat Pumps	Elec. Fan Heaters	Woodfire	Gas	Air Conditioning	Ceiling Fans	Fridge/Freezer	Dishwasher	Washing Machine	Dryer	Beer Fridge	Chest Freezer	Spa Pool	Underfloor Heating	Pool	Sewerage Pumps	Adults	Children	Home During Day?
1	1	5,800	6,437	9,347	●								●	●				●	●	●	●		●	•				2	2	Yes
2	2	11,680	9,062	9,387	●			●						●				●	●	●	●	●	●	●				2	1	No
3	2	6,933	6,156	6,163			●		●					●				●	●	●	●				●		●	2	2	No
4	1	14,800	13,399	11,893	●	●					●	●	●					●	●	●	●	●	●					4	1	Y(2017)
5	2	6,300	7,984	n/a	●		●							●	•			●		●	•	●		•	•		●	2	-	No
6	1	n/a	6,677	6,512	●	•		●			●	●				●		●	●	●	●	●						4	1	Midday
7	2	5,400	5,082	5,185						●				●				●		●	●	●	●			●		3	-	Y(3d/w)
8	1	5,536	5,175	5,073	●		●							●				●	●	●								2	1	No
9	1	2,910	2,455	n/a						●				●				●		●	•							1	2	No

A large dot in the table above indicates the household has a particular appliance. A small dot in the table indicates the household has a particular appliance but does not use it regularly.

Installed systems

A summary of the solar PV systems that have been installed for the nine sites is provided in Table 2 below. The installed solar capacities range from 2kWp to 5.2kWp.

The below should not be used as a measure for sizing a solar system for your home as the best system for your circumstances will vary, based on may factors. A good solar installer will work with you to determine your homes demand profile before specifying a system size.

Table 2:
Summary of the solar PV systems installed at each site

Site No.	PV Module			PV Inverter			Installed Capacity	
	Type[1]	Size (Wp)	Qty	Type	Size (kW)	Qty	DC (kWp)	AC (kW)
1	Si-poly	250	16	String	4.0	1	4.0	4.0
2	Si-poly	260	16	Micro	0.5	8	4.2	4.0
3	Si-poly	260	16	Micro	0.5	8	4.2	4.0
4	Si-poly	260	20	String	5.0	1	5.2	5.0
5	Si-poly	310	14	String	5.0	1	4.3	5.0
6	Si-poly	250	12	Micro	0.5	6	3.0	3.0
7	Si-poly	250	14	String	3.5	1	3.5	3.5
8	Si-poly	310	8	Micro	0.5	4	2.5	2.0
9	Si-poly	250	8	String	2.0	1	2.0	2.0

Wp - Watts Peak. The rating given for the total wattage output when the system is operating under perfect conditions.

kW - Kilowatt. A kilowatt is a measure of power equal to 1,000 watts.

kWp – Kilowatt Peak is the peak power of a PV system or panel.

[1]Si-poly refers to polycrystalline Silicon PV modules, Si-mono refers to monocrystalline Silicon PV modules

Part Three: Solar PV at my place

As the Eastland Network solar PV trial has shown, the amount of electricity produced by a solar PV system is influenced by a number of factors. These can include:

- The size, or capacity, of the solar PV system. This is measured in watts (W) or kilowatts (kW).
- The positioning of the solar panels, particularly in relation to North, and the tilt of the panels in relation to the ground.
- The time of the year. In summer there are more hours of daylight and the sun is higher in the sky. In winter daylight hours are less, and the sun is lower in the sky.
- How much cloud cover there is during the day and any potential sources of shading (e.g. trees, hills, and neighbouring buildings).
- The surrounding air temperature and wind. As solar panels get hotter their efficiency reduces, so cooler temperatures and wind will help the solar panels perform closer to their rated capacity.

Aside from these factors, what else can impact the efficiency of a solar system? Let's take a look at the main things to consider when deciding if solar power will work for your home.

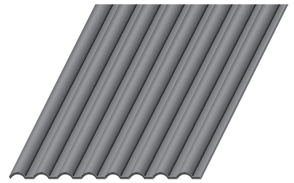
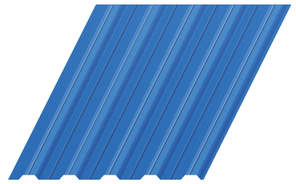
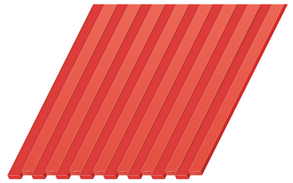
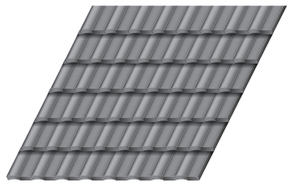
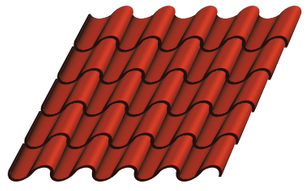
Is my roof suitable for solar PV?

Roof cladding

Some roofs are easier to install solar panels on than others. Some of the more common roofing products installed in NZ are listed. To make it easier to understand, we've listed the roof types in order of ease and cost to install, starting with those that are easier and cheaper to install, down to those that are more difficult and expensive to install.

Some solar installers won't install solar panels on roofs towards the end of this list, due to the risks associated with potential roof damage.

QUICK TIP: Before you go ahead with installing solar, consider the age of your roof. If it will need to be replaced within the next five years, it might not make sense to install solar before the roof is replaced.

ROOF TYPE	APPEARANCE	SUITABILITY FOR SOLAR INSTALLATION
Corrugated iron		**Very suitable.** Framing brackets can often be screwed into joists beneath the cladding, making use of existing screw holes.
Trapezoidal Long Run		**Very suitable** - similar to corrugated iron.
Standing Seam		**Suitable,** but special brackets will need to be fastened to the standing seams.
Decramastic / Pressed Steel Tiles		**Possible,** but requires tile hooks or hanger bolts to mount the framing on the underlying structure. There's also a risk of asbestos in pre-1990 decramastic tiles.
Concrete / Clay Tiles		**Difficult.** Similar to above, this requires tile hooks or hanger bolts to mount the framing on the underlying structure, and tile breakages are highly likely, so ensure you have spare tiles before you begin.
Flat Membrane Roof		This is the **most difficult** and expensive roofing type to retrofit solar to due to risks associated with the waterproof membrane. While installation of solar panels is possible, it's recommended that it's done as part of a new build or roofing replacement.

Roof age and condition

Solar panels are designed to last 25 years or more, and once the structure is installed you ideally want it to stay there as long as possible, so it's a good idea to check the condition of your roof and make any necessary repairs (e.g. replacing rusty iron or corroded roofing screws) or painting your roof prior to installation.

You might also need to consider whether the supporting roof structure is strong enough to hold the weight of the panels (which typically weigh around 18 kg per panel or 11 kg/m2).

We recommend engaging a licenced builder to check your roof's suitability.

Roof direction

North-facing roofs are ideal for solar PV systems because they're aligned with the sun to maximise the amount of generation they can produce. Unfortunately, lots of Kiwi homes aren't aligned directly north, instead facing north-east or north-west, which means solar panels produce around 2-4% less power over the course of a year.

What about roofs facing east or west? These roofs produce significantly less generation than their north-facing counterparts, and generate it at different times of the day. East-facing solar panels will produce about 18-20% less generation over a year compared to those that are north-facing, and will generate more in the morning than in the afternoon. A west-facing solar array in Tairāwhiti will produce about 18-20% less generation over a year compared to those that are north-facing, and will generate more in the afternoon than the morning.

Roof size

Most residential solar panels are approximately 1.65m x 1m in size. As a guide, you'll need around 6.6 m2 (either 6.6m x 1m or 3.3m x 2m) of available roof space for every 1.0 - 1.3 kW of your solar PV system (for a standard sized system using 250W to 315W panels).

For example, a 3kW system of 250W solar panels would require 19.8 m2 of roof space, and the same sized system of 300W solar panels would require 16.5 m2 of roof space.

Roof pitch (or angle)

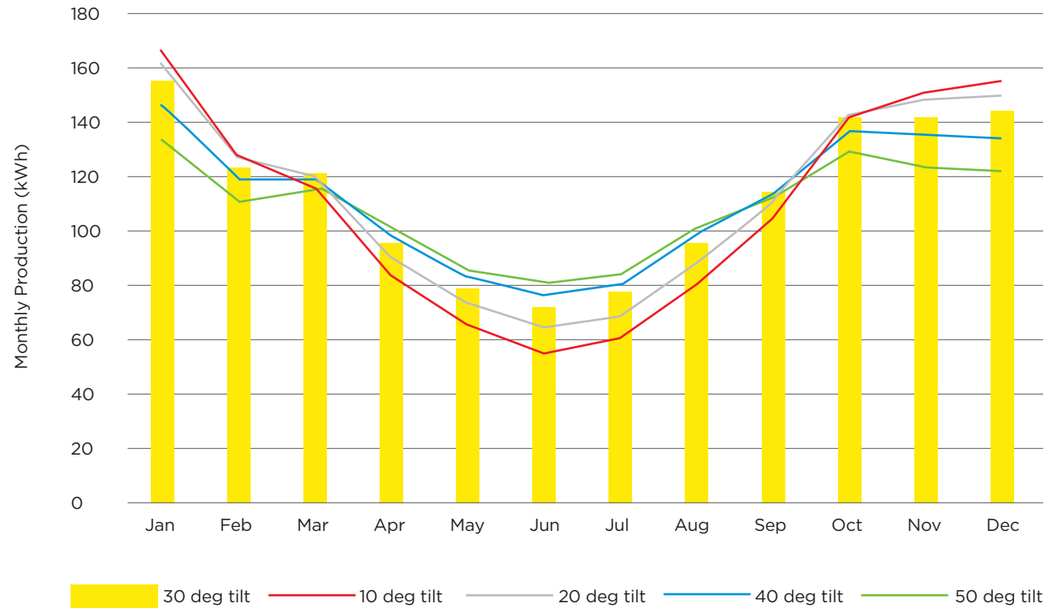
For a north-facing roof on a house in Tairāwhiti, the best roof pitch is between 30-35°. That will place your solar panels in the best position to maximise annual generation.

Roofs with lower or higher pitches than this will produce less than the optimum annual generation, and will also be affected by changes in seasonal sunlight: the lower the pitch of the roof, the more the system will generate in summer and less it will generate in winter; the higher the pitch, the more the system will generate in winter, and the less it will generate in summer.

Shading

Shading from nearby trees or buildings can have a big impact on the performance of your solar PV system, so it's a good idea to consider trimming or removing any of your own trees that are shading your roof. When it comes to buildings or trees on neighbouring properties, consult with your solar installer about whether they're likely to have any impact on the performance of your system, and what can be done to reduce the impact. There are a number of options to help minimise the impact of shading, including installing solar panels on other available roof areas, or using micro-inverters to limit the shading impact to only the specific solar panels that are in shade at any time of the day.

Monthly solar production - North-facing 1kW solar PV array in Gisborne at different tilt angles



QUICK TIP: You need to have a good idea of how much power a solar system produces over a year, right here in Tairāwhiti. In our region, with our sun, a north-facing solar array tilted at about 30° should generate about 1,400 kWh per kW of installed capacity. That's providing there are no significant sources of shading nearby.

How does my house use its power?

Solar PV systems without any form of battery storage can only supply electricity during the day when there's sunlight, so they work best for households with electrical loads that are switched on throughout the day when that electricity can be used. That makes solar PV ideal for households with electric hot water systems, electric appliances, heat pumps, pool heaters and when there are family members home in the daytime.

But solar PV systems aren't ideal for houses with nobody home during the day, hot water that's heated by gas, or where the house is heated by gas or wood fires.

What can I change?

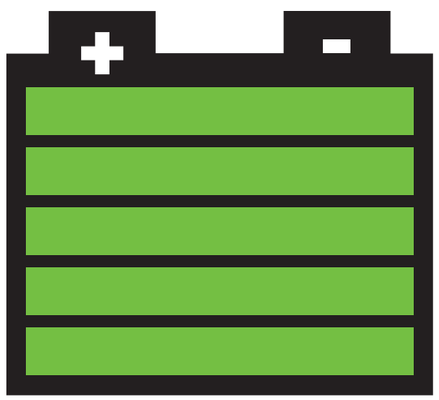
If you don't intend to invest in battery storage, it's really important to consider whether you'll be able to capitalise on your solar generation throughout the day to make it economically viable. For it to pay off in the long run, you'll need to maximise the amount of solar energy that's used in the home and try to minimise the amount that's exported to the grid; this is because the price of buying your electricity from a retailer is much higher than what you'll be paid for any energy that you export.

Loadshifting

You can capitalise on your solar generation by changing the times of day and night that you use your power so that you're benefiting from the daylight hours. Although it can be tricky to adjust to these changes, there's now some great technology available to help with this, including smart load control devices that can do most of the load shifting for you: solar hot water diverters (or timers) use the hot water cylinder as a daytime energy storage system, while most dishwashers, washing machines and dryers now feature a delayed start function so that they can be switched on between 10am and 4pm when the most solar electricity is being generated.

Monitoring

It's also crucial that you know exactly how and when your home is generating and using its power. Fortunately, there are lots of great monitoring systems on the market that are both easy to use and provide real-time feedback about your power use and your current solar generation. While it can be costly (adding up to around $1,000 to the cost of the solar PV system), a monitoring device can help you reduce the amount of solar energy exported to the grid.



How many electrical phases supply my property?

Electrical phases are the electrical system that supplies energy from the power lines to your property. Your connection will be either a single, two or three phase connection. Homes with one phase are ideal for solar, because the appliances and systems that are using power during the day will be on the same phase as the solar.

Homes on a two or three phase supply are a bit more complicated to connect to solar. Generally, a solar PV system on a home with two or three phase connections will only be able to supply the appliances that are on the same phase as the solar PV system.

A solar PV system can supply multiple phases, but it will likely require a more expensive solution. If you have a two or three phase connection, we recommend that you work with an electrician at the time of the installation of the solar PV system to ensure that hot water heating and any daytime electrical loads are shifted onto the same phase as the solar PV system.

How can I find out the number of phases supplying my property?

This information isn't usually noted on your power bill so if you don't know, don't worry - most people have no idea! Take a look at your household switchboard and see how many switches make up the Main Switch (as shown below).

Older switchboards may just have a single large switch, so you might need an electrician to investigate it further.

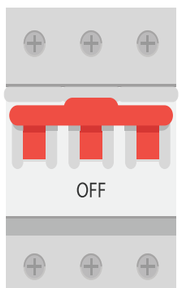
Does solar require a special meter?

Yes, it does. Solar systems require a special import/export meter (or two-way meter) which allows your usage and output to be recorded. Your old meter can't be used for this. Talk to your electrician or Eastland Network for more information.

SINGLE PHASE

TWO PHASE

THREE PHASE



Part Four: Learnings from the Eastland Network solar PV trial

What can you learn from the solar trial?

With the Eastland Network solar PV trial, some very useful information was discovered, especially when it comes to the financial viability of solar power, the size of system required, and the best ways to make solar power work effectively within the home.

Here is some key information learnt from the trial, and what this means for homeowners looking to install a solar PV system.

- It can be hard to use your power during the daytime and match your usage to the times when most power is being generated, particularly if there's no one home during the day.
- It's important to get the size of your system right. This can be tricky to do, reviewing years of your home's electricity data is time consuming, and not all installers will take the time to ensure that the system is the right size, and avoid excessive export to the grid.
- Solar PV systems without battery storage work best for households that have electric hot water systems, heat pumps (for heating or cooling) and when someone is home during the day.
- Solar PV isn't a great option for households where no one's home during the day, where hot water is heated by gas, or where the house is heated by gas or wood fires.
- If your property has more than one phase (that's the electrical system that supplies energy from the power lines to your property) it can cause a few problems. For your system to perform best, it should ideally be on the same phase (and meter) as all daytime electricity loads, especially the hot water cylinder. You may need an electrician to rewire the fuse board - but be aware that this may result in the loss of lower rate-controlled tariffs.
- Monitoring systems are a worthwhile investment. Even with the ideal circumstances for solar, it's hard for consumers to use their solar system effectively without a monitoring system providing real-time feedback about the power usage in the home and the current solar generation.
- The more automated your electricity, the easier it will be to maximise the benefits of your solar system. There are lots of smart load control devices available that can do most of the loadshifting for you.

What has Eastland Network learnt from the solar trial?

In 2016, when the trial began, it became clear that at the time Tairāwhiti wasn't well served by the New Zealand solar industry. The installers themselves noted that while Gisborne is a potential market for solar, it requires an experienced sales person on the ground in the region, as well as affordable financing to overcome the issue of cost which is a problem for many homeowners.

Secondly, the trial was important in supporting other New Zealand and international studies by showing that when clouds moved over a number of solar PV systems that were close together, there were no negative effects to the network (voltage variations etc.) caused by sudden drops in solar generation.

Is solar PV worth it, cost-wise?

Without a doubt, the costs associated with solar PV systems are a huge factor in evaluating their overall benefits, and this information is usually the first thing people want to know when they're investigating solar power for their own home.

So, what did Eastland Networks's trial[2] find? Across all nine sites, the solar PV systems appeared to be economically beneficial over a 25-year lifespan (that's the usual lifespan of solar panels). In technical terms, the data showed a positive Net Present Value[3] (NPV) over 25 years, with savings and grid export amounts totalling more than the cost to install in 2016. Interestingly though, if 15 years was used as the investment timeframe, only three of the sites worked out to be economic.

The trial analysed the data against then current 2019 solar pricing, with all homes showing a positive NPV over 25 years, and three sites showing that they wouldn't be economic over a 15-year period.

The trial also analysed the possible scenario where lines companies (such as Eastland Network) change their distribution pricing from variable to fixed and/or capacity-based, reducing the variable component of your electricity price to as low as 13 c/kWh. In this situation, and based on 2019 pricing for solar PV, only two of the nine test sites would provide an economic pay back over 25 years, and none over 15 years.

Are batteries worth the expense?

None of the properties on the Eastland Network trial had batteries installed. However, we can determine how much energy would have been stored, based on what excess generation was exported to the grid.

Batteries (also called Battery Energy Storage Solutions or BESS) are helpful in allowing you to use the power you generate, rather than selling it back to the grid. Data from the trial shows, on average, batteries result in a 30% improvement in using solar energy on-site, reducing export to the grid.

However, the current cost of batteries means that they're generally uneconomic for grid-connected solar PV systems. Trial data shows that an average 53% drop in price (per kWh) is needed if batteries are to become economically viable in the Tairāwhiti region, although they might become more valuable if their use extends to include things like load control and back-up power during a network outage.

As above, the battery trial included the scenario where lines companies (such as Eastland Network) change their residential pricing from variable to fixed and/or capacity-based, reducing the variable component to as low as 13c/kWh. In this situation, and based on 2019 pricing for solar PV plus battery systems, there wouldn't be any economic payback for consumers - in fact, to be economically viable at 15 years (at a 13c/kWh electricity tariff), the combined solar and battery system price would need to drop by an average of 70%.

QUICK TIP: There is a handy online calculator on the government's GenLess website that can help you work out whether solar will have financial benefits for your household: **tools.genless.govt.nz/individuals/solar-tool/**

[2]The trial allowed for a 5% discount rate, 2% inflation, 3% power price inflation and the trial participants current electricity pricing.

[3]Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time.

Part Five: Choosing the right solar PV system

What's the right sized system for my household?

This question should be top of the list when it comes to choosing the right solar PV system for your home. It can be a hard one to get right, because the system needs to be the right size to supply your daytime electricity needs, while ensuring you're not exporting too much to the grid. And, unfortunately, not all solar providers ensure their customers have the right size installed.

While households are paid for their excess solar electricity that is exported back to the grid, generally, the amount is around 6-8 cents per unit (depending on who your retailer is). Whereas, the cost to buy electricity from your retailer is currently around 30-35 cents per unit. Basically, homes have more financial benefit when they use the electricity generated by solar panels. and not when exporting it.

You need to be sure that the system size is right for your house, and not generating more energy that your home needs. Otherwise you will pay a lot more for a system that is bigger than you need.

Household appliances, electricity consumption, and solar system utilisation for Eastland Network's solar trial participants

		Hot Water				Space Heating				Cooling		Appliances						Other Loads				Occupancy						
Site No.	No. of Phases	Electric (Cylinder)	Separately Metered	HW Heat Pump	Gas	Elec. Heat Pump(s)	Elec. Fan Heaters	Woodfire	Gas Heater	Air Conditioning	Ceiling Fans	Fridge/Freezer	Dishwasher	Washing Machine	Dryer	Beer Fridge	Chest Freezer	Spa Pool	Underfloor Heating	Pool	Sewerage Pumps	Adults	Children	Home During Week Day?	Annual Electricity Consumption(kWh	Actual Installed System Size (kW)	% of Solar Energy Used on Site	Recomended System Size (kW)
9	1				●			●				●		●	●							1	2	No	2,700	2.0	31%	0.6
7	2				●			●				●		●	●	●	●			●		3	-	Partly	5,200	3.5	35%	1.2
8	1	●	●					●				●	●	●								2	1	No	5,300	2.5	26%	1.2
3	2			●				●				●	●	●	●				●		●	2	2	No	6,400	4.2	43%	1.5
6	1	●				●				●		●	●	●	●	●						4	1	Partly	6,600	3.0	50%	2.3
5	2	●						●	●			●		●	●	●		●	●		●	2	-	No	7,100	4.3	18%	1.6
1	1	●						●				●	●	●	●		●	●				2	2	Yes	7,200	4.0	49%	2.5
2	2	●						●				●	●	●	●	●	●	●				2	1	No	10,000	4.2	50%	2.3
4	1	●	●			●	●					●	●	●	●	●	●					4	1	Yes	13,400	5.2	40%	3.1

Doing the maths

If you're located in Tairāwhiti and considering installing a solar PV system without any form of energy storage, here's a guide to help you estimate the right size of system you'll need to meet your daytime electricity usage.

1. First, you'll need to work out how much electricity your household uses in a year. Here's how:

- Locate your power bills for the last 12 months. Check each bill to find the total kWh (units) of electricity that your home has used throughout each month, and add these together find the total kWh unit you've used over the course of the year.

- Or locate one winter and one summer power bill, find the total kWh of electricity used from each bill, and multiply by six.

2. Then you'll need to work out your daytime electricity usage.

- If you have gas hot water, 2-phase supply, or you intend to keep your electric hot water cylinder separately metered, divide your annual electricity amount (the kWh number from above) by three.

- For all others, divide this number by two.

3. Lastly, find the approximate size of the solar array that you'll need. To do this:

- Divide your daytime electricity usage (step 2, above) by 1460 hrs (8760 hours per year x capacity factor of $^1/_6$)[4]. This gives you an approximate size of the solar array in kW.

Here are some examples from the Eastland Network solar trial:

- Site 1 uses 7,200 kWh per annum, has a single phase supply and electric hot water heating, so the calculation is (7,200 / 2) / 1460 = 2.5 kW. It currently has a 4kW system and 51% of the solar energy has been exported to the grid.
- Site 4 uses 13,400 kWh per annum, has a single phase supply and electric hot water heating but this is separately metered on a controlled electricity tariff[5]. It currently has a 5.2kW system and 60% of the solar energy is being exported to the grid because the hot water is separately metered. The ideal size system in this situation would be (13,400 / 3) / 1460 = 3.1 kW
- Site 7 uses 5,200 kWh per annum but has gas hot water and two phase supply. About 65% of the energy produced by the existing 3.5kW system is being exported to the grid. The ideal size system in this situation would be (5,100 / 3) / 1460 = 1.2 kW

QUICK TIP: Your winter power bill alone isn't necessarily a good guide as to what sized system you'll need. That's because most high winter power bills are due to electricity that's used in the evenings when the sun has gone down, and you'll still have these times of higher usage with a solar system unless you install battery storage so that you can use your solar power during the night.

[4]There are 8760 hours in a year. The capacity factor (or maximum possible energy output) of a north facing solar array in Gisborne is about 16.5%, or 1/6 so to work out the kW size that's needed, 8760 is divided by 6 (to equal 1460).

[5]Lines companies (via retailers) offer customers lower tariffs if they have an electric hot water cylinder that allows the lines company to control (i.e. switch off) the cylinder's element during peak times. In some networks this is a reduced price on all electricity used by the customer, in others a separate meter is installed for the hot water cylinder and the reduced rate only applies to electricity used by the cylinder.

What's the best technology for my home?

Solar panels: monocrystalline silicon (mono-Si) and polycrystalline silicon (poly-Si)

Mono-Si solar panels tend to perform slightly better than poly-Si solar panels in low light conditions as well as in warmer weather. The main difference, though, is that mono-Si panels are more efficient, producing higher power outputs per m2 than poly-Si. This means they take up less roof space because fewer panels are required. This efficiency does come at a higher price per kW due to the costs of manufacturing the higher purity silicon. Both technologies should come with similar 25 year performance warranties.

Which type is right for you? The key decider will probably be the available space on your roof. If you don't have sufficient north-facing roof space, then the more efficient mono-Si solar panels would be a good option. If roof space is not an issue, then poly-Si solar panels are a more economic option.

Inverters: micro-inverters and string inverters

Both have their pros and cons. Take a look at the chart below and see which might be the better option for your home.

	MICRO-INVERTERS	STRING INVERTER
PROS	• Performance. Micro-inverters allow the maximum output of each panel, resulting in slightly better performance than a string inverter. They're particularly useful if there's any shading during the day or if the solar arrays are to be installed in more than two roof directions. • Performance monitoring of the solar panels, so that they can more easily detect faults (or faulty micro-inverters). • Known to be safer. The DC is converted to 230V AC at the panel so there's no high voltage DC cabling from the roof.	• Because they're located at ground level, access for maintenance and replacement is much easier. • Cost! String inverters have a 15% lower system cost per kW than micro-inverters. • The performance and monitoring benefits of micro-inverters can usually be achieved by adding DC optimisers to the solar panels (at an additional cost). • Usually has two DC inputs so can work for two separate solar arrays facing in different directions.
CONS	• Cost! Currently more expensive per kW than string inverters. • Require a central hub device to be located somewhere in the home with a dedicated power point (or wired into the switchboard) so that they can communicate via the power lines. This also needs to be close to a source of Internet (Wi-Fi or Ethernet).	• Require an aesthetically and spatially suitable location in the home for the inverter, as well as a position that's close to a source of Internet (Wi-Fi or Ethernet). • Difficult to detect and isolate faulty solar panels. • There's a higher safety risk having a cable carrying up to 600V DC from the roof to the inverter.

The lifespan of a solar PV system

Solar panels are designed to last approximately 25 years, although there are lots of working silicon-based solar panels around the world that are older than this. They usually come with a 10-year product warranty, relating to defects, and a 25-year performance warranty, relating to the annual production of the solar panel over its life (see below).

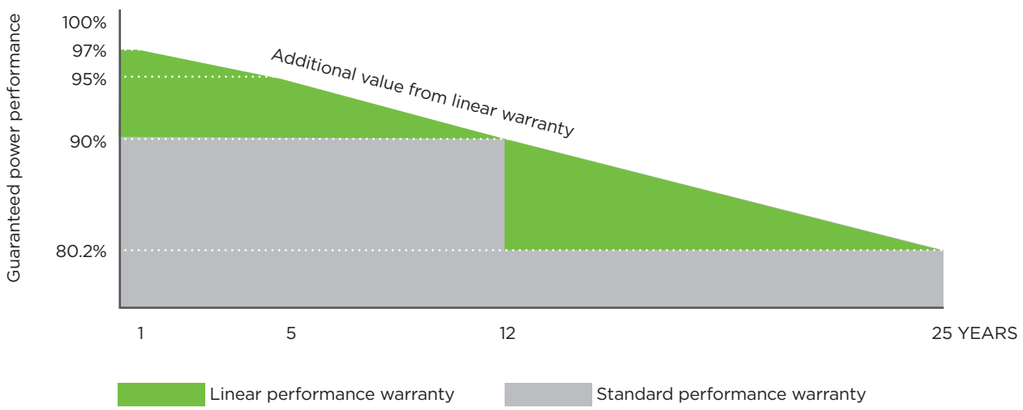
It's important to understand that because solar panels degrade over time, they'll produce slightly less energy each year. Under a 25-year warranty, most manufacturers will expect their solar panels to generate at 80% of their original capacity at the 25-year mark. As technology improves, so do the warranties - some manufacturers are now offering 30 year performance warranties for some large scale solar projects.

String inverters generally have a life expectancy of around 12-15 years, and some inverters from high quality brands have even been known to last longer than 20 years. Most string inverters will come with a 5-year or 10-year warranty (although in some cases you can purchase a 20-year extended warranty), which means it's a good idea to factor in the possibility of having to repair or replace the inverter during the overall 25-year life of the solar system.

Micro-inverters and DC optimisers have an expected life of 20-25 years, and sometimes provide warranties to match, although in recent years some micro-inverter manufacturers have reduced their standard warranties to 10 years.

Batteries tend to have a life expectancy that's influenced by three things: duty (how much it's used), chemistry (whether it's lead acid or lithium-ion) and its operating environment. Just as with solar panels, battery storage capacity becomes less efficient over time. Most current lithium-ion batteries will come with a 10-year performance warranty, which will guarantee between 60-70% storage capacity at year 10 (depending on the amount of energy the battery's processing).

Linear performance warranty
10 year product warranty • 25 year linear power warranty



Brand differences for solar panels and inverters

Not all solar panels or inverters are created equal. Be prepared to do some research - here's a few questions to get you started.

- Which brands do installers stock?
- How long have those brands been in existence?
- What sort of equipment does the brand offer?
- How long are their warranties and what do they cover?
- Is the brand compliant with New Zealand and Australian standards?

QUICK TIP: You can check the make and model of the inverter recommended by your installer on the Australian Clean Energy Council website below. If it's not included on the list, it might not be compliant with AS/NZS standards or approved for connection to the electricity network.

www.solaraccreditation.com.au/products/inverters/approved-inverters.html

Which solar installer should I use?

Comparing prices

Comparing quotes from different solar equipment installers can be tricky because there's such a wide range of technology and configurations available, and big differences in the quality of the equipment.

Unless you're comparing the exact same equipment and layout, here's what we recommend:

1. Make sure that the quotes are for a system size that meets your daytime electricity needs (head back up to 'What's the right sized system for my household?' on page 19 to work out this information). If you think you've received a quote for a system that's too big, ask for a revised quote based on the system size you need.

2. Divide the price of the system by the total kW capacity of the solar panels to give a $/kW per quote.

3. Then rank the quotes based on lowest to highest $/kW so you can see what your costs will be.

Comparing electricity production from different installers

As well as cost, solar PV installers will also provide you with an estimate of how much power the solar system will produce in its first year. Again, this part can be tricky to compare because the expected generation of a solar system is calculated using lots of assumptions, so take this estimate with a grain of salt.

Instead, we'd recommend grabbing a calculator and dividing the expected annual output (in kWh) from the solar system (as provided by the installer) by the total kW capacity of the solar panels. That will give you a specific kWh / kW production for each system.

If the quotes are for similar systems on the same area(s) of roof, the output should be similar between quotes (note that you might see differences if you're comparing string inverters with micro-inverters).

Other factors to consider

Aside from cost and energy production, here are a few other important factors to take into account:

- Is the equipment high or low quality?
- Do any of the quotes specify exclusions that might apply to your property, and therefore push up your costs? (for example whether scaffolding or edge protection is required)
- Are there any additional extras on offer that might improve how well your household can use the solar system? (for example, solar hot water diverters and monitoring systems)
- What is the experience and workmanship of the installer? Don't be afraid to ask how many solar installations the installer has undertaken in Gisborne, and for references so you can speak to past clients.
- Does the installer offer after-sales service? Check whether there's a local outlet that can provide support if required.
- Does the installer offer an annual system service and check-up? Some installers will offer service and maintenance packages to help keep your system in good working order.

Part Six: Before you begin

If you've decided to make the switch to solar, there are some boxes that need to be checked before installation can get underway. There are a few different rules and regulations that go hand-in-hand with applying for and installing a solar system in your home. Here's what you'll need to do before installing a solar system in Eastland Network's region:

Submit a distributed generation application

Before you get started installing a solar system on your property, your solar installer **must** submit a distributed generation (DG) application with your local lines company (that's Eastland Network here in Gisborne, Wairoa and the East Coast). The DG application **must be approved before installation,** so that the network company is aware that generation is being installed on the network, and so that they can ensure the equipment being supplied meets the Electrical Safety Regulations 2011 and a number of standards.

These forms are available on the website below (most residential systems will fall into the 10kW category, listed here).

www.eastlandnetwork.nz

Once your DG application is approved your solar system can be installed, but the system will only be connected once the lines company has sighted the Code of Compliance and Record Of Inspection.

Complete your application for generation equipment metering installation

Once your DG application has been approved by your lines company, you'll need to complete this meter installation application with your retailer so that an import/export meter can be installed at your property. You'll be asked to send in your DG application along with the meter installation application. Meter application forms can usually be found on each retailer's website, or just give your retailer a call.

Receive your code of compliance certificate (COC) and record of inspection (ROI)

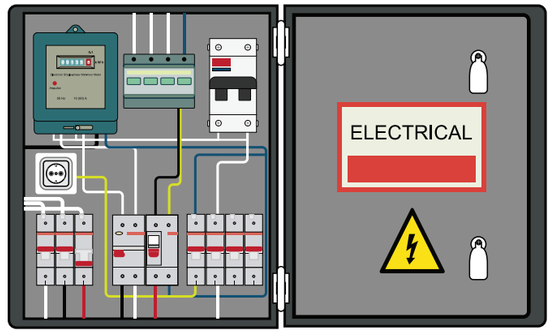
On the day your solar PV system is installed, the electrician who does the installation must provide you with a code of compliance certificate (COC). They can temporarily switch the solar PV system on to test that it's working, but the system must be switched off again until the import/export meter is installed and an independent electrical inspector has inspected the system and provided a Record of Inspection (ROI), a copy of which will be given to you, and another lodged into a national Electricity and Gas High-risk Database by the inspector.

It pays to be aware that, depending on your location, it can take up to a month for a meter installation and inspection to occur after the solar PV system is installed.

For more information, see: https://worksafe.govt.nz/about-us/news-and-media/certification-requirements-for-photovoltaic-pv-systems/

Check for signage

As part of the installation, the electrician must install signage on the switchboard and meter box to warn other electricians that there is a source of electricity on the roof, as well as clear instructions on how to safely shut down the system.



Part Seven: Keeping your system running

To keep your solar PV system in top-notch condition and performing at it's best, it's important that you follow the operating manual and keep your system well maintained.

Washing the panels

Keeping your solar panels clean will help keep them performing as they should; when they're covered in grime, dirt or bird droppings, their efficiency can be reduced by around 20%, so it's worthwhile ensuring they're clean. As a rough guide, you can expect to wash your solar panels at least once a year.

What's the best way to clean them? Here are our tips and tricks:

1. First up, DON'T stand on the solar panels, and DON'T use harsh chemicals, abrasive scrubbers or pressure washers, as these will likely damage the solar panels.

2. Safety is paramount. Don't put yourself in any danger – ideally, you'll be able to access the panels from the ground, but in any case, make sure you can access them safely. If your house is two-storey, or has a steep roof pitch, seek professional help to carry out the clean.

3. Before you do anything, switch the system off at the AC breaker and DC isolator.

4. Choose a time when the panels aren't too hot (i.e. early morning or late afternoon). This will stop the water evaporating too quickly and leaving residue on the panels.

5. You can use your garden hose to clean the panels. Consider investing in a telescopic water brush (with a very soft brush attachment) that will allow you to connect your hose to the brush and clean the panels from the ground.

6. If you can safely access the panels from the roof, wash the surface with a soft cloth or sponge.

7. If there's a mark that won't come off with a hose, fill a bucket with warm water and soap, and dip the brush head or cloth into it before gently washing the panel.

Maintaining other solar equipment

In general, your inverters, switchgear and solar wiring shouldn't need regular maintenance. However, there's no harm in bringing in an electrician to carry out an annual or bi-annual electrical inspection (or check-up) of the system as a safety precaution, and to ensure everything's working as it should.

If your inverter reports a fault (or if you have a faulty micro-inverter), contact your installer to send a technician to check and repair your system.

When the power goes out

If your system doesn't have a battery and there's an outage on the grid, your inverter will automatically stop producing power. This is to make sure your solar system doesn't back-feed into the grid and electrocute anyone working on the lines.

If you've got a solar battery system, you might still be able to use power during an outage. That's because some of these systems have the ability to supply electricity to some of the electrical loads in your house that are isolated from the main supply.

Handy websites:

eastlandnetwork.nz
genless.govt.nz

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