Australian Government
Department of Resources, Energy and Tourism

Solar Water Heater Guide

for Households

Have you been thinking about installing a solar water heater but aren't sure what type of system to get?

Do you have a solar water heater but suspect it may not be working as well as it could?

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Disclaimer:

The information in this guide is presented by the Department of Resources, Energy and Tourism (DRET) for the purpose of assisting consumers to gain a basic understanding of solar water heaters. While DRET has made every effort to ensure that the information in this guide is accurate and up-to-date, readers should exercise their own independent skill and judgment before relying on it. This guide is not a substitute for independent professional advice and readers should obtain any appropriate professional advice relevant to their particular circumstances. DRET is not liable for any damage, loss or expense resulting from reliance on any information or material in this guide. References or links to other documents are inserted for convenience only and do not constitute endorsement of material, sites, or any associated organisations, products or services.

Solar water heaters are increasingly popular and can help households reduce energy costs and their impact on the environment. To ensure you maximise the benefits of installing a solar water heater and avoid any potential problems, it's important to have an understanding of how solar water heaters work, including how they should be installed, operated and maintained.

Whether you are considering buying a solar water heater, or you already have one, this guide is designed to help you gain a basic understanding of solar water heaters. For more detailed information on solar hot water systems, please visit the Department of Resources, Energy and Tourism's solar water heater webpage or any of the webpages listed at the end of this guide.

BEFORE INSTALLATION

What size system should I choose?

The number of people in your household, the amount of water you use and when you use the water will all influence what size system you should get.

It's important to select the right size system for your household's needs. If you have a storage tank that is too small, there is the potential to occasionally run out of hot water, or that the booster will need to be used more often. If your storage tank is too large, energy will be wasted in keeping excess water hot.

Typical hot water usage in Australia is on average approximately 80 litres per person per day. Households with high hot water consumption or that use a lot of hot water at the same time (e.g. if everyone showers at the same time of day), may want to consider getting a larger system.

The types of appliances and features in your home, as well as how you use them will affect your household's hot water consumption. Factors that can increase your hot water consumption include:

- spa baths;
- taking long showers; and
- living in a cold climate.

What is the best type of solar hot water system for my household?

Several factors will influence what type of solar hot water system is best for your household, including where you live and how much space you have.

There are two main types of solar hot water systems: thermosiphon and split system.

- Thermosiphons have both the solar collector and storage tank located on the roof. Some systems may have the storage tank located inside the roof, but this is uncommon. Thermosiphon systems may not be suitable for some roofs due to their weight. They are good for households that have limited ground space.
- Split systems have the solar collector located on the roof and the tank on the ground. Split systems can be more expensive to buy than thermosiphons. They also require a pump to circulate water between the tank and collector. Some existing water heaters can be retrofitted as a split-system solar water heater. Split systems are sometimes preferred in cold climates, as the storage tank can be kept inside, which reduces tank heat loss.

What type of solar collector is best for my household?

A solar collector absorbs heat from the sun and uses it to heat up water. There are two main types of solar collectors: flat plate and evacuated tubes.

- Flat plates are the most common type of collector and are generally the cheapest option. Flat plate collectors are most efficient when the sun's rays hit the collector perpendicular to the surface. If you live in a warm, sunny climate, a flat plate collector is likely to be suitable. In cold climates, some flat plate collectors may suffer some heat loss and could possibly be damaged by frost if not adequately protected.
- Evacuated tubes consist of a series of glass tubes containing an inner water or heat pipe, which is surrounded by a vacuum. The round surface of evacuated tubes allows the sun's rays to hit perpendicular to the surface for a larger part of the day, which means that they are highly efficient for more of the day. This also allows them to be installed facing east or west (if north is not possible), with only a small loss of efficiency. They can be better suited to cold climates, as their vacuum minimises heat loss and they are better protected from frost damage.

If your collector can't be installed facing north, installing evacuated tubes or more flat plate collectors may help compensate for the loss of efficiency. If you live in a cold, frost-prone area, you should consider getting a system with frost protection.

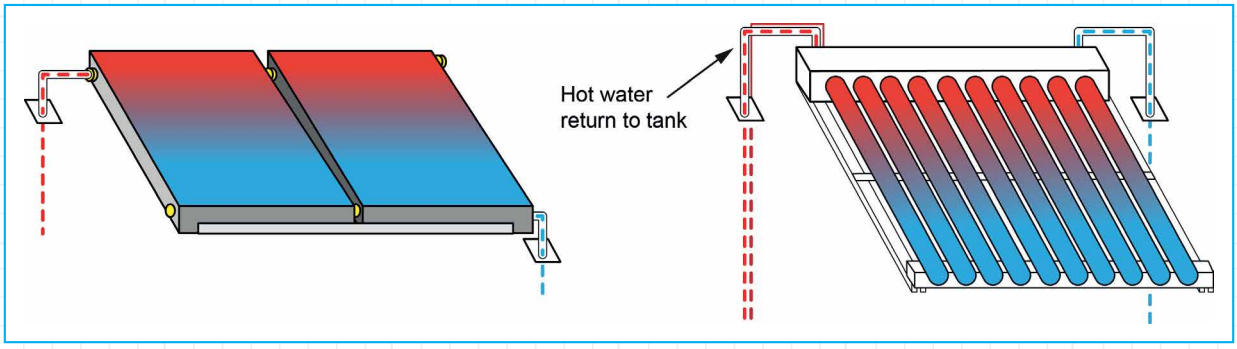


Figure 1. A flat plate collector (L) and evacuated tube collector (R) (Source: Solar & Heat Pump Plumber Reference Guide)

What sort of booster should I choose?

A booster is a back-up heater used to heat your water when there is not enough energy available from the sun. The type of booster you choose will be influenced by what energy sources you have available, if you're retrofitting an existing system and the costs involved.

There are three types of booster: electric, gas (storage and instantaneous) and solid fuel.

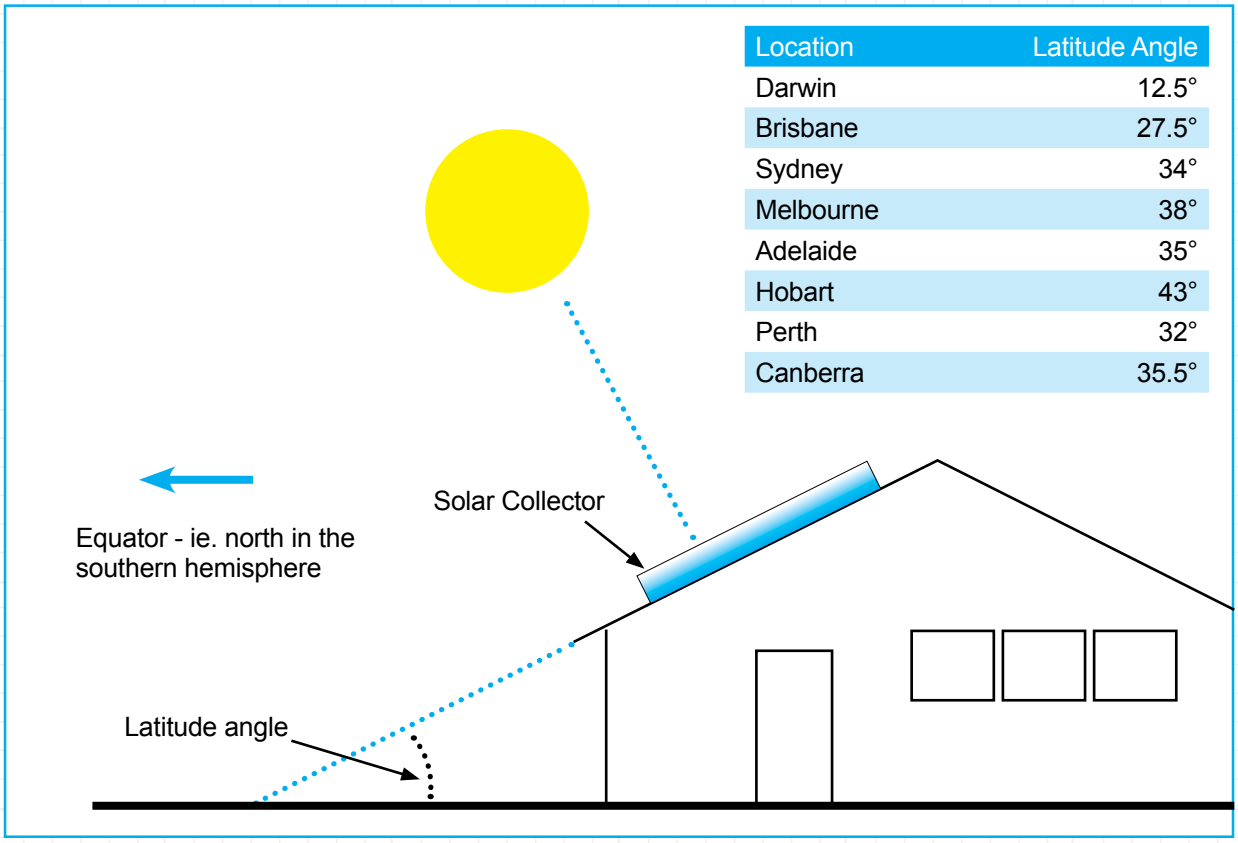
- An electric boosted system can be expensive to run depending on your electricity tariff, but they are generally cheaper to purchase than gas boosted systems. Electric boosters are generally run as storage boosters.
- A gas boosted system generally releases fewer greenhouse gases and is the most energy efficient option. If you have access to mains gas, it also generally has low running costs. There are two different types of gas boosters – instantaneous and storage. Instantaneous boosters heat water only as needed, while storage boosters heat all the water in the tank when the water temperature drops.
- If your home has a wood heater, it may be possible to use solid fuel boosting, however this depends on where your heater is located and if the back and flue of the heater can be accessed to install the necessary plumbing.

It is possible to retrofit some existing water heaters to solar collectors to create a split-system solar water heater. This allows you to continue using your current water storage tank and booster.

Where should the solar collectors be located?

In Australia, solar water heaters will work most efficiently if the solar collectors are facing as close to north as possible. It is possible to deviate up to 45 degrees from north, with only a small loss of efficiency. Collectors can also be installed facing east or west if necessary, although the amount of energy provided by the sun will be lower.

The collectors should also be installed at the correct angle to the ground for your location. The best angle to install the collectors is generally the same as the installation location's angle of latitude, which can vary between 12 degrees and 45 degrees in Australia. See the figure below for a guide to the best installation angle for different locations.



Location	Latitude Angle
Darwin	12.5°
Brisbane	27.5°
Sydney	34°
Melbourne	38°
Adelaide	35°
Hobart	43°
Perth	32°
Canberra	35.5°

Figure 2. Most efficient angles for collector placement in Australian cities
(Source: Solar & Heat Pump Plumber Training Handbook)

What is a selective coating and do I need one?

A selective coating is a coating that is applied to the surface of a solar collector and helps to absorb solar radiation and prevent thermal heat loss from the collector. Selective coatings can be made from materials such as black chrome, black nickel, aluminium oxide with nickel and titanium-nitride-oxide.

A selectively coated solar collector can be up to three times more efficient than a collector that doesn't have a selective coating, with even greater efficiency in cold and frost prone areas. If you live in a hot, sunny climate, you may not need a solar collector that has a selective coating.

Many manufacturers of solar hot water systems don't specify if their solar collectors have a selective coating – ask your retailer for this information.

How do I make sure my solar water heater won't freeze in winter?

If you live in an area that is exposed to frost and temperatures below 4 degrees Celsius, it's a good idea to consider frost protection when choosing a solar water heater. The map below will help you identify if you live in a frost-exposed area.

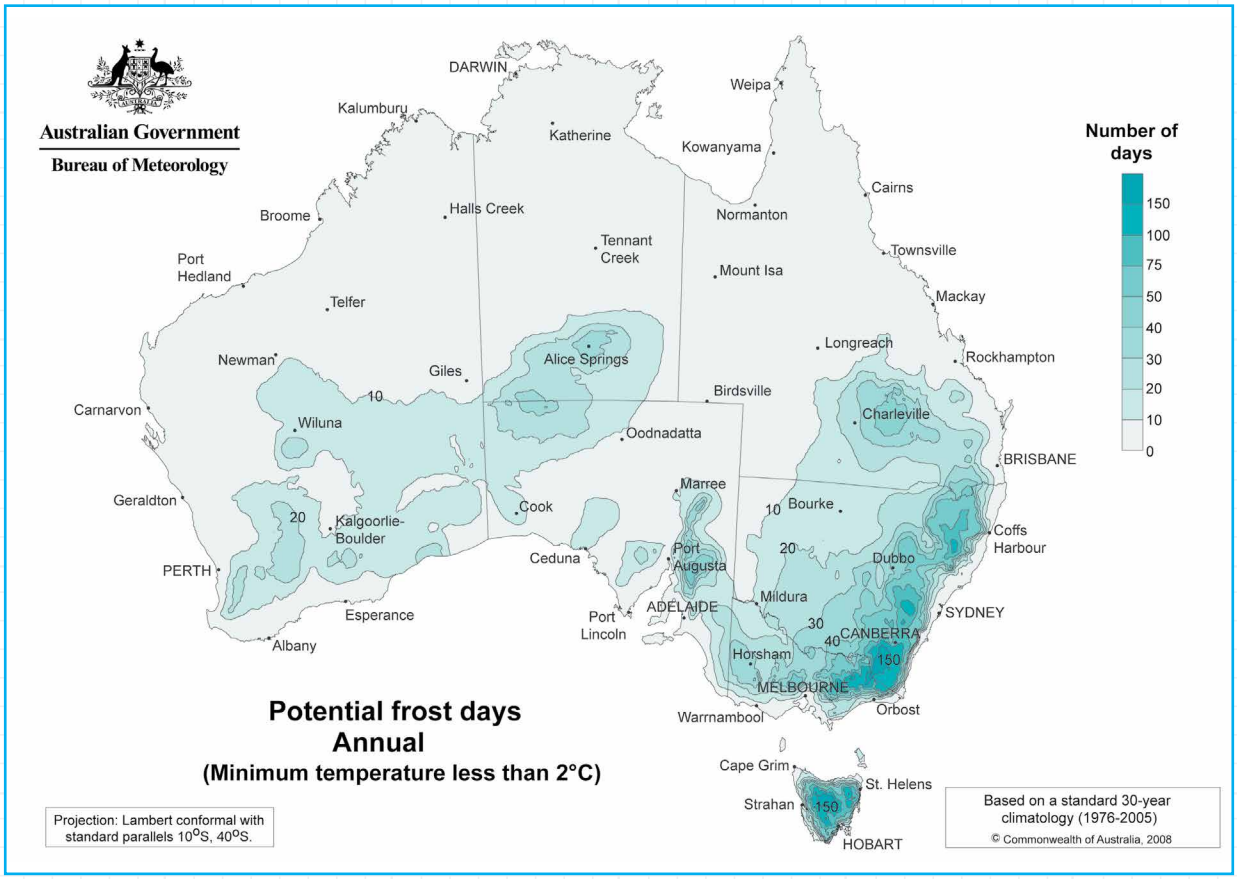


Figure 3. Potential frost days in Australia (Source: Bureau of Meteorology)

The performance and efficiency of a solar water heater can be affected by frost, mainly through heat loss from, and damage to, the collectors.

Evacuated tubes contain a vacuum that acts as insulation and helps reduce heat loss from the tubes in cold weather. While some evacuated tubes contain water, others contain a heat transfer liquid or can even be solid copper, which avoids the problem of water freezing within the collectors.

Flat plate collectors lose some heat in cold weather, which affects efficiency. Flat plate collectors without frost protection can be damaged if water inside them freezes or if condensation and moisture form inside the collectors.

Different types of frost protection include:

- Frost protection valves. These valves release water when the temperature falls below a set level, which relieves pressure and encourages water circulation.
- Antifreeze. The antifreeze is circulated through the collector and kept separate from the water. This is the most common solution in heavy frost or snow areas.
- Circulation pump. This can circulate warm water through the pipes when the water temperature drops below a certain level. However, this uses extra energy through running the pump and water heat loss.
- System draining. The water in the collectors is drained when it starts to be at risk of freezing. This keeps hot water in the storage tank and prevents water in the collectors from freezing.

Another important consideration is pipe insulation. All pipes connected to the collector and storage tank should be insulated with between 9 and 38 millimetres of insulation, even in areas of Australia not exposed to frost. The amount of insulation required depends on your climate and if pipes are internal or external. Thicker insulation should be used in cold areas and for external pipes. External pipes also need insulation that is resistant to UV damage and the weather.

How does water quality affect my solar water heater?

Poor water quality, including hard water and water with lots of dissolved minerals or sediment, can have a harmful effect on the efficiency and lifespan of your solar water heater. If you have poor quality water, your storage tank could be at risk of corrosion or mineral build-up.

There are three storage tank materials:

- Copper;
- Glass (vitreous enamel) lined steel. Lined steel tanks need to be fitted with a sacrificial anode (a metal rod that corrodes instead of your tank) to protect the tank against corrosion. Anodes should be replaced approximately every five years, or more often in poor water quality areas, but check with the manufacturer for replacement instructions; and
- Stainless steel. Stainless steel tanks are not recommended for areas with poor water quality.

Poor water quality can also damage the pipes and collector through a build-up of minerals inside the system. This can result in blocked pipes, lower heat transfer, failed pressure and temperature valves and leaking frost protection valves. If your water quality is poor, you may want to consider choosing collectors that have a heat transfer fluid in the pipes instead of water.

Who can install my solar hot water system?

Anyone installing a solar hot water system must be licensed to install these systems. This generally means being both an accredited plumber and an accredited electrician. For details on what accreditation installers are required to have, contact your local council or state government.

What are all the pipes meant to be connected to?

It is important to ensure that the pipes in a solar hot water system are all connected to the correct inlets and outlets.

For a split system there should be:

- a cold water inlet pipe near the bottom of the water storage tank;
- a cold water outlet pipe running from the bottom of the water storage tank to the collector;
- a hot water outlet pipe running from the top of the collector back to the storage tank; and
- a hot water outlet pipe running from the top of the storage tank into the home.

A thermosiphon system should be set up similarly but with the storage tank generally located in a horizontal position above the collector.

Ask your plumber to point out the pipe locations and direction of water flow during installation.

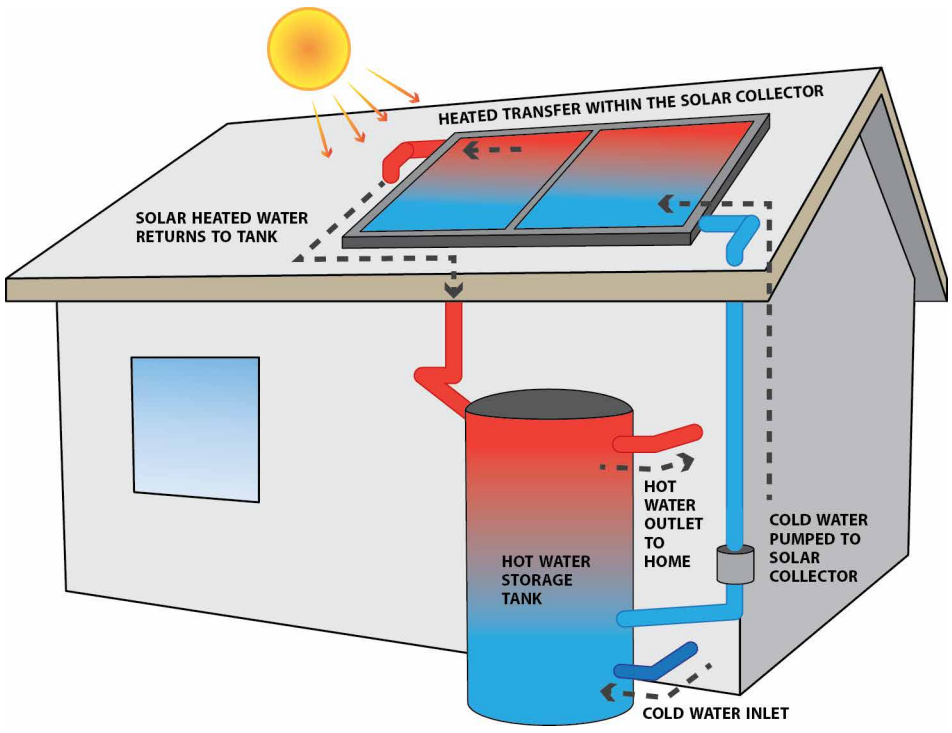


Figure 4. Plumbing of a solar hot water split system
(Source: Department of Resources, Energy and Tourism solar hot water webpage)

How do I maintain my solar water heater?

- During installation, ensure that you get clear instructions from your installer on how to operate and maintain your solar water heater.
- If you have a user manual, make sure to follow the manufacturer's maintenance advice.
- Ensure that the thermostat on the booster is set to 60 degrees Celsius to prevent the growth of harmful Legionella bacteria.
- Check your manufacturer's recommendations on cleaning the collectors and removing shading. Dirt and dust that accumulates on the solar collectors will reduce the efficiency of the system, as will any trees or plants that are shading the collectors.
- Test the pressure and temperature relief valve every six months to ensure that it isn't blocked and there is no mineral build-up. If no water is discharged when the valve is tested, an authorised person must replace it.
- Consider having your solar water heater regularly inspected and serviced. Once every five years is often recommended by manufacturers.

Why am I running out of hot water?

- If your solar hot water system is too small, the amount of hot water in the storage tank won't be sufficient for your household's needs and it will take time for the water in the tank to be reheated. This also applies to periods when there are more people in the household than usual. Adopting water saving measures or spreading out your hot water use throughout the day will help prevent running out of hot water.
- The booster may be switched off or not operating properly. Check that the electricity is connected and switched on. For gas boosters, ensure that gas is available and turned on.
- Check that the pressure and temperature relief valve is functioning properly. The valve is designed to allow a small quantity of water to be discharged during heating, but it should not be discharging more than one bucket of water over 24 hours, or discharging continuously.
- If you have a split system, check that your pump is working correctly. You can do this by checking the indicator lights, listening for noise from the pump and feeling for vibrations. Keep in mind that the pump doesn't run continuously.

Can I change the temperature of the water coming from the system?

If you have a storage system, heating the water in the tank to at least 60 degrees Celsius will prevent the growth of Legionella bacteria. The booster temperature can be set anywhere up to around 85 degrees Celsius but setting the temperature higher than 60-65 degrees Celsius will use energy unnecessarily.

Regulations state that water used in the house for personal hygiene purposes must not be higher than 50 degrees Celsius, to prevent scalding. A tempering valve must be fitted to your hot water pipes to cool the water to 50 degrees Celsius or lower before it enters the house. It's generally not possible for consumers to change the tempering valve temperature.

Why are my electricity/gas bills still high?

- If your collectors are not installed in the correct location, they won't be able to function at maximum efficiency. This would mean that more energy is required for the water to be boosted to a suitable temperature.
- Make sure that the collectors aren't dirty or shaded by trees or other objects.
- Your booster may not be set up to make the most of the amount of energy coming from the sun to heat the water. The booster is needed only when there is not enough energy from the sun to heat the water to a suitable temperature. Depending on your hot water usage patterns and electricity tariff, it may be best to manually switch on the booster when boosting is required, or set it to a timer so the booster is on for only a few hours each day. Using most of your hot water in the morning will also help, as the energy required to reheat water in the tank can come from the sun during the day.
- The amount of energy provided by the sun generally won't be as high during winter, except possibly in northern Australia, so it is normal for electricity/gas bills to be higher during this period.
- Check that the water inlet and outlet pipes to the collector are installed correctly. Pipes installed at the wrong connection point could result in the coolest water from the collectors being taken to the storage tank and more electricity or gas being needed to boost the water temperature.

Will the water overheat on really sunny days?

It is possible for the water in your collector and/or storage tank to reach temperatures of up to 100 degrees Celsius on really sunny days.

In order to prevent water from boiling on hot, sunny days, you can take several actions, including:

- Install a shade cover that can be pulled down to completely cover the collectors for all or part of very hot, sunny days.
- If you live in a hot climate, you might not need to install evacuated tubes or even panels with a selective coating, as they are more efficient at heating water.
- Install collectors at a steeper angle to maximise efficiency in winter and minimise the chance of overheating in summer.
- Ensure that the pressure and temperature relief valve is functioning properly so that steam and water can be released on the occasions when the water in the collector is overheating.

What should I do if I'm going away for an extended period of time?

If you'll be away for a couple of weeks or more, you may want to switch off the booster to save energy. However, there are some things you need to consider before deciding if this is a suitable option for your household:

- Check your manufacturer's recommendations on what to do if you're going away, and follow their instructions to avoid safety issues, damage to your water heater and the possibility of voiding your warranty.
- The stored water may cool below 60 degrees Celsius while you are away. When you return, the water in the storage tank must be boosted to at least 60 degrees Celsius for 35 minutes before any hot water is used, to kill any bacteria that may have grown. It could take several hours for the water to heat.
- Some solar water heaters rely on the booster to provide frost protection. If your booster is switched off, you risk damaging the solar collector and pipes if water freezes in them. This could even result in water damage to your home.
- If you choose to switch off the booster, don't switch off power to the rest of the system, as some solar water heaters rely on the thermostat and circulation pump to prevent damage from freezing and boiling.
- You may want to consider covering the solar collector to prevent damage from overheating.

Check your manufacturer's instructions on safely dissipating any hydrogen gas that could accumulate in storage tanks with a sacrificial anode if not used for two weeks or more.

It may also be possible to switch off the booster in summer to save energy, depending on the weather and your water use. If the booster is switched off, the water should still be heated to 60 degrees Celsius or higher at least once a week.

What should I do if I am having problems with my solar hot water system?

The first point of contact for any issues you have with your solar hot water system should be your retailer or installer. They should be able to identify what the issue is and suggest a solution or possibly send someone to fix the problem.

WHERE CAN I GET MORE INFORMATION?

- Department of Resources, Energy and Tourism: http://ee.ret.gov.au/node/1374
- Living Greener: http://www.livinggreener.gov.au/energy/solar-hot-water-systems
- Your Home Technical Manual: http://www.yourhome.gov.au/technical/fs65.html
- Solar & Heat Pump Hot Water Systems- Plumber Guide and Handbook: http://ee.ret.gov.au/phase-out-greenhouse-intensive-hot-water-heaters/information-industry
- Clean Energy Council: http://www.cleanenergycouncil.org.au/dms/cec/factsheets/CEC_FACTSHEET_SOLARWATERv5.pdf
- CSIRO: http://csirosolarthermal.files.wordpress.com/2012/07/solarhotwaterfactsheet.pdf
- Speak to your installer, retailer or manufacturer

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