EECA
Energy Efficiency and Conservation Authority
Te Tari Tiaki Pūngao

RENEWABLE ENERGY

Fact Sheet 3
Solar Water Heating

In New Zealand, solar rays are an abundant energy source. Many homes are exposed annually to 20 - 30 times more energy from the sun than they use in electricity or gas.

The benefits of solar water heating

The most common use of the sun's energy in homes is to provide light and warmth. However, there is significant potential for providing hot water as well from this renewable energy source.

Solar water heating systems have many benefits including providing reliable hot water and savings on your power bill.

At current electricity prices, you could typically save up to $450 a year at home by installing a solar water heater. Commercial or industrial operations could save even more. These savings will continue to increase as electricity and gas prices are projected to increase over the coming years.

The environmental benefits are significant. With a solar water heating system the dependence on non-renewable energy sources will be reduced. Every system installed is estimated to save about 1.4 tonnes of carbon emissions a year (assuming a mix of coal and gas fired electricity generation is avoided). If commercial and industrial operations installed solar water heaters the environmental benefit would be greater still. Using solar water heating more widely throughout New Zealand would also take a load off our other energy resources.

A national option

Solar rays are free, non-polluting and renewable. Solar water heaters work well from Invercargill to the far north, although the performance varies depending on your location and the time of year. Standard solar water heating systems can produce around 75% of your household's water heating in summer and between 25 - 45% in winter.

Around 35,000 home owners in New Zealand have now installed solar water heating systems, and currently there are around 3,500 new solar water heating systems installed each year.

Solar water heating systems are commonly installed in both new and existing houses, especially when renovating, and are integrated with household electricity and gas supplies.

Recovering the costs of a solar water heating installation, including the hot water cylinder, will take between seven to 15 years depending on the region and electricity prices. The more hot water you use, the more you can save.

For motels, hotels, retirement villages and other large users of hot water, installing solar water heating makes even better sense with payback periods as short as three to four years.

The basics of solar water heating

A solar water heater works by absorbing energy from the sun in collector panels located on your roof. This energy is then transferred to water stored in a hot water cylinder.

A hot water cylinder holds enough water for one day's use, usually between 180 to 270 litres, which is heated over several hours and then held until it is used.

The water is heated from a cool temperature between 5 and 15°C to a minimum of 60°C (to prevent the growth of Legionella bacteria), and stored in the cylinder. When used, the water is mixed with cold so it comes out of your taps at around 55°C.

Heating the water, maintaining its temperature, and compensating for losses in distributing it around the house generally require 6 - 10kWh per day. This could be up to 50% of the average household electricity use.

At times when there isn't enough solar energy to heat the water, 'booster' heating is used to keep the water in the cylinder at the right temperature. The booster heating can be provided by electricity, gas or a wetback. (A wetback system can be installed in to a wood burner to heat hot water. Essentially a wetback is a pipe that circulates water between the fire and the hot water cylinder.)

Solar water heating systems can cost less than your lounge suite or minor house improvements. Unlike other home improvements, a solar water heater can deliver actual cash savings and reduce your household impact on climate change.

Solar water heating technology

Solar water heating systems consist of three main components:

1 a collector panel to absorb the sun's energy,

2 a storage cylinder to store heated water (sometimes the cylinder includes a heat exchanger to transfer heat from the transfer fluid to the usable water), and

3 components like pumps and controllers are appropriate to circulate the heated water through the system and better control the back up.

Open and closed loop systems: In an 'open loop' system, water from the cylinder is circulated through the collector panel and heated directly. In a 'closed loop' system, heat transfer fluid is circulated through a heat exchanger in the cylinder and heats the storage water. This system is preferable in areas prone to frost and freezing.

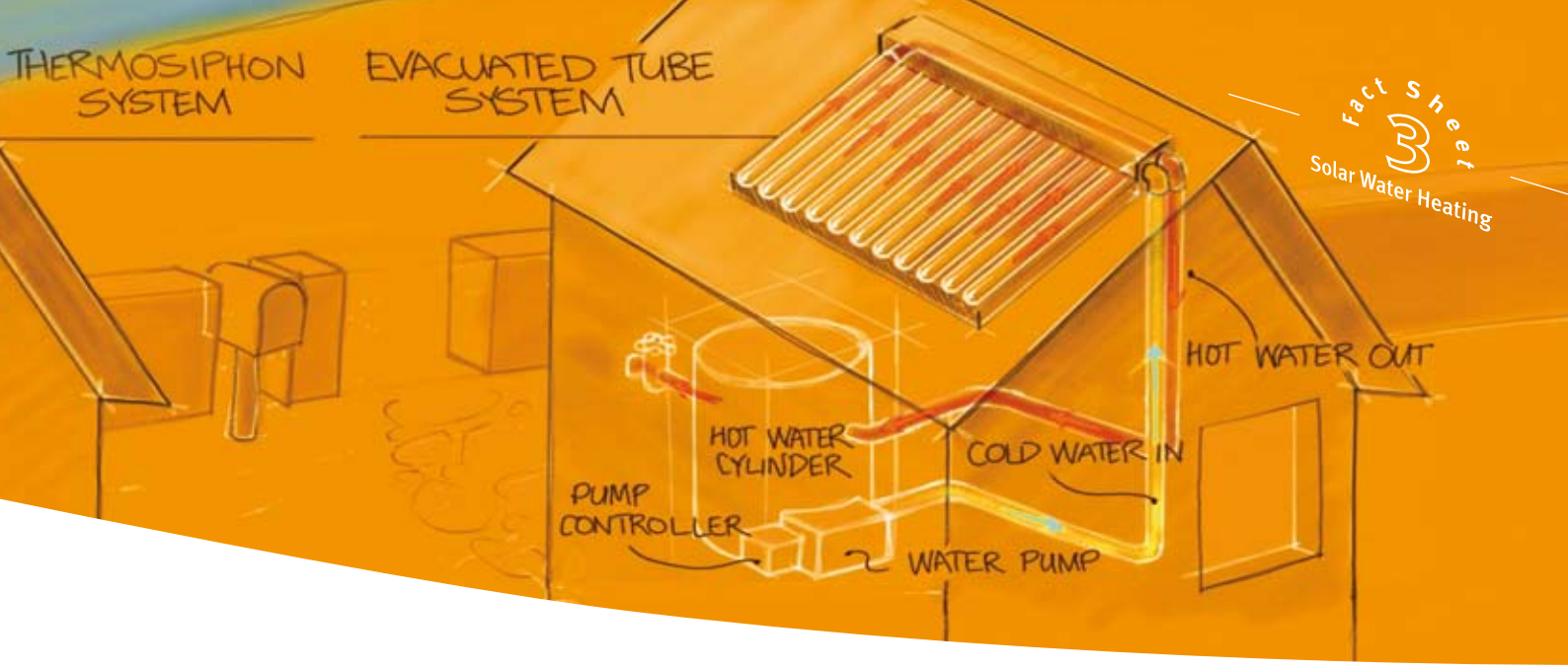
Solar collector: There are two main types of collector panels — a flat plate and evacuated tube. The flat plate consists of a flat sheet absorber or envelope of specially blackened metal. It absorbs the sunlight and transfers the heat produced into the water, or the transfer fluid, flowing through the collector.

The absorber is enclosed within an insulated panel with a transparent cover. The whole enclosure, or 'collector', acts as a greenhouse. It reduces heat loss, enabling the collector to work at elevated temperatures and ensures that a high percentage of the solar energy goes into the water.

Another increasingly common collector is the evacuated tube. This collector typically includes a heat exchanger at its higher end and a transfer fluid, which rises in the tubes and heats the water in the heat exchanger.

Ideally a solar collector should face true north and be installed at an angle that is equal to the latitude of where your house is located. However, it's possible to make deviations (±20%) from this ideal without affecting performance greatly.

The collector on a typical domestic solar water heating system is between three to eight square metres. The actual size is usually related to the size of the cylinder, working to a ratio of about one square metre of collector per 40 to 70 litres of cylinder volume.



Transfer mechanism: Water or transfer fluid is circulated through the collector panel by one of two methods:

- Natural circulation called thermosiphon, results when heated fluid in the collector creates a natural convection. The cool water (or transfer fluid) moves down from the storage cylinder to the panel and the more buoyant heated fluid moves up again. With a thermosiphon system, the storage cylinder must be positioned higher than the collector panel with the connecting pipes sloping at a specified angle to ensure proper performance. The cylinder is normally positioned horizontally and immediately above the collector on the roof, or concealed within the roof space.
- Using a pump to move the water or transfer fluid through the collector panels to the cylinder. The main advantage of a pump is that the cylinder can be below the collectors, which is suitable for a system where a storage cylinder already exists at floor level. The pump is used in conjunction with a control unit which ensures that the pump runs only when the water in the collector panel is hotter than in the cylinder.

Storage cylinder: Solar storage cylinders are often larger than a conventional electric-heated cylinder, so that in good weather the solar heated water is stored rather than wasted. They also have separate solar connection ports and an electric booster element.

It is also relatively easy to fit a solar collector to an existing hot water cylinder, although to do this properly you must use a controller.

A solar water heater can be used in conjunction with supplementary wetback or instantaneous electric or gas systems. Combining with a wetback works well as the solar system performs best in summer and the wetback provides extra heating in winter. Some homes with both solar and a wetback do not need boosting with electricity or gas at all. When combining solar and a wetback it is important to keep the two circulation circuits completely separate by using separate cylinder ports for the wetback and solar connections.

Controllers: Controllers automatically regulate the temperature of the water in the storage cylinder. There are two main types of supplementary heating controllers – time trigger controllers and minimum temperature controllers:

- A time trigger controller can be used to keep the booster heating turned off during the day, to ensure you're not paying for electricity or gas to heat your water when the sun could be doing the job for free. The timer can also be set to turn on the supplementary heating before periods of high water use. This can greatly increase the system's efficiency.
- Minimum temperature controllers simply trigger the supplementary heating whenever the cylinder temperature drops below a minimum pre-defined temperature.

Some new controllers are set up to incorporate both of these functions.

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Frost protection: Solar collectors in colder climates need freeze protection to avoid damage in cold weather. Protection is achieved in a number of ways:

- In closed loop systems, the heat transfer fluid in the panels, such as glycol, has anti-freeze properties.
- In open loop pump circulation systems, temperature sensors turn the pump on to run water from the bottom of the storage cylinder through the panel before it freezes. Frost valves can also be installed to let water flow through the panel when the temperature is close to freezing.
- 'Frost tubes' may also enable the water in the panels to freeze without damaging them.

Easy installation

It's easiest and cheapest to design and install solar water heating systems in new houses, when there is maximum flexibility in placing components to take best advantage of the sun's energy.

However, it is quite practical to fit solar water heating systems in existing buildings. An obvious time to consider a change is when an existing hot water storage cylinder is due for replacement. It's an ideal opportunity to choose a cylinder that will make best use of a solar installation.

Solar water heater performance

Most home solar water heating systems produce up to 15kWh/day on a sunny summer day, and up to 7kWh/day on a sunny winter day. This compares with the 6 - 10kWh/day normally required for home water heating. Solar collectors can last many years and some systems installed in the 1970s are still working well today.

While most promotion for solar water heating has focused on residential installations, the performance can be even better in other buildings that use a lot of hot water. These include motels, hotels and retirement villages which all need hot water more or less continuously throughout the day.

Significantly increased solar gain can be achieved through the use of a time switch on gas or electric boosters. The booster would normally be timed to switch on at the end of the day, just prior to hot water being required, when there has been limited sunshine and the water is not hot enough.

Solar water heater costs

The costs and economics of a solar water heating system vary considerably depending on the size and type of system and how much hot water you use. As a guide, solar water heating systems installed typically cost between $4,000 and $8,000.

Installation costs vary and you will need to get quotes for your site. You should also check with different suppliers as there may be a discount on a particular system that is best suited for your situation. It is advisable to purchase only from an industry accredited supplier as they have demonstrated that their product and installation practices meet the required standards. Accredited suppliers also have approved, trained installers. Regardless of the system you choose, the installation will need to comply with the NZ Building code.

Case study

Waitakere NOW Home® trials energy efficient design

The Waitakere NOW Home® is part of a project trialling the design and construction of affordable homes that are warmer, healthier, cheaper to run – and kinder to the environment.

Energy use in the trial home is remotely monitored while the tenants, a young family, go about 'life as usual'.

Solar water heating

Water heating accounts for 28% of the household's energy use, so the designers installed a solar water heater.

It has collectors on the north facing roof and an electric boosted mains pressure storage tank inside the house. A small circulator moves the water between the tank and collectors, which use an aluminium absorber plate and copper risers.

Significant savings

The solar water heating system provides for more than half (55%) of the tenant's water heating needs. That's equivalent to a saving of about $275 or 1620kWh (compared to similar houses in the area) on water heating alone.

The tenants used the solar system for all their hot water over summer, with electrical boosting only required in the cooler months. An override switch ensures extra hot water is always on-tap when needed.

The young family has enjoyed the home's lower power bills, and say that NOW Home® is the best house they have ever lived in.

This fact sheet was produced by the Energy Efficiency and Conservation Authority (EECA). EECA is a Crown entity implementing the National Energy Efficiency and Conservation Strategy through improving energy choices.

For more information about EECA, the renewable energy target, and links to other information sources visit:
www.eeca.govt.nz

For further information on solar water heating visit:
www.energywise.govt.nz

www.solarindustries.org.nz

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