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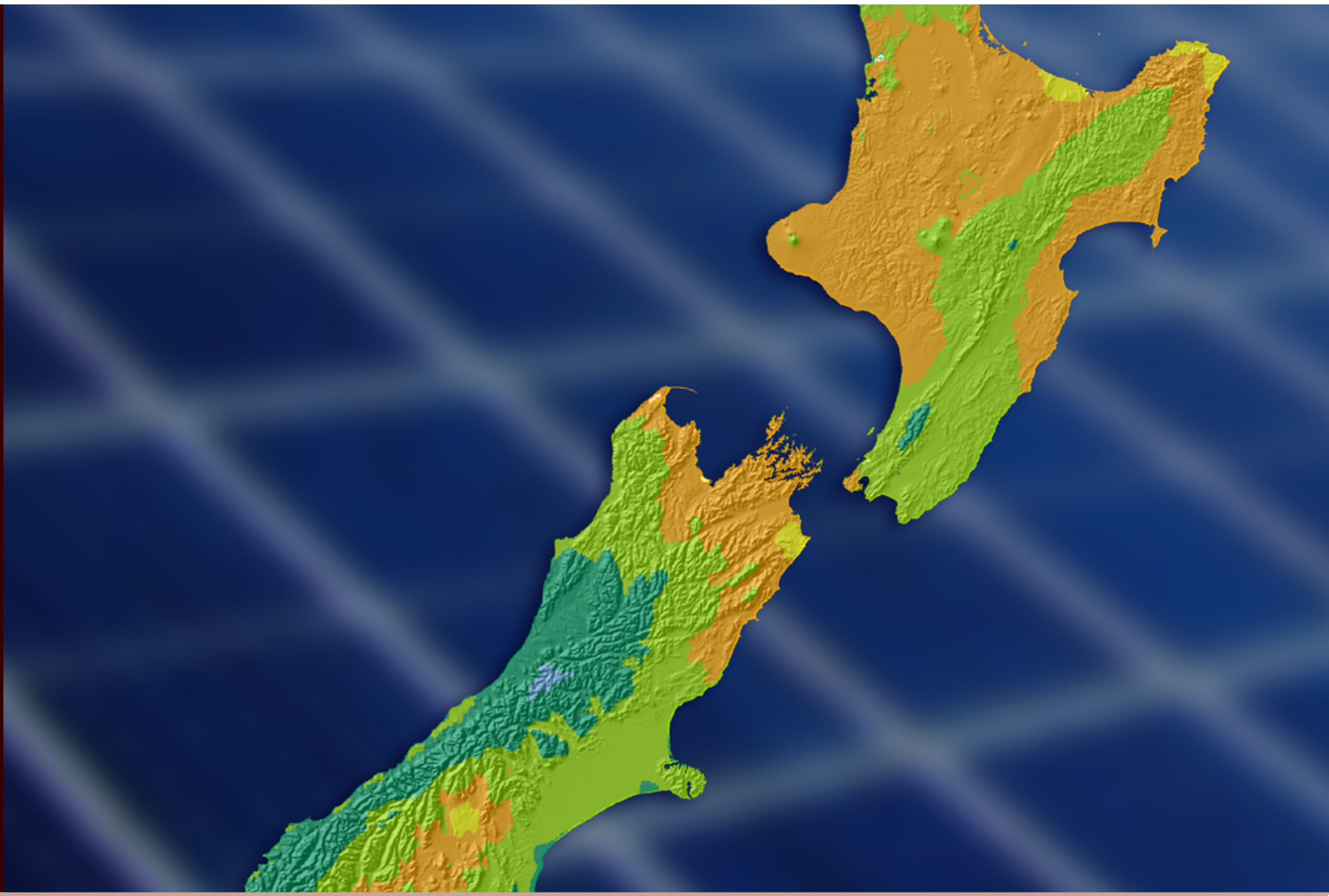
BULLETIN



SOLAR WATER HEATING

June 2010

Solar panel water heaters can significantly reduce water heating bills in many households throughout the country.

This Bulletin gives an overview of the performance, application, installation and construction of solar water heaters.

This Bulletin replaces Bulletin 477 *Solar water heating.*

1.0 INTRODUCTION

1.0.1 Solar energy reaching a building can be used in a number of different ways:
- Solar energy passing through windows provides a large contribution to residential space heating requirements.
- Solar energy can be transformed into electricity by the use of solar photovoltaic (PV) panels.
- Solar collectors can transfer the heat from solar energy into a medium such as water. Solar water heating is the focus of this Bulletin.

1.0.2 Solar water heating systems can be used in a variety of applications in the residential, commercial and industrial sectors:
- Residential applications for solar water heating include providing for household hot water services, swimming pool heating and space heating via pipes in building elements (such as floors) or radiators.
- Commercial applications for solar water heating include water heating typically (but not exclusively) for motels, hotels, retirement homes, motor camps and hostels, as well as institutional buildings such as hospitals and prisons.

2.0 AVAILABLE RESOURCE

2.0.1 Overall, New Zealand's solar energy resources are excellent. The amount of solar radiation available in most parts of New Zealand is higher than in Germany and Japan – two countries that have extensive investment in solar energy (see Figure 1).

2.0.2 The average amount of solar radiation available around New Zealand can be seen in Figure 2.

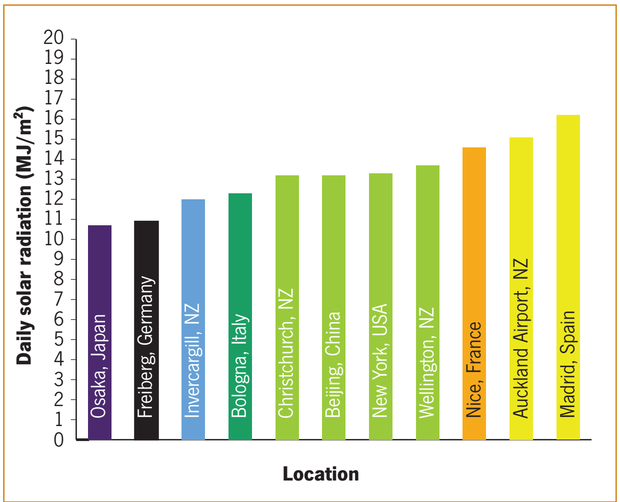


Figure 1. Solar radiation levels from selected cities (data from Atmospheric Science Data Centre, NASA).

2.0.3 AS/NZS 4234:2008 *Heated water systems – Calculation of energy consumption* covers how to calculate the energy use for water heating service. The standard divides New Zealand into two climate zones based on the amount of solar radiation:
- Parts of Otago, Southland, Stewart Island and the West Coast.
- The rest of the South Island and the North Island.

2.0.4 It is also important to consider the local situation when assessing solar energy potential. Locations with terrain, buildings or vegetation obscuring the sun's path across the sky will have reduced solar radiation available. NIWA's SolarView website (www.niwa.co.nz/our-services/online-services/solarview) provides a convenient way to view the impact of terrain for any New Zealand geographical location.

2.0.5 Where sites have low levels of solar radiation or poor solar access, heat pump water heating systems may provide an alternative for an energy-efficient water heating option.

3.0 SOLAR WATER HEATING SYSTEMS

3.0.1 Solar water heating systems are complicated systems involving many components. Getting a system that can reliably save a large proportion of water heating costs requires that the separate components of the system all perform well.

3.0.2 In 2007–2008, BRANZ studied the performance of 35 solar water heating systems using various technologies installed around 2006 in Auckland, Wellington, Christchurch and Dunedin. The results were published in two reports: one on installations (SR184 *An inspection of solar water heater installations*); the second on energy performance and occupant experiences (SR188 *The performance of solar water heaters in New Zealand*). The following provides an overview of the components of a well performing solar water heating system and includes the findings from these reports.

3.1 SOLAR COLLECTORS

3.1.1 The solar collector is the first stage of getting solar energy into the water and involves a collector surface to absorb heat.

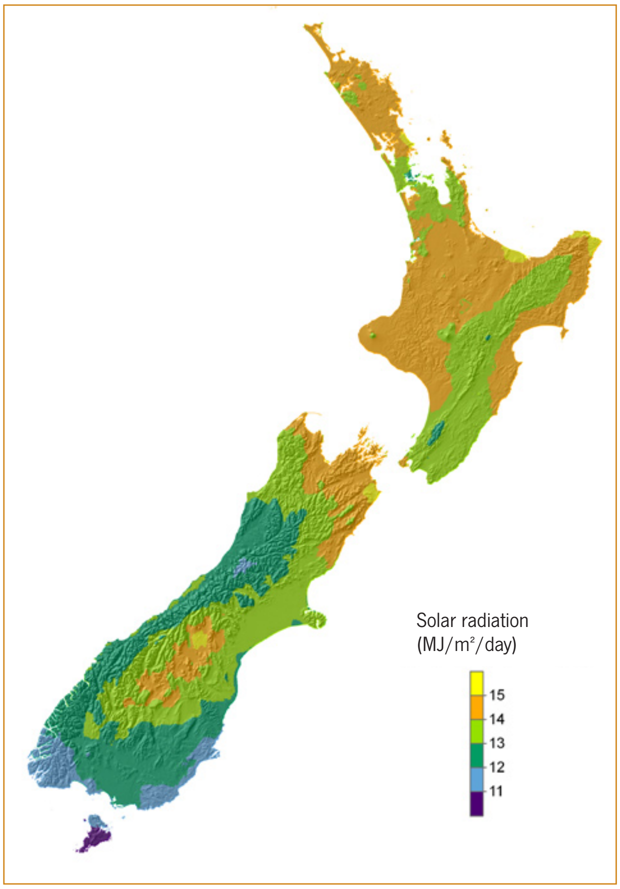


Figure 2. Average solar radiation around New Zealand (courtesy of NIWA).

3.1.2 Solar collectors are typically one of three types:
- Flat plate collectors are made of a flat metal absorber covered with a pane of glass. Fluid is circulated to remove heat from the collector, and insulation is used to reduce heat losses from the absorber to other materials.
- Evacuated tube collectors are made of a number of concentric glass tubes with a vacuum between them. They work in much the same way as a thermos flask, with the collector surface within the inner tube.
- Unglazed collectors are typically formed from black plastic or rubber tubes and are very efficient for lower-temperature applications such as pool heating. Unglazed collectors are less efficient at higher temperatures due to higher heat losses.

3.1.3 Solar collectors should be:
- of sufficient size to meet demand – different collectors will have different performance levels
- installed at the same angle as the latitude of the location to get year-round performance
- facing north preferably or within the NE to NW quadrant
- not subject to shading
- protected from frost where appropriate.

3.1.4 Frost protection may include:
- drain-back systems where water in the collector is drained back to a reservoir when temperatures fall
- closed-loop anti-freeze systems that replace water in the collectors with an anti-freeze solution
- frost valves that discharge water in the collector when the temperature falls.
- pumped circulation that circulates heated water from the hot water cylinder through the collector.

3.2 HOT WATER CYLINDERS

3.2.1 The hot water cylinder stores heat from the solar collector or other heating sources. The hot water cylinder can be directly connected to a solar collector or installed separately from the solar collectors.

3.2.2 Cylinders designed for use with solar collectors feature additional ports or coils so that heat can be transferred to the cylinder appropriately.

3.2.3 Where a solar collector is added to an existing hot water cylinder, the use of special fittings may be required. However, often this does not provide an optimal outcome due to the position of the heating element, the limited size or insulation grade of the existing cylinder.

3.2.4 The size of the hot water cylinder should be sufficient for the amount of solar collectors used (for example, a minimum of 50 litres per square metre of collector area) and to provide storage for not less than 1 day's expected hot water use (for example, 40–60 litres per person).

3.2.5 Fluid in glazed solar collectors can reach high temperatures. The solar water heating system needs to be protected from these temperatures with appropriate control systems, use of appropriate materials and over-temperature safety devices.

3.2.6 Solar water heating systems need to store heat for a long time, so they benefit from high levels of insulation.

3.2.7 Cylinders that are installed outside are subject to more extreme temperature and will have higher heat loss unless higher levels of insulation are used. Where a solar water heating system includes an outside cylinder, the level of cylinder insulation should be checked from product literature.

3.3 SUPPLEMENTARY HEATING

3.3.1 To provide hot water on days when there is little solar radiation, it is necessary to provide supplementary heating (usually electricity or gas) for the solar hot water system.

3.3.2 The most common configuration of supplementary heating is to provide electrical heating within the hot water cylinder that is connected to the solar collectors. In this case, placement of heating elements, thermostats and outlet locations is important and should be specified by the manufacturer of the system. A poorly designed system may provide little opportunity for solar energy to heat cold water entering the hot water cylinder.

3.3.3 Another configuration is the preheat system, where heat from the solar collectors is stored within a hot water cylinder that then feeds the cold input of a water heating system, such as another hot water cylinder (electric or gas) or a continuous-flow gas system.

3.4 WETBACK CONNECTION

3.4.1 Heat from a solid fuel burner may also be able to be inputted into a hot water cylinder via a wetback connection. Solid fuel burners are primarily used during the winter space-heating season when solar radiation levels are lower. Therefore, a wetback connection to a solar water heating system provides a good seasonal balance of energy inputs. However, it may not always be possible to add a wetback to a solar water heating system.

3.4.2 There is little information available on how well wetback systems work with solar water heating systems. The additional input increases the complexity of the pipework and the likelihood of unusual circulations with the solar water heating system. Solid fuel burners may also need to meet any clean air requirements.

3.5 GAS WATER HEATING

3.5.1 Storage gas water heating and instant gas water heating can be combined with solar water heating using preheat configurations. Gas water heater suppliers can provide details of suggested configurations.

3.5.2 Some gas water heaters are designated 'solar ready'. Other gas water heaters may require the installation of flow diversion values to limit the gas burner cycling when the incoming water is within 10°C of the delivery temperature.

3.6 CONTROLLERS

3.6.1 Additional control should also be used on the supplementary heating (in addition to the thermostat). Supplementary heating can be reduced by using timers that only heat for a few hours before anticipated water demand.

3.6.2 Controllers should be displayed in a prominent location so that users can monitor how the system is operating – optimising the system when they use hot water or minimising when supplementary heating is needed.

3.7 *LEGIONELLA* CONTROL

3.7.1 Conditions within the solar water heating system need to be controlled to reduce the risk of *Legionella.* New Zealand Building Code Acceptable Solution G12/AS2 *Solar water heaters* provides three *Legionella* control strategies.

3.8 CONNECTIONS

3.8.1 The operating conditions for solar water heating systems are more challenging than for standard domestic plumbing. Some components may need to be updated and installed by an appropriately qualified person familiar with the requirements for solar water heating.

3.8.2 Pipe run lengths should be kept short and well insulated.

3.8.3 It is also important that piping arrangements do not permit reverse thermosiphon currents from occurring by including heat traps in pipework.

4.0 ASSESSMENT

4.0.1 Stages that may be considered during the life cycle of a solar water heating system include assessment, design, consenting, installation, commissioning, ongoing monitoring, maintenance and decommissioning.

4.0.2 A major consideration during the assessment stage should be a financial analysis of the costs and benefits of solar water heating.

4.0.3 Where a solar water heating system is considered for a new house or where the existing hot water system has failed and needs replacing, the costs of the solar water heating system over and above the cost of a standard hot water system need to be examined alongside the benefits from the reduced energy use of the solar water heating.

4.0.4 A solar water heating system added to an existing hot water system will have a lower performance than a complete new system. Existing hot water cylinders may be too small, not have elements and thermostats in favourable locations and may have lower levels of insulation. The lower energy savings these systems deliver frequently make them an uneconomical option.

4.0.5 Financial analysis of energy efficiency improvements frequently only give the pay-back period for the improvements. A more complete financial analysis would also include an internal rate of return for the improvement so that the investment in the energy efficiency improvement can be more directly compared with other investment opportunities.

5.0 ENERGY PERFORMANCE INFORMATION

5.0.1 Historically, it has been difficult to estimate the energy savings resulting from the installation of solar water heating systems. However, the computer program TRNSYS can reliably determine how much energy such a system will save, if all the components are known and specified.

5.0.2 AS/NZS 4234:2008 provides guidelines of how to use TRNSYS to predict savings, with results generally presented for Auckland (Zone 5) and Dunedin (Zone 6). Results for a number of complete systems are on the Energy Efficiency and Conservation Authority (EECA) website www.energywise.govt.nz/solar-systems.

5.0.3 These results only apply to the complete specific system listed. Lower performance will occur if elements of the system are replaced with lower-performing systems or the system is configured differently (such as solar collectors not being optimally positioned).

5.0.4 EECA has announced that it is investigating the inclusion of solar water heating systems in the ENERGY STAR programme, where higher-performing solar water heating systems can display the ENERGY STAR label. ENERGY STAR is the global mark of energy efficiency. It is typically awarded to the top 25% of the most energy-efficient appliances.

6.0 NEW ZEALAND BUILDING CODE

6.0.1 The installation of a solar water heating system needs to meet the performance requirements of the New Zealand Building Code, in particular clauses:
- B1 *Structure*
- B2 *Durability*
- E2 *External moisture*
- F2 *Hazardous building materials*
- G9 *Electricity*
- G11 *Gas as an energy source*
- G12 *Water supplies*
- H1 *Energy efficiency*.

6.0.2 In 2007, Acceptable Solution G12/AS2 *Solar water heaters* was released, which provides a deemed-to-comply but non-mandatory pathway for the installation of solar water heating systems.

6.0.3 Through feedback from industry, some of the limits of application of G12/AS2 have caused concern, in particular:
- the maximum 4 m^2 collector area limit
- the inclination angle requirements on low-pitched roofs in southern locations
- the exclusion of some combinations of particular materials
- the need to retest solar water heating systems to AS/NZS 2712:2007 *Solar and heat pump water heaters – Design and construction* when a solar water heating system has already passed similar European standards.

6.0.4 Consequently, the Department of Building of Housing (DBH) has issued guidance showing how the Building Code performance criteria required for solar water heating systems outside the scope of G12/AS2 will be met (see *Solar water heaters – Guidance for suppliers, installers and building consent authorities* on the DBH website). Figure 3 provides an overview of this process.

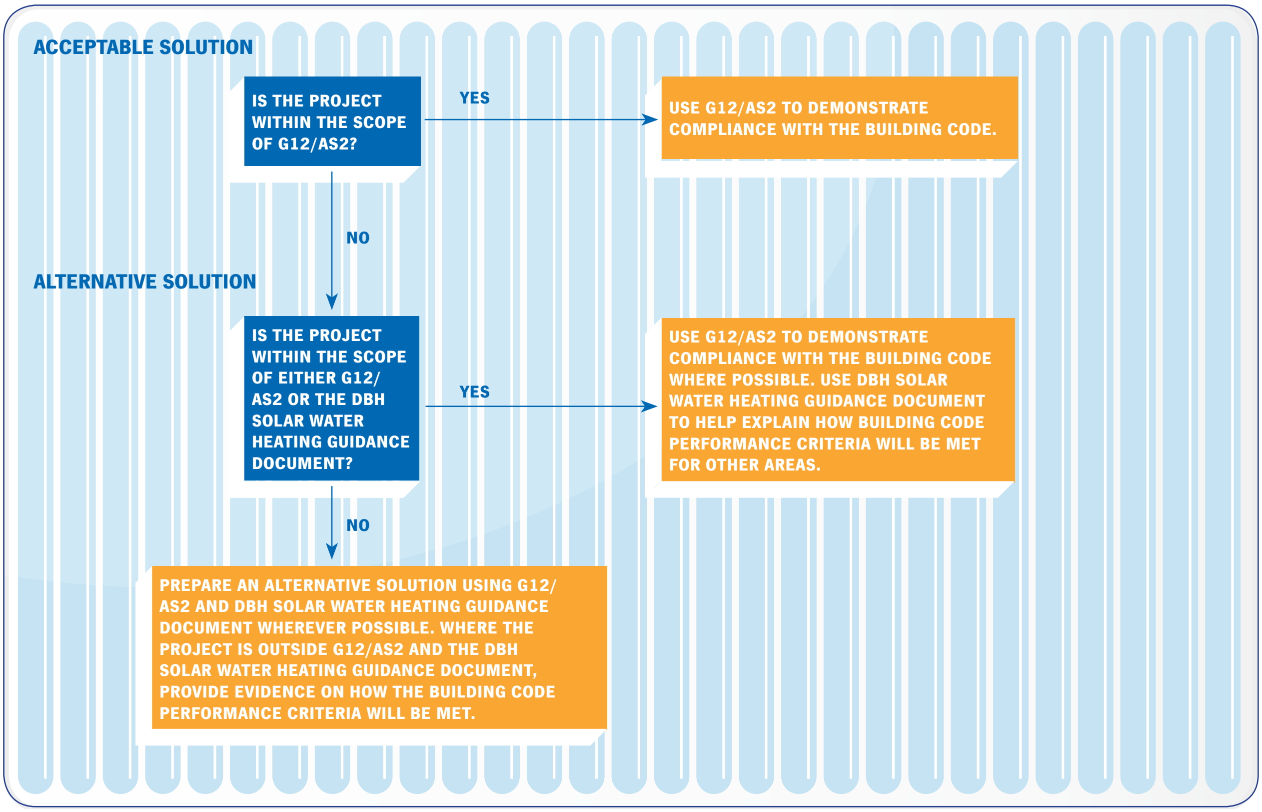


Figure 3. Ways to demonstrate how the Building Code performance criteria will be met for a proposed solar water heating system.

7.0 COMMISSION AND OPERATION

7.0.1 Once the installation is complete, it is important for the installer to educate the homeowner about how the system works and how they need to operate and monitor it.

7.0.2 During the operational phase, the homeowner needs to monitor the performance and seek help when this is not up to standard.

8.0 MORE INFORMATION

8.0.1 The EECA website www.energywise.govt.nz/solar provides a range of information on solar water heating systems in general as well as providing details of government programmes to support the uptake of solar water heating. Currently, a $1,000 grant is available for the installation by an approved installer of selected packaged systems from a participating supplier.

8.0.2 The Solar Industries Association (SIA) website www.solarindustries.org.nz contains a range of detailed information on solar water heating. The SIA is a grouping of manufacturers, suppliers, installers, researchers and consultants looking to promote and develop the solar water heating industry in New Zealand. The SIA has established an accreditation system for the industry to give consumers confidence. Accredited suppliers have demonstrated to the SIA that their equipment meets the relevant performance standard AS/NZS 2712:2007 and that they have an acceptable level of competence as a designer/supplier/installer.

8.0.3 More general information on solar water heating can also be found on the Level website www.level.org.nz and the Smarter Homes website www.smarterhomes.org.nz.

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