Australian Government
Office of the Renewable Energy Regulator

# REQUIREMENT

# REC CALCULATION METHODOLOGY FOR SOLAR WATER HEATERS AND HEAT PUMP WATER HEATERS WITH A VOLUMETRIC CAPACITY OVER 700 LITRES[1]

***Version 10 as update January 2008***

**Introduction**

This methodology document is to be used to calculate renewable energy certificate (REC) entitlement (energy savings) for solar water heater (SWH) or heat pump water heaters (HPWH) with a volumetric water storage capacity over 700 litres for the purposes of their listing in the Register of Solar Water Heaters (http://www.orer.gov.au/publications/swh-register.html).

The annual energy savings for a solar water heater or heat pump water heater is calculated by subtracting the boost energy required by the SWH or HPWH to deliver a prescribed load from the electrical energy consumption of an electric water heater to deliver an equivalent load. This needs to be calculated for each of the four climate zones in which RECs are to be claimed.

The annual savings are multiplied by ten to determine the total estimated savings of the system over ten years. The total savings are then rounded down to determine the systems REC entitlement, with each REC representing one whole megawatt hour of electricity saving.

[1] Note: The information provided in this document may be subject to change with amendments to the *Renewable Energy (Electricity) Act 2000*, the *Renewable Energy (Electricity) Regulations 2001*, and the administrative processes adopted by the Office of the Renewable Energy Regulator (ORER).

The boost energy required by the system to deliver a prescribed load profile (the **total annual auxiliary boost energy**) is calculated in accordance with Australian Standard AS4234 (with the TRNSYS thermal modelling software) with the exception of a number of TRNSYS input parameters that are defined below.

This methodology also describes the proper treatment of dual element tanks and manual controls for the purposes of REC calculation.

**Treatment of Dual Element Tanks**

For systems where a bottom element is, or can be, fitted in the tank (e.g. a dual element tanks) the bottom element is to be used for REC calculation purposes. The minimum boost time for a bottom element shall be nominal off-peak times of 11pm to 6am.

Some tank designs may be modified by the installer to insert an element at the bottom of the tank even if this element has been blanked off. If a model uses a tank that can have the bottom element connected, the ORER the ORER requires that the bottom element be used to determine REC values.

**One-Shot Boosting**

One-shot boosting is a manual control that allows a default boost mode (such as off-peak boosting) to be overridden so that the user can satisfy a short term high demand for hot water.

Where the system automatically resets to the default boosting mode within 24 hours of the user changing the boost mode, the one-shot boosting can be ignored for the purposes of REC calculation.

Where the system does not automatically reset to the default boosting mode within 24 hours of the user changing the boost mode, the boosting mode activated by the manual control must be considered to be active at all times for the purposes of REC calculation.

**Family of Products**

A ‘family of products’ is where a combination of tanks and collectors are used in a modular fashion to create a product range of different sizes.

Where a range of solar collector array sizes are used on the same storage tank the performance of the family of products may be determined from detailed simulation of the performance of the largest, smallest and midpoint array sizes. The performance of other members of the family may be determined by interpolation.

**REC Calculation Methodology**

1. Use the following TRNSYS input parameters to calculate the **total annual auxiliary boost energy** (MWh) for the solar water heater using Version 14 or later of the TRNSYS computer modelling package:

   a. Solar collector efficiency parameters determined in accordance with AS/NZS2535.

   b. Air source heat pump Coefficient of Performance (COP) and power consumption performance shall be determined from full system tests in a calorimeter chamber. The performance shall be correlated using methods described in Morrison et al. (2004) or other methods approved by the Office of the Renewable Energy Regulator (ORER).

   c. Tank heat loss determined using the ORER Heat Loss Test Procedure for Solar Water Heaters with a Hot Water Storage Tank Greater than 630 Litres (http://www.orer.gov.au/householders/heatloss.html).

   d. Modelling shall be carried out using a simulation time step of 0.1 hr or less.

   e. Solar collector slope = 20 degrees

   f. Solar collector azimuth = 45 degrees

   g. Peak winter hot water load for Solar water heaters and solar boosted heat pump water heaters is set at 10 MJ/($m^2$ aperture area)/ day

      *Air source heat pump water heaters*

      Peak winter load for annual performance assessment is 60% of the maximum no-solar load capacity. The maximum no-solar load capacity is the largest hot water energy delivery that can be achieved with outlet temperatures greater than 40 degrees Celsius (40°C). The no-solar capacity is determined for July in zone 4 (maximum winter load) using the modelling package with the daily load pattern specified in Table 2 and the AS 4234 no-solar conditions for zone 4 (radiation = 0, ambient temperature = 10°C, relative humidity = 60%, cold water temperature = 9°C).

h. Hot water usage, daily and seasonal are provided in Tables 1 and Table 2.

i. Cold water temperatures for each zone are provided in Table 3.

j. Length of piping between storage tank and the closest corner of the solar collector array for a pumped circulation system shall be the manufacturer's specification or 25 m (each way), which ever is larger. The length of the return pipe shall account for additional piping length associated with reverse return plumbing.

The length of piping between the 'pumped circulation solar preheat tank' and the 'series auxiliary booster' shall be the manufacturers specification or 10 m which ever is larger.

The length of piping between the 'thermosiphon solar preheater' and the 'series auxiliary booster' shall be the manufacturer's specification or 25 m which ever is larger.

The diameter of all connecting piping shall be equal to the manufacturer's specifications.

k. The thermostat setting for the purpose of the rating shall produce a minimum temperature of 60°C at the hot water delivery point after each heating cycle.

l. Boosting may be continuously available, or at standard off-peak tariff times or limited by a local controller in order to separate the boost time from the solar operation times.

If off-peak boosting or other time limits on auxiliary boosting are employed then the product must be able to deliver the selected load under the no-solar climate conditions specified in AS 4234. Under no-solar conditions the minimum delivery temperature of any draw-off must be greater than or equal to 40°C. If the product fails to meet this condition then a lower load condition shall be used or the boost volume increased until the required condition is satisfied.

m. Weather data to be used for the climatic zones can be obtained on request from ORER or from MechLab (MechLab@unsw.edu.au). Some of these TMY files differ from the weather data used for AS 4234.

Zones 1 & 3 : Adelaide

Zone 2: Alice Springs

Zone 4 : Melbourne

Further documentation of weather data is available at http://solar1.mech.unsw.edu.au/glm/trnaus/tmy99.pdf.

2. Determine the annual energy use of an electric water heater supplying the same hot water load. The heat loss from the electric system will be taken as 15% of the hot water load.

3. Subtract the 'total annual auxiliary boost energy input' (MWh) of the solar water heater from that of the conventional electric water heater to determine the annual saving in MWh of input energy.

4. Multiply this calculated annual saving by 10 to determine the 10 year energy saving.

5. Round the result down to an integer value to determine the system's REC eligibility.

**Table 1: Monthly Hot Water Energy Usage Patterns for Each Zone (Fraction of Peak Month Load)**

| *Location* | *Monthly Usage Pattern (Ratio of peak month)* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Jan* | *Feb* | *Mar* | *Apr* | *May* | *Jun* | *Jul* | *Aug* | *Sep* | *Oct* | *Nov* | *Dec* |
| Zone 1 - Adelaide | 0.69 | 0.69 | 0.67 | 0.74 | 0.80 | 0.87 | 0.98 | 1.00 | 0.94 | 0.93 | 0.84 | 0.76 |
| Zone 2 - Alice Springs | 0.44 | 0.50 | 0.58 | 0.69 | 0.86 | 0.94 | 1.00 | 0.92 | 0.75 | 0.61 | 0.53 | 0.47 |
| Zone 3 - Adelaide | 0.69 | 0.69 | 0.67 | 0.74 | 0.80 | 0.87 | 0.98 | 1.00 | 0.94 | 0.93 | 0.84 | 0.76 |
| Zone 4 - Melbourne | 0.68 | 0.68 | 0.73 | 0.81 | 0.92 | 0.97 | 1.00 | 0.95 | 0.89 | 0.81 | 0.76 | 0.70 |

| Table 2: Daily Hot Water Energy Usage Patterns for all Zones (As Fraction of Daily Load) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Time of day | 7-8 | 8-9 | 11-12 | 13-14 | 15-16 | 16-17 | 17-18 | 18-19 |
| Fraction of load | 0.150 | 0.150 | 0.100 | 0.100 | 0.125 | 0.125 | 0.125 | 0.125 |

**Table 3: Monthly Cold Water Temperatures**

| *Location* | *Cold Water Temperatures (°C)* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Jan* | *Feb* | *Mar* | *Apr* | *May* | *Jun* | *Jul* | *Aug* | *Sep* | *Oct* | *Nov* | *Dec* |
| Zone 1 – Adelaide | 20.53 | 20.79 | 21.46 | 18.86 | 16.73 | 14.21 | 10.34 | 9.79 | 11.82 | 12.27 | 15.36 | 18.14 |
| Zone 2 - Alice Springs | 29.00 | 27.00 | 24.00 | 20.00 | 14.00 | 11.00 | 9.00 | 12.00 | 18.00 | 23.00 | 26.00 | 28.00 |
| Zone 3 – Adelaide | 20.53 | 20.79 | 21.46 | 18.86 | 16.73 | 14.21 | 10.34 | 9.79 | 11.82 | 12.27 | 15.36 | 18.14 |
| Zone 4 - Melbourne | 20.00 | 20.00 | 18.00 | 15.00 | 11.00 | 9.00 | 8.00 | 10.00 | 12.00 | 15.00 | 17.00 | 19.00 |

**References**


1. AS/NZS 4692.1-2005, Electric water heaters. Part 1: Energy consumption performance and general requirements, Standards Australia.

2. AS/NZS 2535-2007, Test methods for solar collectors - Thermal performance of glazed liquid heating collectors including pressure drop (ISO 9806-1:1994, MOD), Standards Australia.

3. TRNSYS 15 User Manual, Kline, S.A. et al. University of Wisconsin Solar Energy Laboratory, l998.

4. TRNSYS Extensions for Australian Solar Products (TRNAUS). Solar Thermal Energy Laboratory, School of Mechanical & Manufacturing Engineering, University of NSW. Report 2007-7.3. (http://solar1.mech.unsw.edu.au/glm/trnaus/trnaus.pdf)

5. AS4234-1994 Solar water heaters - Domestic and heat pump - Calculation of energy consumption, Standards Australia.

6. Morrison G.L and Litvak A. Condensed solar radiation data base for Australia. http://solar1.mech.unsw.edu.au/glm/trnaus/tmy99.pdf

7. Morrison G.L., Anderson T and Behnia M. (2004) Seasonal performance rating of heat pump water heaters. ISES Solar World Congress conference 2002, also Solar Energy V76, 147-152, (2004).