



## REQUIREMENT

# REC CALCULATION METHODOLOGY FOR SOLAR WATER HEATERS AND HEAT PUMP WATER HEATERS WITH A VOLUMETRIC CAPACITY UP TO AND INCLUDING 700 LITRES<sup>1</sup>

*Version 13 as update January 2008*

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### 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 up to and including 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 for 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.

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

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<sup>1</sup> 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* (the Regulations), and the administrative processes adopted by the Office of the Renewable Energy Regulator.

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 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.

### **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 is determined in accordance with AS/NZS 4692.1 or AS 1056 test procedure.
- 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. Use Table 1 to determine the hot water load (small, medium or large) based on the size of the solar storage tank.
- h. Peak loads for each climate zone and product size is provided in Table 2
- i. Monthly usage patterns are provided in Table 3.
- j. Monthly cold water temperatures for each zone are provided in Table 4.
- k. Length of piping between storage tank and solar collectors for a pumped circulation system shall be the manufacturer's specification or 10 metres (each way), whichever is larger.

Length of piping between pumped circulation solar preheat tank and a separate series connected auxiliary booster shall be the manufacturers specification or 5 metres whichever is larger.

Length of piping between a thermosiphon solar pre-heater and a separate series auxiliary booster shall be the manufacturer's specification or 10 m whichever is larger.

- l. The thermostat setting for the purpose of the rating shall produce a minimum temperature of 60 degrees Celsius at the hot water delivery point after each heating cycle.
- m. 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 degrees Celsius (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.

- n. Weather data to be used for the climatic zones can be obtained on request from ORER or from MechLab ([MechLab@unsw.edu.au](mailto: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. By default, the AS 4234 software reports auxiliary boost energy as average daily kJs for each month. Multiply average daily kJ by the number of days in each corresponding month. Sum the monthly totals to determine **total annual auxiliary boost energy**. Convert kJ to MWh.

Alternatively the AS 4234 software can be set to output the boost energy as total kJ per month. In this case the sum of the monthly totals should be converted to MWh to determine **total annual auxiliary boost energy**.

3. From Table 1 look up the size of the equivalent conventional water heater (small, medium or large) using the peak load delivery capacity of the solar water heater (MJ/day).
4. From Table 5 look up the electrical energy consumption of an equivalently sized (small, medium or large) electric water heater' (note: use Table 5 in place of the energy consumption tables in AS 4234).
5. Subtract the **total annual auxiliary boost energy** (MWh) of the solar water heater or heat pump water heater from that of the equivalently sized (small, medium or large) electric water heater' to determine the annual saving in MWh of input energy.
6. Multiply this calculated annual saving by 10 to determine the 10 year Renewable Energy Certificate (REC) allocation.
7. The savings calculated in Step 5 should be rounded down to an integer value.

<b>Table 1: Hot Water Rating Loads</b>		
<i>Hot water load</i>	<i>Single tank product with solar &amp; auxiliary inputs to the one tank</i>	<i>Solar preheat product with series connected instantaneous booster and two tank products</i>
Large	Tank volume equal to or greater than 400 L	Preheat tank volume equal to or greater than 200 L
Medium	Tank volume less than 400 L and greater than 220 L	Preheat tank volume less than 200 L and greater than 110 L
Small	Tank volume equal to or less than 220 L	Preheat tank volume equal to or less than 110 L

<b>Table 2: Peak Winter Hot Water Energy Load for each Zone (MJ/day)</b>			
<i>Location</i>	<i>Peak Load (MJ/day)</i>		
	<i>Large system</i>	<i>Medium system</i>	<i>Small system</i>
Zone 1 – Adelaide	60	40	24
Zone 2 - Alice Springs	61.3	40.9	24.5
Zone 3 – Adelaide	60	40	24
Zone 4 – Melbourne	63	42	25.2

<b>Table 3: Monthly Hot Water Energy Usage Patterns for Each Zone (Fraction of Peak Month Load)</b>												
<i>Location</i>	<i>Monthly Usage Pattern (Ratio of peak month)</i>											
	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
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

<b>Table 4: Monthly Cold Water Temperatures</b>												
<i>Location</i>	<i>Cold Water Temperatures (°C)</i>											
	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
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

<b>Table 5: Standard Electrical Energy Consumption for Conventional Systems</b>				
<i>System Size</i>	<i>Electrical Energy Consumption (MWh/a)</i>			
	<i>Zone 1</i>	<i>Zone 2</i>	<i>Zone 3</i>	<i>Zone 4</i>
Large system	5.9	5.1	5.9	6.1
Medium system	4.3	3.6	4.3	4.4
Small system	2.7	2.3	2.7	2.7

Please contact the ORER if you have any questions and check the ORER website ([www.orer.gov.au](http://www.orer.gov.au)) regularly to ensure that you are using the latest version of this methodology.

### References

1. AS/NZS 4692.1-2005, Electric water heaters. Part 1: Energy consumption performance and general requirements
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, 1998.
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).