

NSW ESS Solar Hot Water Activity Specification: Addendum 1

Prepared for

Office of Energy and Climate Change, NSW Treasury

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Basis of EnergyConsult Work

The work of EnergyConsult in connection with this assignment has been reliant on information and analyses supplied by third parties and the Department. We have performed research and analysis using this data and publicly available information drawn from a wide range of information services, output of analyses conducted by third parties, and other information which was available to use within the timeframe specified for the preparation of the report. This data was used in order to provide the Department with analysis which may be relevant to the requirements of the Department. The analysis also relies on several assumptions, both stated and unstated in the report, which are in turn based on our analysis of third-party information.

EnergyConsult has not independently verified, nor can we accept any responsibility or liability for independently verifying, any of the information on which our work is based, and nor do we make any representation as to the accuracy or completeness of the information which has been used in our analysis. We accept no liability for any loss or damage which may result from the Department's reliance on any research, analyses or information so supplied, nor from our report, research and analyses based on this information.

1. Introduction

Background

The Energy Saving Scheme (ESS) is an NSW scheme which creates a market and provides a financial incentive to help households and businesses save energy. The Scheme aims to reduce the consumption of electricity and gas through the implementation of energy efficiency upgrades.

Energy savings are achieved by installing, improving or replacing energy savings equipment. Accredited Certificate Providers (ACPS) may be able to create energy saving certificates (ESCs) from these projects from each notional MWh of energy saved. ACPs can then sell the certificates to Scheme Participants (primarily electricity retailers) who have a legal obligation to meet energy savings targets, which is met annually by purchasing and surrendering ESCs.

The Scheme Administrator, the Independent Pricing and Regulatory Tribunal (IPART) accredits ACPs and provides a registry for certificates. IPART also functions as the Scheme Regulator and ensures electricity retailers meet their obligations.

The ESS is established under Part 9 of the Electricity Supply Act 1995, Part 8 of the Electricity Supply (General) Regulation 2014 and the Energy Savings Scheme Rule of 2009 (ESS Rule).

The Office of Energy and Climate Change, NSW Treasury (OECC) develops the policy behind the ESS, including the ESS Rule, which defines eligible energy saving activities and methods for calculating energy savings.

OECC has requested that EnergyConsult update the calculations that underpin the Activity Definitions in the Energy Savings Scheme Rule of 2009 (ESS Rule) for certain Water heating activities in the Deemed Energy Savings Method of the Home Energy Efficiency Retrofit (HEER) sub-method.

Addendum: Objectives and context of this review and update

Context

In 2020, the former Department of Planning, Industry & Environment (DPIE) contracted EnergyConsult to draft Activity Definitions and supporting information for solar and heat pump water heaters. The final report and spreadsheet calculations for a number of Activity Definitions was completed in July 2020¹.

¹ NSW ESS Solar Hot Water Activity Specification, EnergyConsult, 23 July 2020. File name: Solar Hot Water - ESS V1.0.docx

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Subsequently, DPIE published new Activity Definitions in the 2021 Rule Change², as follows:

- D17: Replace an existing electric water heater with an (air source) heat pump water heater
- D18: Replace an existing electric water heater with a solar (electric boosted) water heater
- D19: Replace an existing gas water heater with an air source heat pump water heater
- D20: Replace an existing gas water heater with a solar (electric boosted) water heater
- D21: Replace an existing gas water heater with a solar (gas boosted) water heater

These activity definitions were not published using the baseline end-user equipment energy consumptions that were provided in the EnergyConsult report. Instead, the baseline energy consumptions were changed to the values of the reference energy consumption as published in AS/NZS 4234:2021.

The EnergyConsult report and analysis spreadsheet calculated baseline and installed end-user equipment energy consumption with adjusted (lower) hot water usage loads, compared to AS/NZS 4234:2021. This was explained in the report, as end-user hot water loads were assessed (see the reported references) as lower than the values provided in AS/NZS 4234:2021³.

As only the baseline energy consumption was adjusted by DPIE (and not the installed end-user equipment), this created a larger calculated energy saving (and number of certificates). Effectively, the baseline equipment was calculated with 185 L/day of hot water, while the end-user equipment (as calculated by EnergyConsult) used 128 L/day of hot water (for medium load). This mismatch provided 44% higher energy savings for the medium load.

OECC have asked that EnergyConsult review the previous 2020 analysis and update it with the latest ABS census (2021) and the latest version of AS/NZS 4234 (2021). Also to separately provide a calculation for heat pump climate zone 5 (HP5), as the current calculations are using climate zone 3.

Work scope

The items to be updated include:

1. Update the model: ESS-SWH.HPWH.Calcs.V1.1, including:
 - update the HP3 tab and create a HP5 tab

² Energy Savings Scheme (Amendment No. 1) Rule 2021. Published 28 February 2022

³ Note that the Medium load in the standard is assumed by many to be the average load however the average household hot water use is now much closer to the small load due to reduced household occupancy and more water efficient appliances.

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- update reference energy consumption and other relevant values from AS/NZS 4234:2008 to AS/NZS 4234:2021
 - update census data (2016 to 2021) and resulting analysis in each tab
 - update gas factors in the tabs
 - updates from census data will flow through to the gas replacement activities
2. Draft an Addendum to the report: Solar Hot Water – ESS V1.0, referencing changes in the report where appropriate, including:
- briefly explain the context (2-3 paragraphs)
 - update census data (2016 to 2021)
 - updates of standards (as required)
 - provide the resulting update in electricity and gas factors for all electric and gas replacement activities (D17 to D21), and suggested modifications to include Climate zone HP5
 - confirmation of the product registry fields mapped to the equations (including 'thermal peak load size')
 - update VEU context, and how this might be relevant to further ESS rule changes

This Addendum addresses the items in Item 2 of the scope. The spreadsheet calculations are provided to OECC in file [ESS-SWH.HPWH.Calcs.V2.0.xlsx].

2. Activity Definition Updates

Baseline and activity energy use

The spreadsheet calculations have been updated to AS/NZS 4234:2021 and the ABS 2021 Census. There is no change from the 45 l/day per person used in the 2020 EnergyConsult calculations.

Census data

Average household size has changed to 2.77, from 2.86 persons. This reduces the average hot water load slightly for the baseline and activity energy use. It has a flow-on effect of changing the value for factor a in the activity definition, for example in Zone 3:

- Heat pump, previous $a = 2.320$, revised $a = 2.291$
- Solar electric, previous $a = 2.355$, revised $a = 2.310$

AS/NZS 4234:2021

The reference electric water heater energy consumption has changed in the 2021 standard. The reference electric water heater is not used in the activity definitions. This is used in the calculation spreadsheet to show examples of the activity definitions and what a replacement unit would achieve (in terms of energy savings and certificates).

The reference gas water heater has changed in the 2021 standard and is now a 4-star gas water heater (it was a 3-star gas water in the 2008 standard). This has impacted the activity definition calculations, as an adjustment was made to the calculation of activity energy use to account for solar gas water heater having their solar savings and Bs evaluated against a reference of 3-stars, when the baseline used for the ESS was 4-stars. This adjustment is no longer required. Therefore the value of a is revised, as well as the adjustment due to the updated Census data.

- Solar gas, previous $a = 2.173$, revised $a = 2.322$

The hot water thermal loads have not changed in the 2021 standard.

Revised baselines

The baselines are provided in the spreadsheet, and are calculated using the same methodology as the 2020 EnergyConsult calculations and report. Compared to the 2020 EnergyConsult report and spreadsheet [ESS-SWH.HPWH.Calcs.V1.1.xlsx], the baseline energy consumption for all activity definitions are lower (by about 1.0% to 1.2%) due to the change in household size.

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The resulting updated electricity and gas factors for the Activity Definitions are shown below:

D17	Baseline A	Factor a
Small	23.18	2.291
Medium	35.14	2.291

D18	Baseline A	Factor a
Small	28.98	2.310
Medium	43.93	2.310

D19	Baseline A	Baseline B	Factor a
Small	0.58	28.029	2.291
Medium	0.58	47.337	2.291

D20	Baseline A	Baseline B	Factor a
Small	0.73	35.036	2.310
Medium	0.73	59.171	2.310

D21	Baseline A	Baseline B	Factor a
Small	0.73	35.036	2.322
Medium	0.73	59.171	2.322

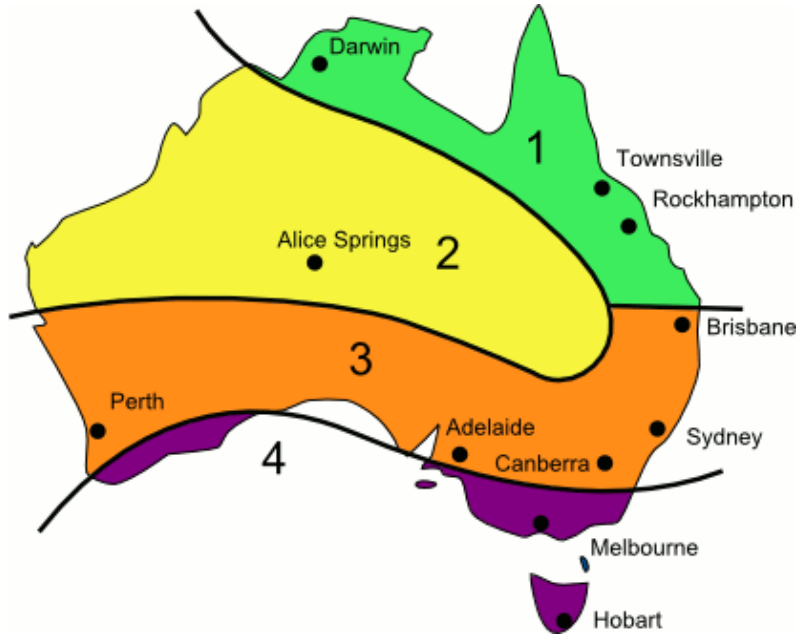
Factor $b = 4.167$ (unchanged)

All references to AS/NZS4234 in the Activity Definitions can be updated to AS/NZS4234:2021

HP5 climate zone

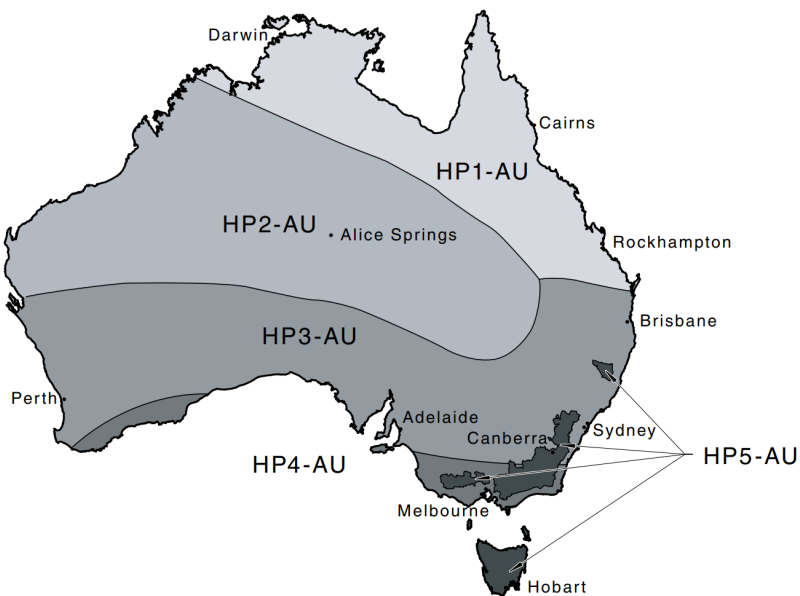
Solar and heat pump water heater energy use is determined by adjusting the simulated energy use of these water heaters determined by AS/ANZ 4234. The standard evaluates the performance under 4 solar water zones (Figure 1) and 5 heat pump climate zones (Figure 2).

Figure 1: Solar water heater climate zones



The heat pump zones are the same as the solar climate zones for 1 to 4 with HP5-AU corresponding to Australian Building Code zones 7 and 8 (see Figure 2).

Figure 2: Heat pump water heater climate zones



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The HP5 zone calculations are detailed in the spreadsheet in tab [ESS.SHW.ZHP5]. This only applies to heat pumps installed in that zone. The calculations are using the same methodology as the Zone 3 calculations and sources associated with AS/ANZ 4234 zone HP5 (water temperatures and thermal loads). The effect of the change is to increase the baseline energy consumption, as zone HP5 has lower cold water temperatures, and therefore increases the savings. However, the value for factor a is also revised to reflect HP5 data.

The resulting activity definition for heat pumps installed in HP5 is:

D17	Baseline A	Factor a
Small	25.43	2.310
Medium	38.49	2.310

D19	Baseline A	Baseline B	Factor a
Small	0.58	31.650	2.310
Medium	0.58	52.750	2.310

These values for HP5 can be inserted into the relevant Activity Definitions as specific for Climate Zone HP5-AU installations.

3. Other items considered

VEU context

The VEU program has recently been updated to change the modelling required to the 2021 version of *AS/NZS 4234:2021 - Heated water systems — Calculation of energy consumption* from the 2008 version.

Prior to that, the energy consumption was calculated using Medium and Low loads from the Standard and then a post modelling calculation was undertaken to scale down the energy savings to account for the fact that households in Victoria generally used less than these loads. The scaling was done using constant factors for different types of water heaters. This was developed in a 2017 evaluation. The ESS activity definitions developed by EnergyConsult in 2020 are based on this methodology.

Subsequently in 2022 work was commissioned by the Victorian Department (then DELWP now DEECA) to look at that whether a more accurate outcome would result from modelling at lower hot water use rather than adjusting after the modelling⁴.

The 2017 evaluation assumed a hot water consumption of 45 litres per day per person⁵ and ABS data on average and small household occupancy sizes to adjust the AEF, SEF and Abatement factor values.

Hot water consumption of 45 litres per day per person leads to the average household using close to the small load in AS/NZS4234 Zone 4 (23.4 MJ/day vs 22.8 MJ/day, i.e. 102.6%). And for small households the load is close to the Very Small load in AS/NZS 4234 (14.1 MJ/day vs 15.2 MJ/day, i.e. 93%). Consequently, it was decided to model at Small and Very Small loads rather than Medium and Small loads to estimate the performance of Solar and heat pump water heaters. Whilst we haven't done a calculation for NSW for Zone 3. It is likely to be similar in NSW.

For **electric boosted solar water heaters**, it showed that the ratio of total energy purchased ($Be^6 + Bs^7$) when moving from load⁸ two (medium) to load one (small)

⁴ *Victorian Energy Upgrades Specification Updates For Water Heaters*, 11 February 2022

⁵ This is based on Sustainability Victoria 2017, *Gas Water Heater Retrofit Trial*. DPIE NSW is undertaking a hot water monitoring program across Australia and NZ for E3. The results of that program may provide more accurate estimates of hot water consumption by households. Results are not expected until 2023.

⁶ The auxiliary (or sometimes called parasitic) energy is represented by the term Be in the Standard AS/NZS4234

⁷ The supplementary energy is represented by the term Bs in the Standard AS/NZS4234. It can be either electricity or gas. For an electric boosted solar or a heat pump water heater, Be and Bs can be added and not treated separately.

⁸ Load is the amount of energy required to be added to cold water to bring it to the temperature required for use in residential dwellings. The loads are designated as very small, small, medium and large in AS/NZS4234. When used in modelling software these loads are

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varies considerably from product to product by up to ± 16.4 per cent and that going from load one to load zero (very small) varies by up to ± 10.3 per cent.

It also showed that the B_s value varies considerably and that the B_e reduces by approximately 10 per cent between loads and is not constant as assumed in the 2017 specification.

For heat pumps, the analysis showed that the ratio of energy purchased when moving from load two (medium) to load one (small) is similar in Zone 4 and Zone 5, but that it varies from product to product by up to ± 4 per cent and that going from load one to load zero (very small) varies by up to ± 7.8 per cent.

Consequently, the new VEEC calculation is based on modelling at a lower load that represents the average, rather than modelling at the load current at that time and then adjusting post modelling to approximate the performance at the average load.

However, the threshold value of energy savings is still based on modelling at the previous loads to maintain continuity and so that households that use larger volumes of hot water will still be able to achieve good savings and not run the risk of running out of hot water.

This means that the modelling is done for two rather than one load for every product that is registered in Victoria. As most of the modelling is automated it is only a marginal increase in effort to model, report and audit to two loads per product.

A similar approach could be implemented for the NSW ESS, but using Zone 3, and the products registered with the two loads (as in Victoria). This would then harmonise the methodologies used in the schemes again.

Confirmation of the product registry fields mapped to the equations

The IPART registry contains the fields shown in the spreadsheet tab [Map.Registry]. This sheet maps the relevant fields to the formula in the equations. In particular, the fields relating to thermal peak load are:

- Zone 3 System Size => small or medium thermal peak load in accordance with AS/NZS 4232, Zone 3
- Zone 5 System Size => small or medium thermal peak load in accordance with AS/NZS 4232, Zone HP5

designated by numbers – very small = load 0, small = load 1, medium = load 2, large = load 3.
On average Victorian households consume hot water approximately equal to the small load.