FINAL

(APPENDIX B to RIS 2009-06 - *Proposal to Revise the Energy Efficiency Requirements of the Building Code of Australia for Residential Buildings — Classes 1, 2, 4 and 10*)

Regulation Impact Statement: for Decision

Specifying the Performance of Water Heaters for new Class 1 Buildings in the Building Code of Australia

Prepared for the

Department of the Environment, Water, Heritage and the Arts

by

George Wilkenfeld and Associates

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GEORGE WILKENFELD AND ASSOCIATES Pty Ltd
ENERGY POLICY AND PLANNING CONSULTANTS
PO Box 934 Newtown NSW 2042 Sydney Australia
Tel (+61 2) 9565 2041

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Executive Summary

Background

The overarching objective of this proposal is to contribute to Australia meeting its obligations under the Kyoto Protocol and any subsequent agreements in the most efficient way, by:

- bringing about reductions in greenhouse gas emissions from water heating below what they are otherwise projected to be;
- reducing the cost of abatement; and
- helping businesses and households adjust to the impacts of an emissions trading scheme.

Water heating accounted for nearly 23% of the energy used in Australian households in 2008, and about 22% of the greenhouse gas emissions associated with household energy use (and over 5% of total stationary energy sector emissions). Because electricity is the most greenhouse-intensive form of delivered energy, it accounts for nearly 80% of water heating emissions.

The first water heater installed in a house tends to set the precedent for the life of the house, because the conditions of replacement favour like for like. About half of initial water heater selections are made by the builder exclusively, and in the rest of cases the builder and plumber exert considerable influence. These market conditions favour the least capital cost water heating options, irrespective of lifetime operating costs.

The Problem

The problems which the proposed regulation are intended to address are:

- The demonstrated principal-agent market failures in the water heating market as it applies to new buildings. Without regulations, builders tend to adopt water heating options with the lowest capital cost, which in areas without natural gas is electric;

- The likely impact of the impending carbon pollution reduction scheme (CPRS) on energy prices, which will magnify the consequences of those market failures;

- The risk that greenhouse gas emissions from water heaters installed in new homes will be significantly higher than otherwise, so increasing the demand for emissions permits under the CPRS and raising the overall adjustment costs to the Australian economy; and

- The inconsistencies in the present State building regulation regimes which seek to address those market failures.

Between 2004 and 2007, NSW, Victoria, Queensland, SA and WA all adopted requirements for water heaters in new houses, either in planning codes or as special provisions in their appendices to the BCA. Requirements have been enacted in the

ACT, to take effect on 31 January 2010. Although these are all different in detail, they all prevent (or at least limit) the use of electric resistance water heaters.

The *National Strategy on Energy Efficiency* endorsed by the Council of Australian Governments in July 2009 includes Measure 2.2.4 *Phase-out of inefficient and greenhouse-intensive hot water systems*. This states an intention to adopt:

> 'A set of measures (including energy efficiency standards) to phase-out conventional electric resistance water heaters (except where the greenhouse intensity of the public electricity supply is low) and increase efficiency of other types'…

The Proposed Regulation

The proposal is to revise the text of Volume 2 of the Building Code of Australia to add performance requirements for water heaters installed in new houses (Class 1 buildings).

A water heater will comply with the proposed requirements if the greenhouse gas intensity of the water heater does not exceed 100 g CO_2-e/MJ of thermal energy load determined in accordance with Australian Standard AS/NZS 4234. Electric resistance water heaters have a higher intensity, while nearly all other types have a lower intensity.

If the proposed text is added to the BCA the provision will become mandatory for new construction in all jurisdictions, unless those jurisdictions insert special provision in the BCA, to state that either (a) no requirements for water heaters apply in that jurisdiction, or (b) other requirements for water heaters apply.

Cost and Benefits

The projected costs and benefits of adopting the proposed regulations (the 'PR' case) in the May 2010 revision of the BCA have been calculated for all new houses to be built between 2010 and 2020. The costs are the increases in the average capital cost of water heaters to new home builders and buyers, compared with what the cost would be under one of the following scenarios:

1. a Minimum Regulation (MR) scenario – where jurisdictions with regulations less stringent than those proposed adopt the proposed BCA rules, while jurisdictions with regulations resulting in lower emissions than would be the case under the proposed BCA rules retain their current regulations; or
2. a National Consistency (NC) scenario) – where all jurisdictions adopt the proposed BCA rules in place of their current regulations, in the interests of national consistency.

In most cases the benefit is the net present value (NPV) of the reductions in energy costs to the buyer or occupant of the new house, including the value of emissions permits avoided.

In the MR Scenario 1 the overall impacts are estimated to be:

- A net benefit of $11.3 million

- A benefit to cost ratio of 3.7:1
- Total greenhouse gas emission *reductions* of 58 kt CO_2-e for houses constructed between 2010 and 2020.

Costs and benefits are assumed to come only from the proposed regulation's effects within the Northern Territory and Tasmania, where no regulations of this nature currently exist. No other jurisdiction would change its current regulations.

In the NC Scenario overall impacts are estimated to be:

- A net benefit of $186.9 million
- A benefit to cost ratio of 3.2:1
- Total greenhouse gas emission *increases* of 794 kt CO_2-e for houses constructed between 2010 and 2020.

Table S1 summarises a range of variables which could impact on net benefits and benefit/cost ratios.

In areas with natural gas available, the compliance options would be natural gas, solar-gas, solar-electric and heat pump. In areas without natural gas available, the compliance options would be solar-electric, heat pump, LPG and solar-LPG. There is some risk that more builders in non-gas areas will install LPG because of its low capital cost, and will impose high energy cost on the home buyers. If that turns out to be the case, a number of policy options may be available to address this.

Table S1 Factors that could increase or reduce cost-effectiveness of the proposal

	Current assumptions	Factors that could reduce B/C ratios	Factors that could increase B/C ratios
Energy prices	CPRS-5 (starting 2010)	Delay CPRS to 2012	Adopt CPRS-25
Tariffs for solar-elec and HP	Half day rate, half OP	All day rate	All OP
Capital cost of water heaters	Based on supplier & builder surveys; $40/REC to buyers	Fall in REC values; intermediaries retain greater share of value	Rise in REC values, economies of scale for solar & HP suppliers
Matching capital cost to hot water demand	90% of solar & HP sized for medium delivery (22+ RECS)	Require higher performance standards for solar and HP	Allow smaller solar & HP to be used in 3 bedroom houses
Average hot water use	Range 110 to 200 l/day	Assumptions cover extremes of likely range	
Service life of water heaters	10 – 14 years yrs	Shorter service life for all types	longer life advantage for solar types
Discount rates	7%, 3% and 11%	Assumptions cover extremes of likely range	

Comparison with Current Regulations

As the five largest states and the ACT already have relevant regulations, the great majority of the costs and benefits of excluding greenhouse-intensive water heaters in new houses is already being realised. If these jurisdictions adopted the proposed BCA provisions there would be additional benefits to water heater suppliers and to builders operating across jurisdictions, in terms of reduced compliance and information costs. These costs are presently being borne by State energy agencies (ie taxpayers), by water heater suppliers (who have to monitor the rules and indicate to builders, installers and other buyers which models may be installed in each State) and by builders. Supplier and builder costs are passed on in product and house prices.

It has not been possible to quantify the value of removing these costs. Therefore, the benefits modelled are considered conservative.

For NSW, Queensland, South Australia, Western Australia and the ACT the proposed regulations would lead to outcomes almost identical to those being achieved under current regulations, although the rules and thresholds are framed somewhat differently in each case, so there may be small changes according to dwelling size.

If Victoria adopted the proposed BCA provisions in place of its current '5 Star' regulations, it is likely that most builders would try to minimise the initial capital cost of water heaters by using gas rather than solar-gas water heaters in gas-available areas.

Table S2 indicates the effects of Victoria adopting the proposed BCA provisions in place of its current '5 Star' regulations:

- combined greenhouse gas emissions for all cohorts of house built 2010-2020 would be about 25% (852 kt CO_2-e) higher than under current '5 Star' regulations[1]; and
- the financial benefits to new home owners in both gas and non-gas areas would outweigh the costs (even with greenhouse emissions permit prices internalised in energy prices). The average capital cost of new water heaters would fall by $847, and the B/C ratio of changing from the current regulations to the proposed BCA regulations would be 3.2.

The National Hot Water Strategic Framework states that '…individual jurisdictions may opt to bring forward the program including introducing more stringent requirements' (MCE 2008). Therefore, for the purpose of the Minimum Regulations scenario analysis, it is assumed that Victoria will retain its current regulations rather than adopt the proposed regulations.

In the MR scenario the capital, energy and greenhouse impacts of the proposed regulation would be limited to those jurisdictions that do not currently have regulations: Tasmania and the NT. Adoption of the proposed regulations would lead to higher capital costs (an average $211 per new house over the period 2010-2020) but lower energy costs (an average lifetime energy saving of $784).

For Tasmania, the net benefit would be $M 6.5, at a B/C ratio of 3.6. For the NT, the net benefit would be $M 4.8, at a B/C ratio of 3.9 (at a discount rate of 7%). There would be a total reduction in the greenhouse gas emissions from water heating energy in Tasmania and the NT combined of 58 kt CO_2-e for buildings constructed over the period 2010-2020.

The National Hot Water Strategic Framework states that 'the framework provides for the reduction of greenhouse gas emissions associated with water heating …except where the emissions intensity of the public electricity supply is low…' (MCE 2008).

[1] This equates to about 0.08 Mt CO_2-e per annum over the period, compared with national annual water heating emisions of 14.5 Mt CO_2-e in 2008.

The implications of this clause have not been tested, but if it were to apply to Tasmania, due to the historically high hydro component in its electricity supply, the only impact of the measure would be in the Northern Territory.

Table S2 Summary of costs and benefits: Proposed Regulations vs Current Regulations

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net impact $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	0.0	0.0	0.0	0	0	0	0	0.0
VIC	-256.2	80.6	-175.6	3.2	852	-847	267	2.8
QLD	0.0	0.0	0.0	0	0	0	0	0.0
SA	0.0	0.0	0.0	0	0	0	0	0.0
WA	0.0	0.0	0.0	0	0	0	0	0.0
TAS	2.5	-9.0	-6.5	3.6	-9	522	-1893	-2.0
NT	1.7	-6.4	-4.8	3.9	-48	111	-430	-3.2
ACT	0.0	0.0	0.0	0	0	0	0	0.0
Australia (NC Scenario)	-252.1	65.2	-186.9	3.2(a)	794	-245	63	0.8
Tas, NT only (MR scenario)	4.2	-15.5	-11.3	3.7	-58	211	-784	-2.9

7% discount rate, Medium hot water delivery, medium water heater capacity. (a) Note that in Victoria the benefit of the proposal is lower capital cost and the cost is higher energy cost, whereas in Tasmania and NT the cost is higher capital cost and the benefit is lower energy cost.

Impacts on Stakeholders

No new types or models of water heater would need to be introduced for builders of new houses to comply with the proposed regulations. Of the 260 models of electric storage resistance water heater currently on the Australian market, 208 could no longer be installed in new houses. The other 52 (of 50 litres or less) could be still be used in certain restricted circumstances.

Of the 71 models of gas storage water heater on the market, 22 meet the proposed minimum 5 star performance standard, and of the 124 models of gas instantaneous water heater, 109 meet the proposed minimum standard. Of the 6,870 models of solar and heat pump water heater, over 99% meet the proposed minimum criteria for use in small houses, and 82% meet the criteria for installation in houses of 3 bedrooms or more, which comprise 90% of the market.

Therefore the range of water heater types and models available to house builders will still be very wide, and supplier competition and price competition are not expected to be affected. All of the suppliers of electric resistance water heaters also make one or more types of water heaters that meet the requirements of the proposed regulation, so none will have their entire model range affected. In fact, the increase in average water heater capital cost should increase the revenues of the water heater industry and of installers.

The proposed regulation should have very little impact on housing design and construction cost (ie other than the direct cost of the water heater itself). Builders pass on the cost of water heaters to owner/buyers, as they do the cost of all other materials and components. The capital cost impact of the proposed regulations would be less than 0.5% of average new house construction cost. This is not considered significant in comparison with much larger fluctuations in the costs of labour, materials and financing.

The impact on electricity networks could be significant. Off-peak electric resistance water heaters have enabled network operators to reduce the domestic water heating load at peak periods, when cooking, lighting and seasonal space heating and cooling loads are heaviest. The proposed provisions would mean that this capability would be diminished in new Class 1 buildings, but the impact on the electricity networks can be mitigated by more cost-reflective pricing and by demand response programs and technologies, the use of which is growing. In any case, electricity demand would be lower overall due to the reduced electricity load from hot water heating.

Conclusion

The adoption of the rules in the proposed text of Volume 2 of the Building Code of Australia shows net economic benefits for Australia.

The net financial benefit would be greatest if the same rules were adopted in all jurisdictions (the National Consistency scenario). However, this is likely to raise greenhouse gas emissions from water heating in new homes by a moderate amount, compared with the Current Regulations scenario.

The Minimum Regulation scenario would lower emissions from water heating in new homes by a small amount, while still achieving a small net financial benefit.

The estimated financial benefits are based on the projected cost to new home owners of water heaters and of the energy required to operate them. The benefit estimates are conservative, because there would be an additional benefit to industry from rationalising requirements between jurisdictions. This benefit has not been quantified in this analysis, and it is uncertain how it would be shared between water heaters suppliers, builders and homebuyers.

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Glossary

ABCB	Australian Building Codes Board
AS	Australian Standard
AS/NZS	Australian and New Zealand Standard
BAU	Business as Usual
BCA	Building Code of Australia
CR	Current Regulations case
CSWH	Central service water heating installation (may consist of several separate water heaters coupled together)
DEWHA	Department of the Environment, Water, Heritage and the Arts
DTS	Deemed to satisfy
ESWH	Solar water heater with electric boosting
F&M	*Factors and Methods Workbook* published occasionally by the AGO
GSWH	Solar water heater with gas boosting
GWA	George Wilkenfeld and Associates
HE	High efficiency
HP	Heat pump water heater (where water is heated mainly by a vapour compression process, although may be boosted by other means)
IWH	Instantaneous water heater (where the water is heated on demand by gas or electricity rather than stored hot for use)
LPG	Liquefied petroleum gas
MEPS	Minimum Energy Performance Standards
MRET	Mandatory Renewable Energy Target
NCFA	Net conditioned floor area (as defined in AccuRate)
NR	No Regulations case
OP	Off-peak (electricity tariff)
ORER	Office of the Renewable Energy Regulator
PR	Proposed Regulation case
RECs	Renewable Energy Certificates (as determined by ORER)
SE	Standard efficiency
S–E	Solar with electric boost
S–G	Solar with gas boost
SWH	Storage water heater (where water heated by electricity, gas, solar energy or any combinations is stored hot for later use)
TRNSYS	TRaNsient SYstem Simulation Program (used for simulating the performance of water heaters in AS/NZS 4234
TS	Thermosyphon: a type of solar water heater in which the storage tank is mounted on the roof immediately above the collectors.
WH	Water heater

1. The Problem

Domestic Water Heating

Domestic water heating is the supply of hot water in houses, apartments and other accommodation for personal washing, showering, cooking, dishwashing, clothes washing and similar uses. It is a different service from the supply of hot water for space heating, although in some cases the same equipment may heat water for both purposes.

Domestic hot water in a Class 1 building – a house – is invariably supplied by one or more separate water heaters serving only that house. The reticulation of hot water via 'district heating' systems, which is common in Europe, is not used in Australia.

This document covers new water heaters installed in Class 1 buildings at the time of construction. The energy use and other aspects of the performance of the water heating service is due largely to the characteristics of the water heater itself, although the layout of the hot water plumbing also has an effect.

In the other building classes in Table 1 the design decisions are more complex, because there is usually a choice between separate water heaters, each serving a single apartment or accommodation unit, and a central or 'service' water heating system serving all units. If separate water heaters are selected in these building types, the options are usually somewhat narrower than in Class 1, because of space constraints and difficulty of access for ventilation and to roof areas suitable for solar energy collection. If the choice is service water heating, it is necessary to select both the water heater/s as well as to design the distribution system.

Because of these fundamental differences in design approach and differences in product technologies and markets, water heating services for building classes other than Class 1 are not covered in this RIS.

Table 1 Building classes and types of domestic water heating service

BCA Class	Definition	Practical water heating options	
		Separate water heater	Service water heater
1	Detached and semi-detached dwellings	Yes (a)	No
2	Apartments	Yes	Yes
3	Hotels, motels, dormitories etc	Yes	Yes
4	Dwellings over shops, etc	Yes	Yes
9C	Aged care hostels and accommodation	Yes	Yes

(a) Only this option covered in this RIS

Energy Use

Water heating accounted for nearly 23% of the energy used in Australian households in 2008, and about 22% of the greenhouse gas emissions associated with household energy use (Table 2). Water heating is the second largest energy user in households after space heating and cooling, and the second largest source of emissions after electrical appliances.

Natural gas and electricity each account for about half the delivered energy used in water heating, with some use of LPG as well as direct solar (Figure 1).[2] Because electricity is the most greenhouse-intensive form of delivered energy, it accounted for nearly 80% of the emissions from water heating (Figure 2).

Table 2 End use share of household energy used and related emissions, Australia 2008

	Share energy	Share CO_2-e
Space heating & cooling	40.4%	19.4%
Water heating	23.2%	21.8%
Cooking	4.8%	4.8%
Refrigeration	6.7%	11.4%
Lighting	6.7%	11.5%
Standby energy use	3.7%	6.3%
Other electrical appliances	14.6%	24.8%
Total	100.0%	100.0%

Source: EES (2008), GWA (2008)

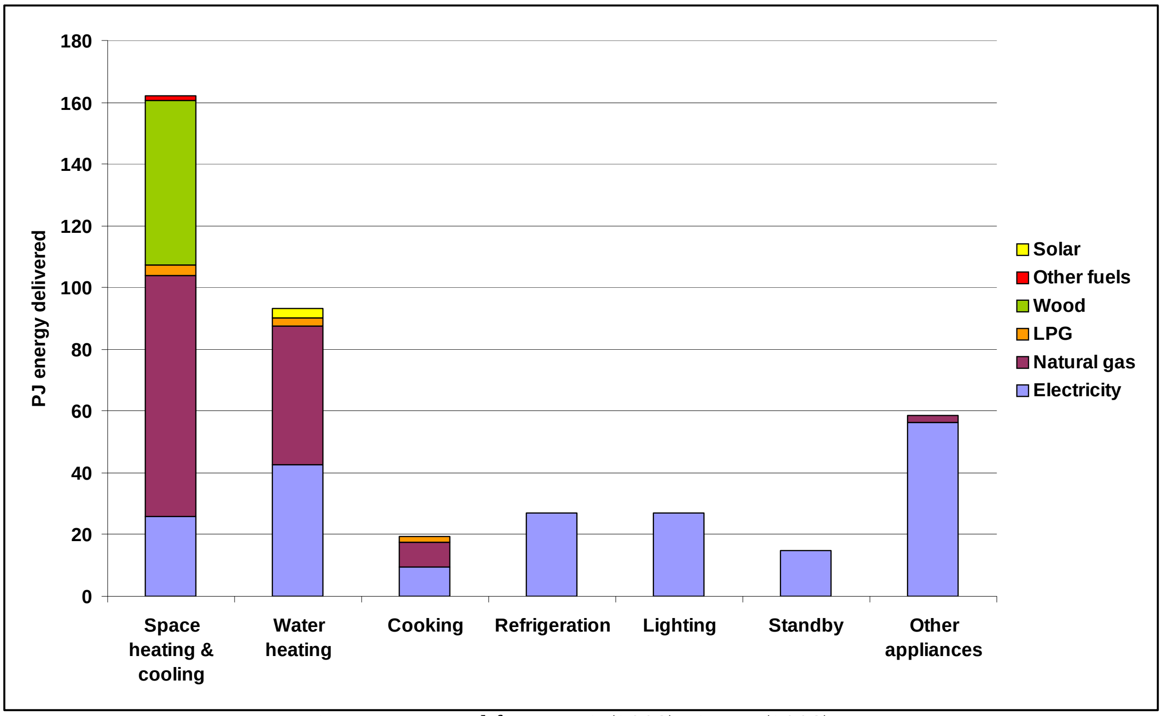
Reducing greenhouse gas emissions is a policy objective endorsed by all Australian jurisdictions, both at the Council of Australian Governments (COAG) level and through numerous policy statements by Commonwealth, State, Territory and local governments.

More specifically, the reduction of greenhouse gas emissions associated with the operation of houses and other buildings has been adopted as an objective of the Building Code of Australia (BCA).

In 2003, minimum thermal performance standards for new houses were incorporated in the BCA. Emissions associated with water heating in houses exceed those for heating and cooling, so on these grounds alone reducing the emissions associated with water heating merits consideration in the BCA.

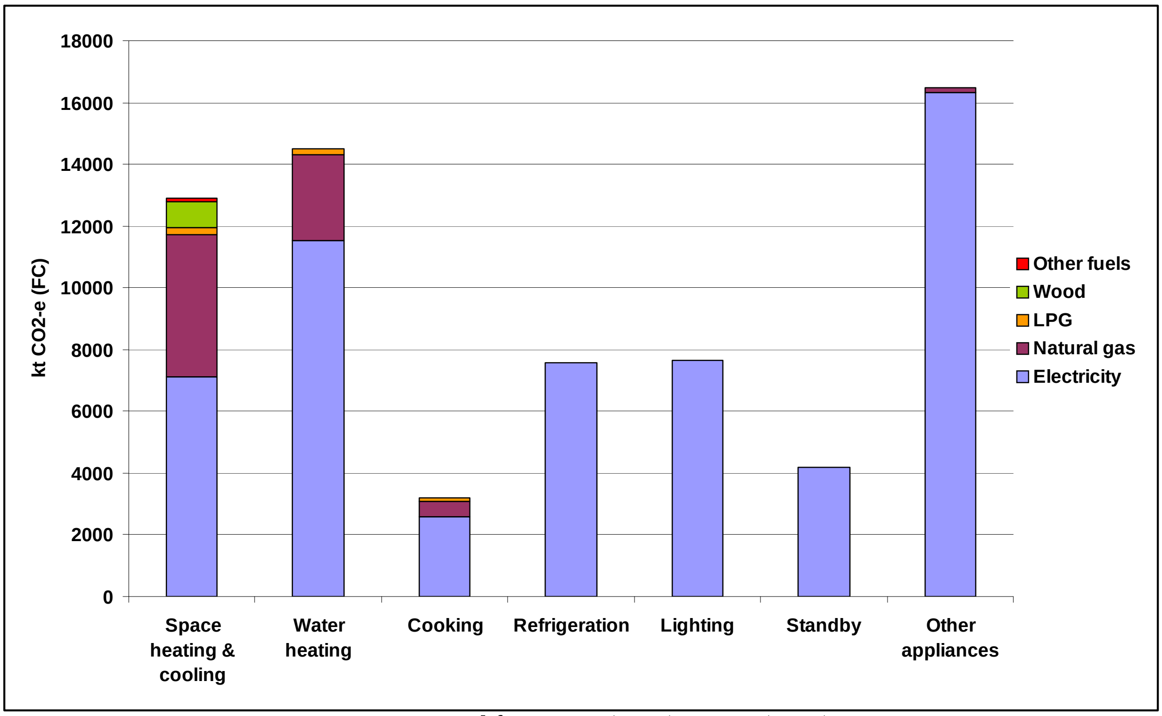
[2] Figure 1 includes the active solar contribution to solar water heating, but not passive solar contribution to space heating or ambient energy contribution to space and water heating via heat pumps.

Figure 1 Energy used in the residential sector, Australia 2008



Source: Derived from EES (2008), GWA (2008)

Figure 2 Greenhouse gas emissions from residential sector energy use, Australia 2008



Source: Derived from EES (2008), GWA (2008)

The Water Heater Market

Influences on the market

Nearly all houses in Australia have at least one water heater, and this has been the case for decades. While the number of replacement sales is fairly steady from year to year, the volume of sales to new homes and renovations varies with building activity. It is estimated that in 2006 about 72% of water heater sales were for the replacement of an existing unit at the time of failure, 22% were installed in new houses and nearly 7% installed during renovation of an existing house (Table 3).

Table 3. Separate water heater market, Australia 2005-06

	House-holds ('000)	Share	WH sales ('000)	At time of building	At time of failure	At time of ren-ovation	At time of building	At time of failure	At time of ren-ovation	Share of WH sales
Owner-occupied	5490.1	69%	534.0	118.0	376.0	40.0	15.6%	49.7%	5.3%	71%
Private rental+other tenancy	2067.3	26%	189.4	39.5	141.9	8.0	5.2%	18.7%	1.1%	25%
Public tenancy	368.8	5%	33.7	6.3	25.4	2.0	0.8%	3.4%	0.3%	4%
	7926.2	100%	757.2	163.8	543.4	50.0	21.6%	71.8%	6.6%	100%

Source: Author estimate based on BIS (2006); includes separate water heaters in Class 1 and Class 2

The choice of water heater in a project home is usually made by the builder. All water heaters provide a similar service and are not easily distinguishable with regard to efficiency or running cost, so home buyers are rarely aware of or concerned with their performance. After complying with building regulations, the builder’s over-riding criterion is to maximise profit. This generally means the lowest capital cost water heater, irrespective of running cost, which will be borne by the eventual occupants. Thus the eventual occupant may be left with a water heating service that is less cost-effective than if a water heater with a higher capital cost but lower running cost had been installed.

In market segments which are promoted as ‘green’ or ‘energy-efficient’, the builder may consider that the additional capital cost of a solar water heater can be more than recovered through a higher sale price. Again, this may not be the most cost-effective option for the buyer, who may never recover the higher capital cost in energy savings.

In the case of a commissioned dwelling, the initial owner has an opportunity to choose the water heater, although the choice will be heavily influenced by the advice of intermediaries: the builder, designer or plumber. Relevant information to assist the owner to compare water heater types can be hard to find, difficult to interpret or not available. Therefore, the ‘search costs’ associated with the owner collected and digesting this information (if available) are often transferred to the builder, designer or plumber. Nearly half of initial water heater selections for new houses are made without reference to the owner at all, and when owners are involved they are likely to rely heavily on the advice of the builder. A 2006 survey of water heater installations in new construction reported that:

> ‘When deciding on the type of hot water system to install, just over half (54%) involve the owner. Company policy of the builder is involved in 49% of installations with regulations accounting for 40% nationally…
>
> …Amongst large builders, the type of hot water system is mostly influenced by company policy (64%) with only 35% of decisions involving the owner. For small builders this is reversed with 74% of decisions involving the owner, while only 36% are due to company policy. Regulation and local government requirements also effect larger builders more than smaller builders in deciding on the type of hot water system’ (BIS 2006)[3].

Water heater replacements subsequent to the time of construction are usually subject to the constraints of time or of previous decisions. Decisions are usually rushed: the very high value which occupants place on continuing availability of hot water limits the time available for research, selection and installation of a replacement water heater. Decisions also tend to be made under capital constraint: failures are rarely anticipated or budgeted for, so the cheapest capital cost replacement is often preferred even if it is known to have higher lifetime costs and lower cost choices are available.

For example, if natural gas is available in the street but not to the dwelling, there would be both additional time and cost in connecting to it. If the existing water heater is located inside the dwelling it would take additional time and cost to install the replacement outside (as required for heat pump, solar and higher efficiency gas). Alternatively, the roof configuration may preclude a solar collector. For these reasons, the most common pattern of replacement is like for like (Table 4).

Table 4 Share of water heater replaced with same type

Type of water replaced	2006	2008
Electric	79%	63%
Gas (a)	95%	96%
Solar	76%	87%
All types	86%	78%

Source: BIS (2008). (a) Includes replacement of storage with instantaneous and vice versa

The water heater market in Class 1 buildings is therefore characterised by the following factors:

- A lower level of user involvement in the initial choice than in other major energy-using household products;
- Little incentive for builders to select water heaters that are the most cost-effective for occupants (taking both capital costs and running into account);
- Physical and behavioural constraints on subsequent replacements which slow the rate of adjustment of the water heater stock to changes in energy price and other factors;

[3] Note: The findings from surveys such as BIS 2008 should be considered in consideration of the individual survey’s limitations and the inherent uncertainty associated with extrapolated results.

- Continuing involvement in replacements by intermediaries; BIS (2008) reports that when a water heater fails 46% of home occupants contact a plumber, 15% a hot water specialist, 15% an energy retailer and 2% a builder: only about 18% go to the types of retailers or specialised stores that would be normally be the first point of contact for the purchase of large appliances.

The choice of initial water heater installed in a house is usually characterised by split incentives, and as that choice sets the pattern for subsequent replacements, the initial market failures tend to be perpetuated for the life of the dwelling.

Preferred types of water heaters

Electric storage water heating was, until recently, the most popular type in new homes as well as in the replacement market (Figure 3). Electric water heaters have a number of attractions for home builders: low capital cost, low installation cost, no need for a gas connection and flexibility in location. On the other hand, they have high running costs (unless connected to off peak) and high greenhouse gas emissions (Figure 4).

Gas has accounted for about the same market share as electric storage, although there has been a shift from SWHs to IWHs within the gas segment. Gas has its highest market share in Victoria, where most new houses are connected to gas for space heating, and electricity its highest share in Queensland, which has a limited gas network.

Electricity has lost market share since 2006, and solar has gained it, largely in response to regulatory changes in several States, and incentive schemes which are described in the following sections. If the current regulations and incentives were removed, the 'business as usual' (BAU) case would most likely be one where electricity continues to dominate,

Figure 3 Water heater market share by type, Australia

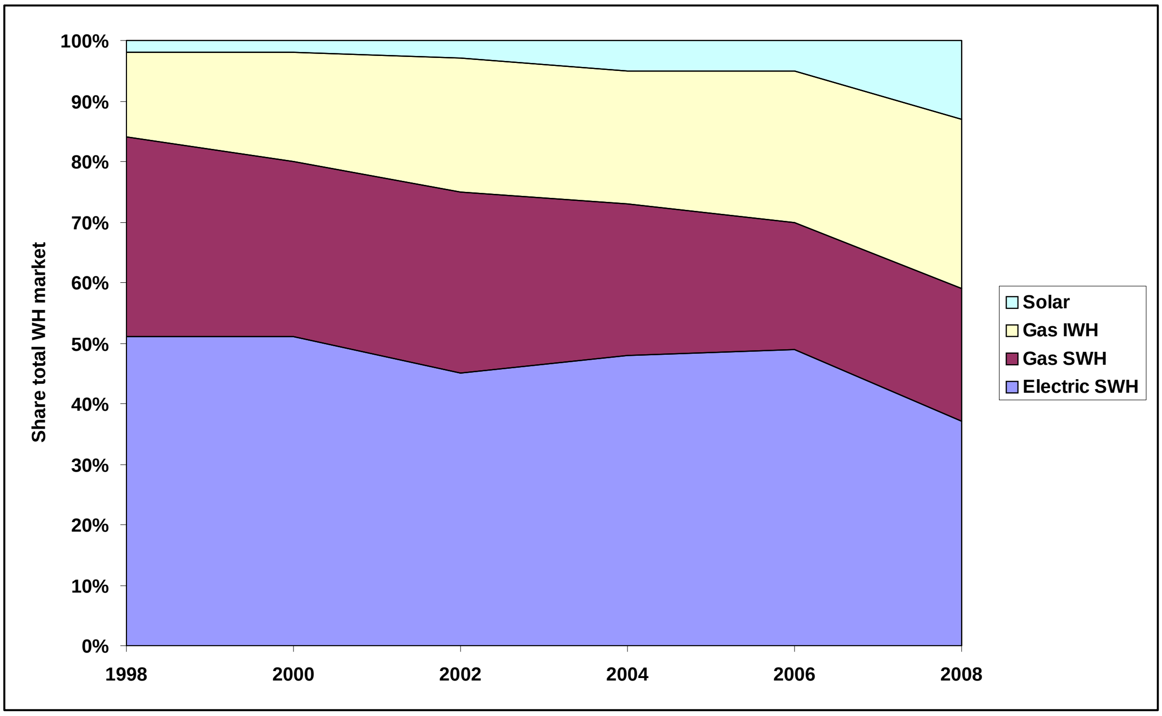


Figure 4 Typical capital and lifetime operating costs (undiscounted), new water heaters installed, NSW 2008 (medium hot water delivery, Solar Zone 3)

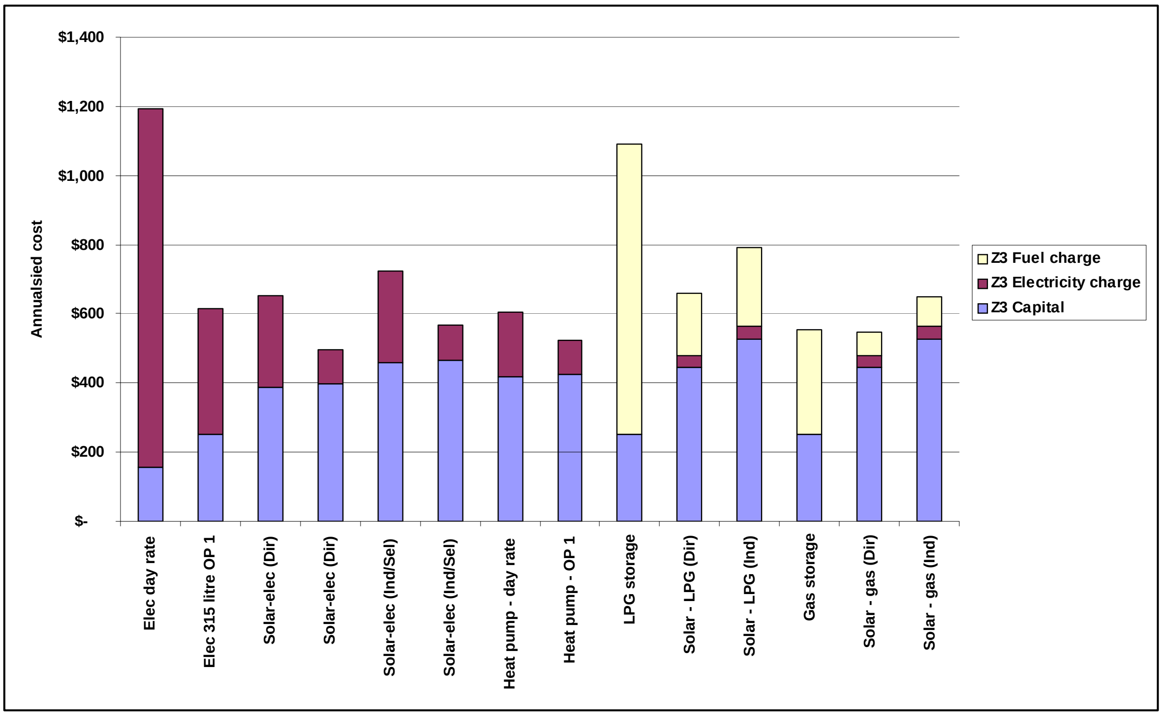


Figure 5 Typical capital and lifetime operating costs (undiscounted), new water heaters installed, Victoria 2008 (medium hot water delivery, Solar Zone 4)

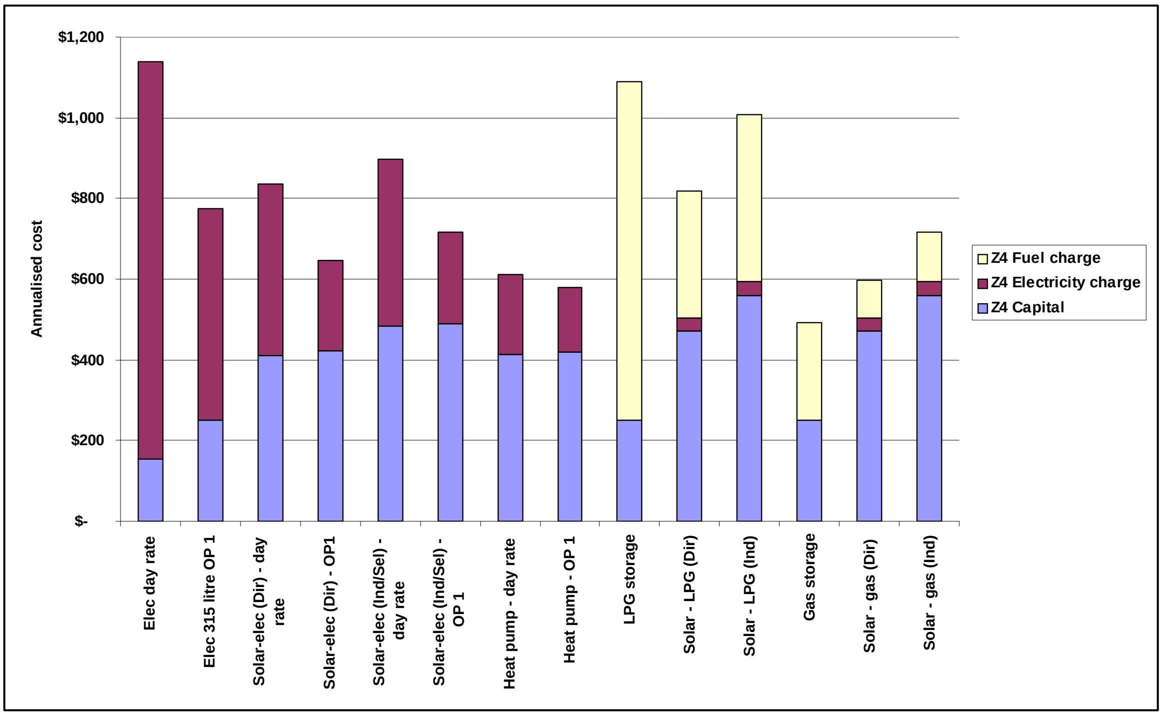
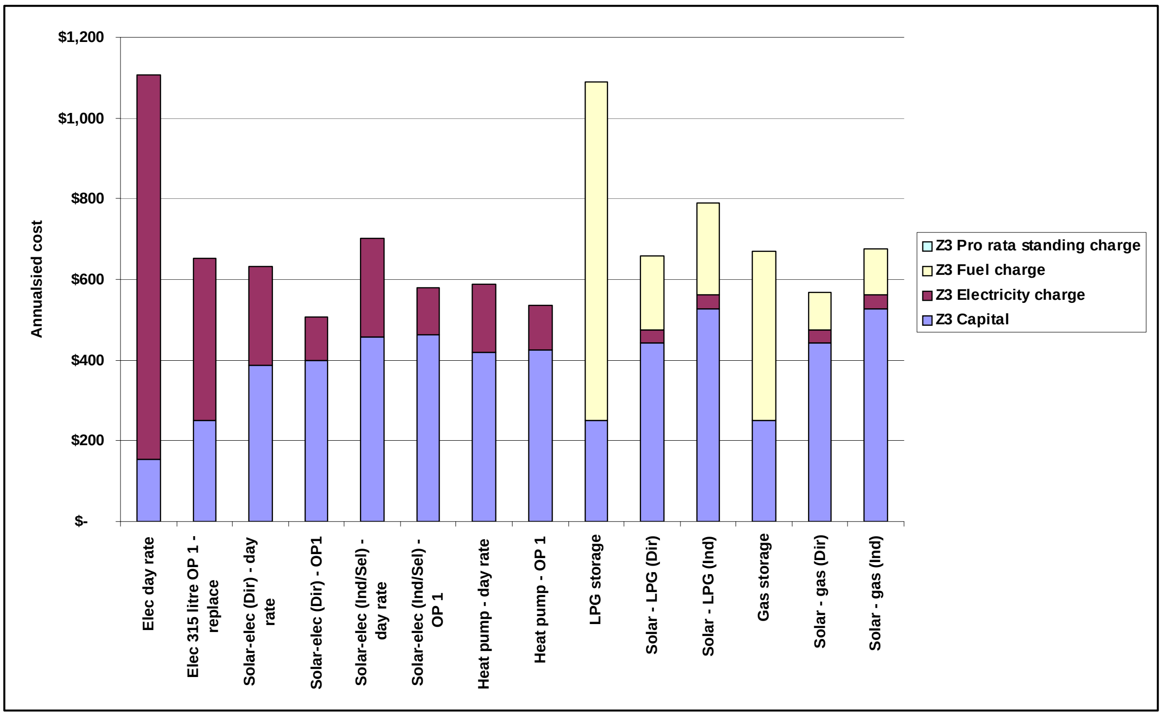


Figure 6 Typical capital and lifetime operating costs (undiscounted), new water heaters installed, Qld 2008 (medium hot water delivery, Solar Zone 3)



New Houses vs Total Market

Several jurisdictions have implemented mandatory performance requirements which constrain the choice of water heaters in new houses (these are detailed later). There are also several incentive schemes which offer subsidies for the purchase of solar and heat pump water heaters. While most target the replacement of existing electric water heaters, in order to address the rigidities of 'like-for-like' replacement described above, the Mandatory Renewable Energy Target (MRET) also impacts on the new home market by subsidising the cost of all solar and heat pump water heaters in proportion to their estimated reduction in grid-supplied electricity compared with all-electric models.

These policy settings have led to major differences in the pattern of water heater installation in new houses and in replacement purchases. Figure 7 illustrates the differences in the total water heater market and the new house market, in the five jurisdictions for which data are available – all of which have water heater requirements for new houses. In NSW, BASIX has resulted in a virtual disappearance of electric water heaters from the new house market, in favour of gas, solar and heat pump types. Although the proportion of new houses in NSW built where natural gas is available is not known, the fact that 70% of new houses in NSW use gas for water heating suggest that where gas us available it will almost certainly be used for water heating (and cooking as well – 71% BASIX ratings indicate gas for cooking energy).

As Table 5 and Figure 8 indicate, there have also been major reductions in the electric resistance share of the new house water heater market in the other States, although the market share diverted to other types has differed from State to State. NSW has by far the highest share of heat pumps in new houses, and Victoria the highest solar share. Victoria is the only State where new solar water heaters are more likely to be boosted by gas than electricity, as a result of the '5 Star' regulations, which require gas boosting for solar water heaters in new houses in gas-connected areas.

Table 5 Estimated share of water heaters installed in new houses

	NSW 2008(a)	Vic 2009(b)	Qld 2006(c)	SA 2006(c)	WA 2006(c)
Elec storage	<1%	4%	54%	26%	3%
Gas + LPG storage	20%	10%	6%	11%	37%
Gas + LPG instantaneous	38%	18%	14%	49%	24%
Solar-electric boost	19%	15%	21%	9%	24%
Solar-gas boost	11%	52%	1%	4%	10%
Elec Heat Pump	10%	2%	4%	1%	2%
Total	100%	100%	100%	100%	100%
New houses using gas for water heating (d)	70%	80%	21%	64%	71%
All houses using natural gas for water heating (e)	23.9%	64.2%	7.4%	43.8%	52.3%
All houses using natural gas for water heating (e)	1.6%	1.5%	4.3%	2.4%	6.1%
All houses using natural gas	37.5%	81.1%	12.5%	55.9%	68.1%
All houses using LPG	13.1%	8.7%	18.1%	13.2%	19.0%

(a) BASIX 2008; weighted average of Sydney and regional. (b) Based on advice from Victorian DSE (November 2009) that 68% of new dwellings in Victoria have solar water heaters. (c) BIS 2006. (d) Sum of gas and solar-gas. Data do not separate natural gas from LPG. (e) ABS 2008; excludes 'Don't' know'

Figure 7 State water heater market share by type, total and new houses (solar and heat pump combined)

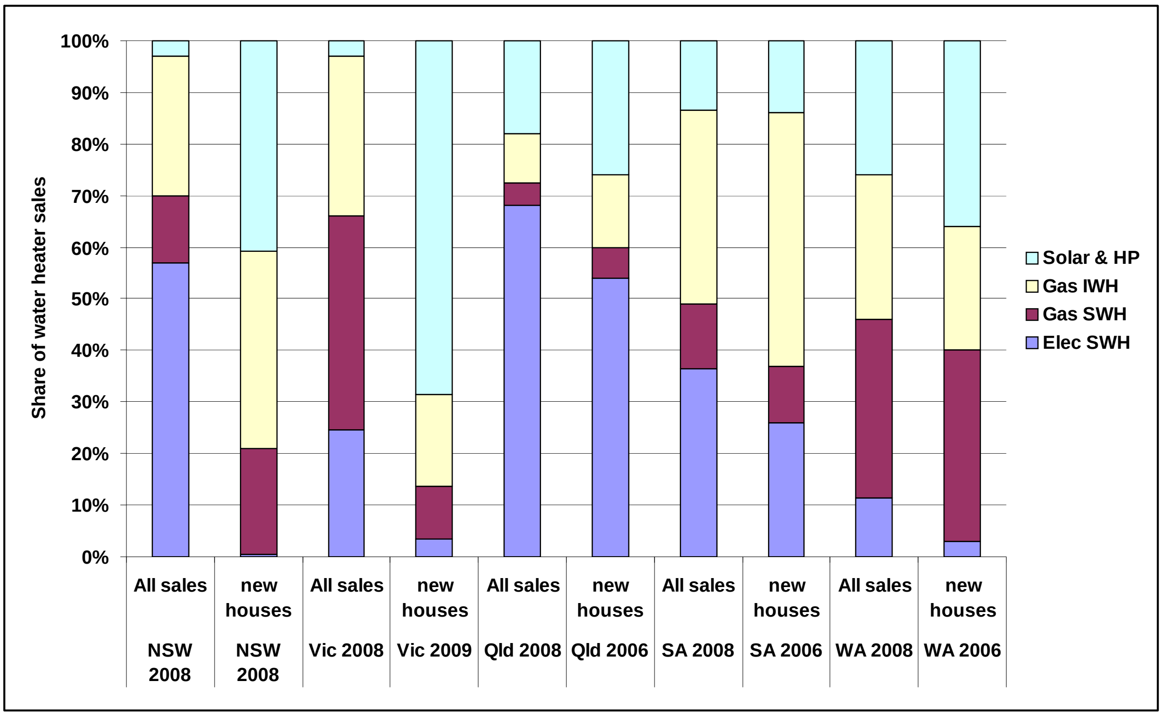
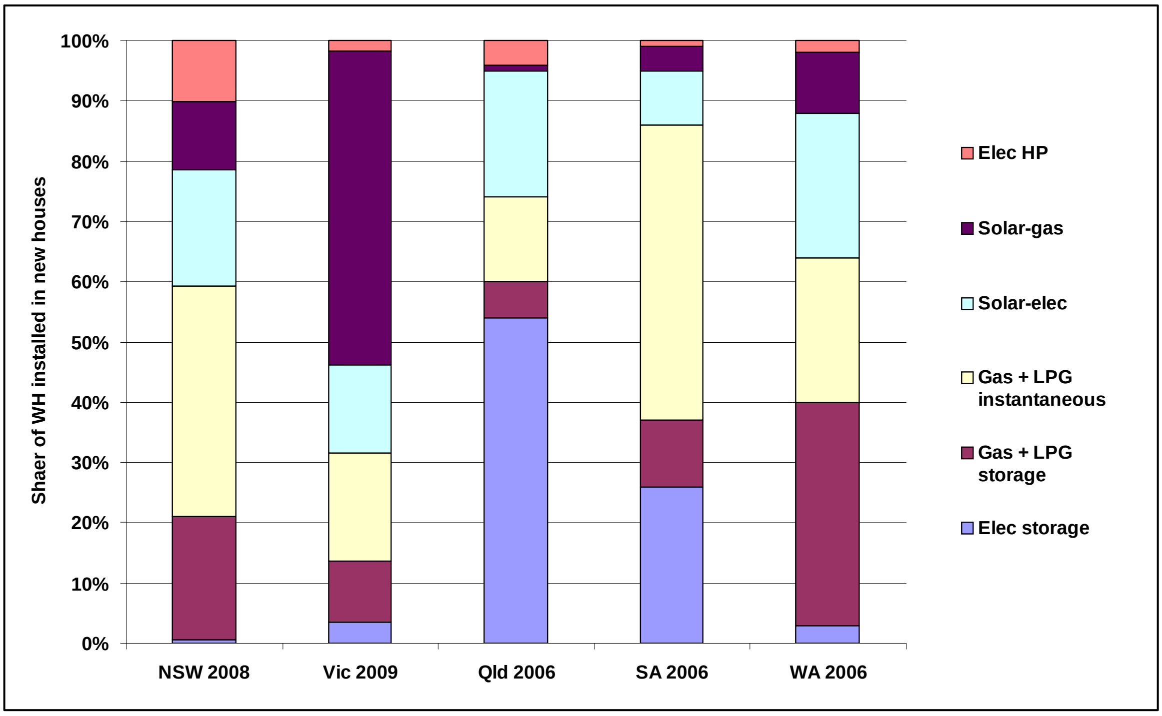


Figure 8 State water heater market share by type, new houses (solar boosting and heat pump disaggregated)



Types of Water Heaters

There is a wide range of technologies capable of supplying domestic hot water. These may be classified in a number of ways, including:

- the form of energy or fuel used – the most common forms are electricity, natural gas and liquefied petroleum gas (LPG), although wood and other fuels could also be used;
- whether the system maintains a volume of hot water ready for use ('storage' types) or whether it heats the water as required ('instantaneous' or 'continuous flow');
- water storage capacity (eg litres) or 'delivery' capacity (eg litres that can be drawn off before the water falls below a given temperature);
- whether the system is designed to work with a supply of energy available at all times (eg 'continuous' or 'day rate' electricity) or whether it is designed to work with a time-constrained supply (eg 'restricted hours' or 'off-peak' electricity);
- the maximum rate of energy transfer (eg kW for electric types, MJ/hr for gas) and for storage types, the rate at which heat is lost from the stored water;
- whether the system is capable of collecting radiant (solar) energy, and if so by what means (eg flat-plate collector or evacuated tube);
- if solar, whether the collectors and the storage tank form a single unit (close coupled systems that use natural 'thermosyphon' action) or whether they can be located apart ('split' systems, which usually require a pump);
- whether the system heats the delivery water directly or indirectly (eg via a heat exchanger or a secondary fluid). Indirect heating is a common form of frost protection for solar panels;
- for electric units, whether the energy is supplied to a resistance element (or more than one), a motor driving a heat pump which collects ambient energy (a 'heat pump'), or both;
- whether the system is supplied as a single unit (as is the case with most gas and electric water heaters) or whether it is assembled from components on-site (eg some solar water heater systems);
- For gas, LPG and other fuel systems, whether it must be installed outside or may be installed inside with flueing to the outside.

All types of water heaters are intended to meet the same basic task: the delivery of a given quantity of water at a given temperature as required. The amount of energy consumed to carry out this basic task can be determined either by physical testing of entire systems or by calculations based on the measured performance of components. These approaches are described in various standards.

Relevant Standards

The standards for water heaters using different energy forms (electricity, gas and solar) have evolved independently, but are now converging. Table 6 lists the main standards relevant to the energy consumption of water heaters in Australia. Water heaters are also covered by standards relating to electrical and gas safety, durability of construction and materials, safety of potable water and other general plumbing requirements.

Table 6 Main standards related to energy use of water heaters, Australia

AS/NZS 4234-2008	Heated Water Systems—Calculation of energy consumption
AS 2984	Solar water heaters—Methods of test for thermal performance—Outdoor test method
AS 4552-2005	Gas fired water heaters for hot water heater supply and/or central heating
AS/NZS 4692.1	Electric water heaters Part 1: Energy consumption, performance and general requirements
AS/NZS 4692.2	Electric water heaters Part 2: Minimum energy performance standards (MEPS) requirement and energy labelling
AS/NZS 2535	Solar collectors with liquid as the heat-transfer fluid—Method for testing thermal performance

The main factor determining the energy consumption of conventional electric resistance storage water heaters is their standing heat loss, since the transfer of electricity to water is near 100% efficient for every unit. The method of measuring standing heat loss is set out in AS/NZS 4692.1 (the successor to AS 1056.1) and maximum levels of heat loss are specified in AS/NZS 4692.2. These levels are known as Minimum Energy Performance Standards (MEPS), and are given mandatory effect through legislation in every State, Territory and in New Zealand (the MEPS levels applying in Australia and NZ are slightly different). This means that no electric water heater may be sold (whether for installation in a new house or as a replacement) unless it meets these levels. Although it is possible for water heaters to have lower heat losses than the MEPS levels, there is no system for labelling such products at present.

The factors determining the energy consumption of gas water heaters are more complex, varying with the combustion efficiency and rate of heat transfer and, for storage types, the rate of heat loss. Efficiency can vary with the task (the volume of water drawn off in a day, and the embodied energy therein) and the pattern of draw-off (the length of draws and the intervals between them). AS/NZS 4234 assumes an even rate of draw-off during the day (a ‘flat profile’).

The calculation of the gas consumed to meet a given task is set out in AS 4552. This requires physical tests of burner efficiency and maintenance rate (a proxy for storage tank heat loss), and sets out methods of calculation based on these. AS 4552 specifies minimum burner combustion efficiencies and maximum maintenance rates. It also sets out a basis for rating the energy performance of a system according to the nominal amount of gas consumed for a standard delivery task of 37.7 MJ/day (equivalent to raising the temperature of 200 litres of water by 45°C) or 13,760 MJ/year in delivered hot water. A unit which just meets the minimum performance levels in AS 4552-2005 would rate about 1.8 stars and consume about 27,300 MJ/yr, giving a task efficiency of

13,760/27,300 = 50.4%. Each reduction of 2,023 MJ in estimated annual gas consumption rates an additional star (Table 7). The efficiency of gas water heaters, like other types, varies with the delivery task.

Table 7 Star ratings for gas water heaters

Energy rating Stars	Maximum Annual MJ(a)	Task efficiency at threshold	Number of SWH models(b)	Number of IWH models(b)
1.0 – 1.9	28900	47.6%	3	0
2.0 – 2.9	26877	51.2%	7	0
3.0 – 3.9	24854	55.4%	26	2
4.0 – 4.9	22831	60.3%	13	13
5.0 – 5.9	20808	66.1%	22	107
6.0	18785	73.3%	0	2
			71	124
Average rating for models rated 5.0 or higher			5.1	5.4

(a) For 37.7 MJ/day task (b) Australian Gas Association Product Directory, January 2009 edition.

At present, the labelling of gas water heaters with their energy rating and estimated annual MJ consumption is in effect done by agreement between manufacturers, through their industry associations. DEWHA has recently published a RIS on a proposal to implement national minimum energy performance standard for gas water heaters (E3 2008/07). These would initially be set at 4.0 stars with the possibility of being raised later.

The performance of solar water heaters is more complex to measure, calculate or estimate than electric or gas water heaters, because it depends on a wider range of factors:

- the performance of the solar collectors;
- the orientation to north (azimuth) and angle to the horizon (inclination);
- the performance of the boosting equipment (which may be capable of functioning as a complete electric or gas water heater on its own);
- the control and interaction of solar and conventional elements, including pumping energy; and
- the hot water load (both magnitude and profile, ie whether flat, morning peak or evening peak).

It is possible to determine the key performance parameters of a solar water heater through outdoor testing to AS 2984, but this is a long and expensive procedure (8 to 10 weeks) due to the need to obtain stable inputs for a range of operating conditions. The procedure could be shortened by indoor testing under a controlled simulated solar load.

However, all physical tests have the disadvantage that they only give results for the models and configurations actually tested. Solar water heater manufacturers offer literally hundreds of combinations of collector panels, boosting systems, configurations (one, two or three separate components) and control strategies. It would be prohibitively costly to test all of these for three standard deliveries (corresponding to the needs of small, medium and large users of hot water) and four standard solar zones described in Table 8. (Note that these bear no relation to the 8 Climate Zones in the BCA nor the 69 AccuRate climate zones used for modelling thermal performance. There is some discussion at present whether Canberra should have its own distinct Climate Zone under AS/NZS 4234 or whether this should be treated as part of Zone 4).

The expense of outdoor testing prompted the development of AS 4234-1994, which sets out a method of determining the annual performance of domestic solar and heat pump water heaters using a combination of test results for component performance and a mathematical model to determine an annual load cycle task performance. The mathematical basis of the model is the TRNSYS simulation program.[4]

Table 8 Australian Climate Zones in AS 4234

Zone	Data source for typical meteorological year	Zone extends into:	Capital cities in this zone	Dwellings in this zone, 2006 (a)	
				Class 1	Class 2
1	Rockhampton	NT, Qld	Darwin	428,900	38,000
2	Alice Springs	WA, NT, SA, Qld, NSW		115,500	13,400
3	Sydney	WA, SA, NSW, Vic, Qld	Perth, Adelaide, Sydney, Canberra, Brisbane	4,703,500	705,800
4	Melbourne	WA, SA, Vic, Tas	Melbourne, Hobart	1,763,600	163,500
Total				7,011,500	920,700

(a) 2006 Census data mapped to climate zones by author

The AS/NZS 4234 Climate Zones vary with regard to climate (dry-bulb and wet-bulb temperature, solar insolation etc), cold water inlet temperatures and the energy use of the ‘reference’ conventional water heater used to estimate nominal solar contribution.

While AS/NZS 4234 is designed to cover the performance of all types of water heater, the actual testing of each type is covered by its own separate standard. A test standard for quantifying air source heat pump water heater parameters for use in AS/NZS 4234 is currently being developed. (For the time being, the Office of the Renewable Energy Regulator (ORER) uses an interim method of allocating RECS to heat pump water heaters).

AS/NZS 4234 contains minimum performance standards for solar water heaters boosted with electricity or gas, expressed as minimum ‘annual energy saving‘ or ‘solar contribution’ compared with a conventional water heater using the same form of energy. For solar water heaters supplying large or medium load a model must achieve a minimum of 60% ‘annual energy saving’ compared with a schedule of gas and electric reference systems, when operating in Zone 3. There is no minimum performance requirement for solar water heaters supplying a low load, to accommodate some models with slightly lower performance, which are still cost-effective for users due to their lower capital cost.

[4] TRaNsient SYstem Simulation Program, which is a public domain model developed by the University of Wisconsin, is an algebraic and differential equation solver, typically used to simulate performance of a range of energy systems including water heaters, HVAC systems and renewable energy systems.

Greenhouse intensity of water heating

Greenhouse intensity of energy supplied

The greenhouse gas intensity with which a water heater supplies hot water depends on the greenhouse-intensity of the types of energy it uses, and the quantity of each energy type it consumes to deliver a given level of water heating service.

The greenhouse intensity of each energy form can be determined in a number of ways, even for the same physical arrangements of energy generation or production and distribution. Methods vary significantly according to:

- How they account for flows of energy between interconnected systems (eg the electricity grids which comprise the National Electricity Market);
- Whether they are based on historical data (ie backward-looking) or projections (ie forward-looking); and
- Whether they are based on 'average' intensity, or 'marginal' intensity. Average intensity is based on average generation fuel mix, whereas marginal intensities are based on the characteristics if the type of generation that would need to be added to the system to accommodate projected growth in energy use and in response to policy drivers such has the Carbon Pollution Reduction Scheme (CPRS). Marginal emission factors have been used in the past to project the greenhouse impacts of proposed electricity efficiency measures, or programs to substitute fuel for electricity, but they are difficult to calculate. The last set of comprehensive factors was produced by the AGO in 2003 (GWA 2007)

For example, although coal accounts for the great majority of present generation in most States, it is likely that future generation will be dominated by natural gas and renewables, so avoiding a kWh of future consumption will have a *lower* greenhouse impact than the historical average. In hydro-dominated systems such as Tasmania, if future hydro development is constrained, additional demand for electricity will be met by fossil-fuel based generators located either in Victoria or in Tasmania itself, so avoiding a kWh of future consumption will have a *higher* marginal greenhouse impact than the historical average

The Department of Climate Change (DCC 2008a) publishes a workbook for the National Greenhouse Accounts (NGA), with a set of electricity and natural gas intensities for the use of companies reporting greenhouse gas emissions under the National Greenhouse and Energy Reporting System (NGERS). These historical (ie backwards-looking) averages for each State are illustrated in Figure 10.

Forward-looking emissions factors are based on the projected change in the fuel mix of electricity generation. These have been calculated for each State on the basis of the modelling for the proposed CPRS published by the Treasury (2008). Figure 11 illustrates the overall national trend projections under the Treasury's CPRS-5, CPRS-15 and Garnaut-25 scenarios.[5] (The trends for each State are illustrated in Appendix 2.)

[5] At the time of writing the Government had just announced the intention to delay the start of the CPRS from July 2010 to July 2011, and to abandon the CPRS-15 option in favour of a '25% reduction target' to

The 'Projected CPRS' emission factors for each State in Figure 10 are the average intensities under the CPRS-5 scenario over the period 2010-2022, corresponding to the service life of water heaters that would be installed in 2010.

The factors above differ by State and by whether they cover historical data or projections. This makes them difficult to use for purpose such as the BCA, which requires a simple and stable method of calculating the performance of buildings and water heaters. GWA (2007) developed a set of national 'BCA default intensity factors' which were representative of State historical intensities (except Tasmania's) and also reflected the fact that the marginal intensity of *new* generation in each State was converging, because the great majority of new generation in all States was likely to be a mix of natural gas and renewables.[6] This set of factors is illustrated in Figure 10.

As recommended in GWA (2007), the BCA default intensity factors are used to test whether particular types of water heaters would meet a given performance requirement, and so whether they should be deemed to satisfy that requirement.

However, the costs and benefits of adopting the requirement as modelled using the projected CPRS-5 greenhouse gas intensities and electricity prices.

Emissions intensity of water heaters

The proposed emissions intensity requirements for Part 2 of the BCA (covering Class 1 buildings) are as follows:

(a) 'Compliance … for a heater in a hot water supply system is verified when the annual greenhouse gas emission attributed to the water heater does not exceed 100 g CO_2-e/MJ of thermal energy load determined in accordance with AS/NZS 4234.

(b) The greenhouse gas intensity of the water heater in (a) is the sun of the annual greenhouse gas emissions from each energy source in g CO2-e divided by the annual thermal load of the water heater.

(c) The annual greenhouse gas emission from each energy source in (b) is the product of-

(i) the annual amount of energy consumed from that energy source; and

(ii) the emission factor of-

(A) if the energy source is electricity, 272 g CO_2-e/MJ; or

(B) if the energy source is liquefied petroleum gas, 65 g CO_2-e/MJ; or

(C) if the energy source is natural gas. 61 g CO_2-e/MJ; and

---

be adopted in the event of an international commitment to such a target. As a (deferred) CPRS-5 scenario is now the only one to which there is a commitment, and the probability of adoption of a CPRS-25 scenario is not known, CPRS-5 is retained as the sole energy and emissions projection scenario.

[6] If coal fired power stations using carbon capture, sequestration and storage are built, they would most likely have an intensity between gas and renewables.

(D) if the energy source is wood or biomass, 4 g CO_2-e/MJ' (BCA 2009).

The reference level of 100 g CO_2-e/MJ effectively divides water heaters into two groups: electric resistance water heaters exceed this level and nearly all other water heater types fall below it in most parts of Australia (Figure 9).

The annual energy use of a wide range of water heater types has been calculated by Thermal Design Pty Ltd, using the TRNSYS model, in 4 separate studies (TD 2007, 2007a, 2009, 2009a). The studies all use the method of calculation of annual energy use in AS/NZS 4234, and cover a wide range of cases, with regard to:

- water heater configurations, including 5 conventional electric resistance models; 15 conventional gas models (at all star rating levels), 4 heat pump models, 10 solar-electric models and 6 solar-gas models;

- a range of daily hot water deliveries, ranging from 70 to 300 litres per day (the energy content of this quantity of hot water varies with delivery temperature, season and location, and is specified differently in the 4 studies, as indicated in Table 10;

- 4 solar zones: the performance of solar and heat pump water heaters in particular is sensitive to the Zone, and this performance affects the number of RECs allocated to a model (and hence its capital cost) as well as the running cost;

- Solar boost modes: gas boosting is always available, but for solar-electric and heat pumps performance has been modelled for both continuous and restricted hours (off-peak);

- Draw-off patterns: AS/NZS 4234 assumes that whatever daily hot water demand is selected, the water is drawn off at an even rate during the day (ie drawoffs of equal magnitude and at regular intervals). In TD (2009a) each hot water demand level was modelled for three draw-off patterns: 'flat', morning peak and evening peak. This make a significant difference to the performance of solar water heaters.

Table 10 summarises the combinations of options modelled. They total nearly 1200 discrete simulations. Some additional calculations were also undertaken by GWA.

The efficiency of a water heater can be defined as Useful Energy (UE) which it transfers into hot water divided by Delivered Energy (DE) – ie electricity, gas, LPG or other fuel. For conventional gas and electric water heaters, UE/DE is always less than 1, but for heat pump and solar types it is higher than 1.

The efficiency range for conventional water heaters is fairly narrow, across both types and water heater drawoffs (Table 9). The range for heat pumps is somewhat wider. The efficiency range for solar water heaters is by far the widest, and is sensitive to many factors including delivery, drawoff, collector efficiency etc. For the same model of solar water heater, the lower the hot water demand the higher the efficiency. For conventional water heaters and heat pumps, efficiency increases gradually with delivery, all else being equal. For solar water heaters on the other hand, efficiency increases steeply as delivery declines, and falls as delivery increases.

Table 9 Indicative range of modelled water heater efficiencies

Type	Highest Efficiency (a)	Lowest Efficiency (b)	Range
Electric (off peak)	0.90	0.70	0.20
Electric (continuous)	0.90	0.98	0.12
Gas IWH	0.75	0.60	0.15
Gas SWH	0.78	0.55	0.23
Heat pump	2.2	3.5	1.3
Solar-electric (evacuated tubes)	6.0	1.5	4.5
Solar-gas (flat plate, small)	2.7	1.1	1.6
Solar-gas (flat plate, medium)	7.0	1.5	5.5
Solar-electric (flat plate)	10.0	1.7	8.3

(a) See Appendix 4. Efficiency varies with delivery and other factors.

Figure 9 illustrates the emissions intensity, for the 40 MJ/peak day task, in the four States and Zones which together account for about 85% of new construction. The differences in the emissions for each type of water heater reflect the efficiency of the water heater, the variations in the energy requirement for the same water heating task from zone to zone, and differences in the projected CPRS-5 greenhouse intensities (which vary from State to State) and the default factors proposed for the BCA (which are the same in all States, so the intensity of water heaters only vary with their Zone).

Electricity-related emissions are also included for those gas and solar-gas water heaters which use electricity for standby energy, combustion fans or pumps. It is apparent that in all the cases shown, conventional electric water heaters give by far the highest emissions, but the ranking and relative differences between the other options depends on zone and State.

In 2007 the Australian Building Codes Board and the Australian Greenhouse Office commissioned a study to develop options for specifying domestic water heaters in the BCA. The report of the study (GWA 2007) recommended an assessment method for calculating the greenhouse gas emissions associated with water heater operation, and discussed a range of possible emissions intensity factors, especially for electricity. The method (in Appendix 1 of the present RIS) is proposed as the BCA method.

Although the most cost-effective benchmark level (expressed as a maximum g CO_2-e/MJ added to hot water) was not determined, it was clear that if a greenhouse benchmark had any impact at all it would exclude conventional electric water heaters, and a value of 100 g CO_2-e would have this effect. One of the findings of the study was:

> The benchmark value (being determined under a separate Preliminary Impact Analysis) should be the same in all 4 climate zones, for all 3 deliveries, and the same value irrespective of whether the house is constructed in an area where natural gas is available or not. A benchmark value of 100 g CO_2-e/MJ would be met by gas water heaters rated 5.0 stars or higher, and by the majority of solar-electric, solar-gas water and heat pump water heaters (GWA 2007a).

If the 'deemed to satisfy' MEPS level for gas water heaters in new houses is set at 5.0 stars, as it is in SA, Queensland WA and ACT, then the average star rating of the 22 gas SWH models passing that MEPS level would be 5.1, and the average for the 109 IWH models passing would be 5.4 (Table 7). The average gas water heater installed in new houses would then easily meet a benchmark of 100 g CO_2-e/MJ.

All solar-gas water heater models should meet the benchmark.

With solar-electric water heater model, some types and configurations may not meet the benchmark in all climate zones. For example a typical medium-efficiency solar-electric water heater would comply in zone 3, but in zone 4 a somewhat higher collector efficiency or perhaps additional collectors would be required.

Figure 9 g CO_2-e/MJ of hot water, selected States and Zones

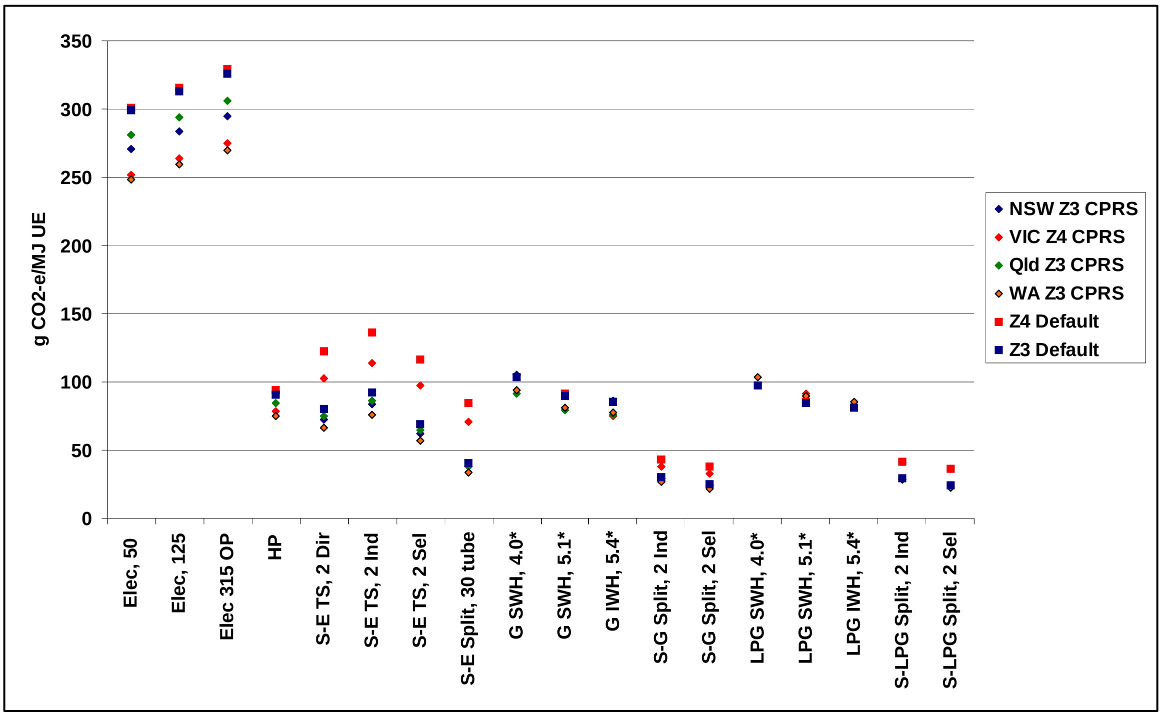
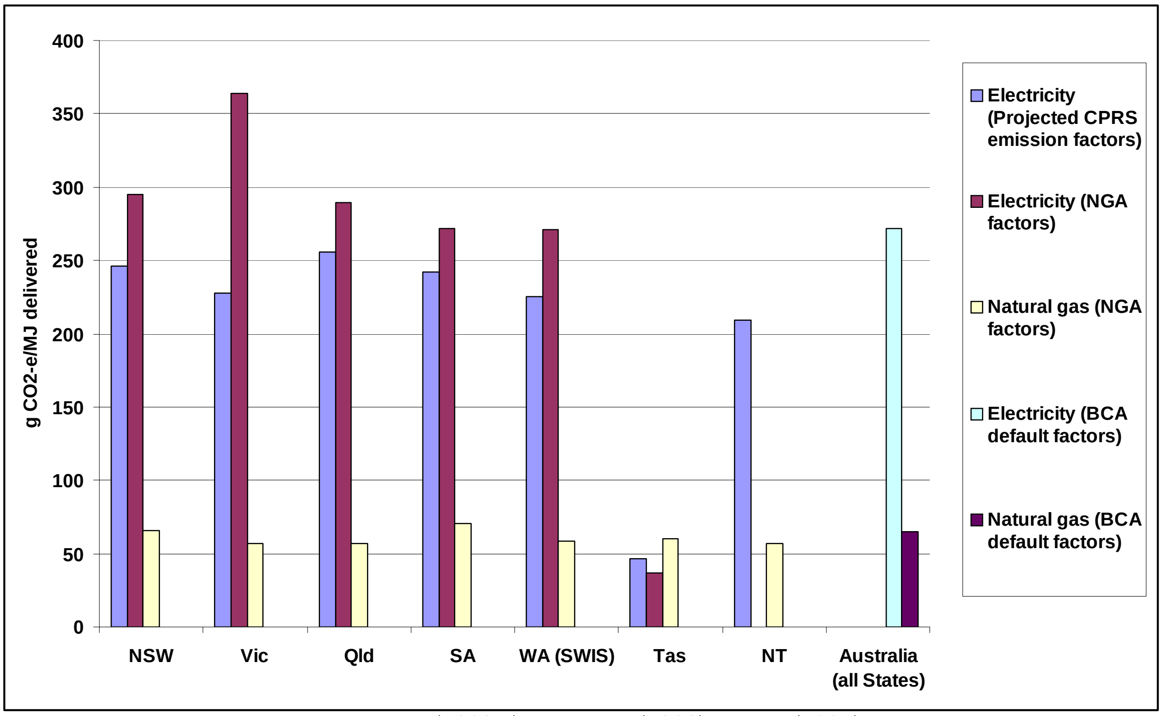


Table 10 Summary of water heater performance modelling used in this RIS

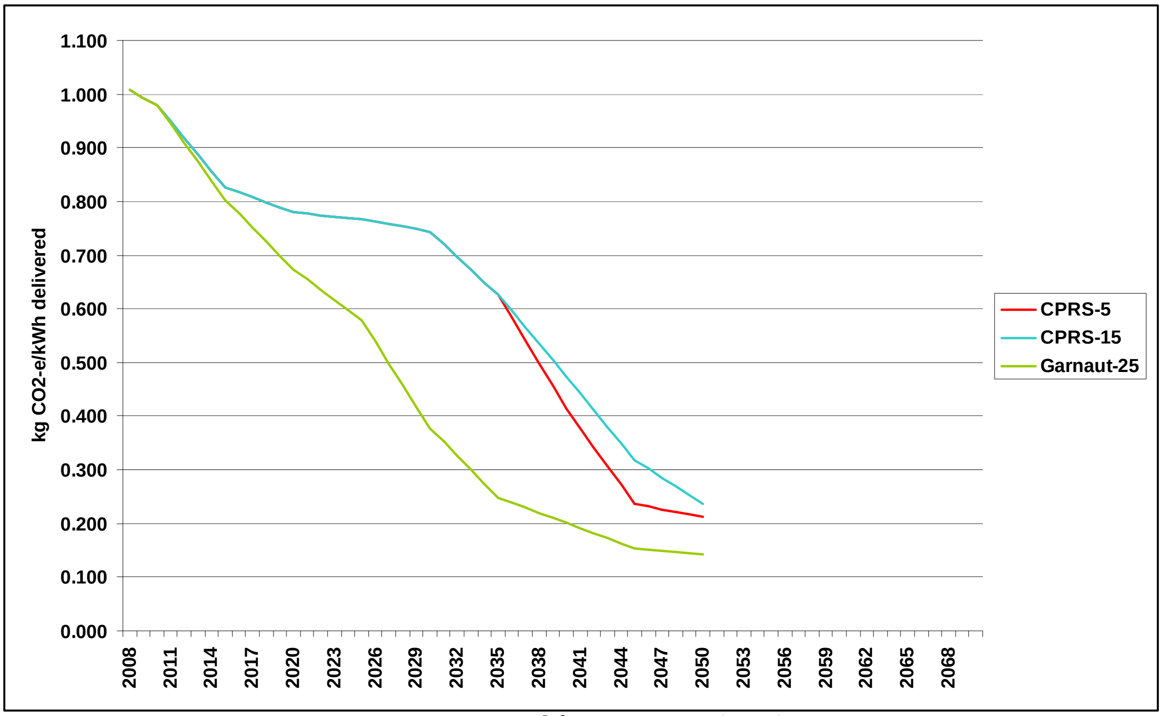
Case		Vol	Panels/ tubes	TD (2007) Flat drawoffs			TD (2007a) Flat drawoffs			TD (2009) Flat drawoffs			TD (2009a) Flat, morning and evening peaks							
													Continuous				Off-peak			
	GJ/yr (range for Zones 1 to 4)			6.6	13.2	19.8	5.0	9.9	14.8	7.4 8.3	12.3 13.9	18.8 20.9	3.8 4.9	5.9 7.6	10.7 13.9	16.1 20.8	3.8 4.9	5.9 7.6	10.7 13.9	16.1 20.8
	Peak winter load MJ/day (range for Zones 1 to 4)			20	40	60	15	30	45	23 25	38 42	57 63								
	Litres/day												70	110	200	300	70	110	200	300
1	Electric day-rate	85	NA	X	X	X														
2	Electric day-rate	150	NA				X	X	X											
3	Electric off-peak	300	NA																	
4	Electric off-peak	250	NA							X	X	X								
5	Electric off-peak	315	NA							X	X	X					X	X	X	X
6	Electric air source heat pump Tank	300	NA	X	X	X														
7	Electric air source heat pump	150	NA				X	X	X											
8	Electric air source heat pump	340	NA										X	X	X	X	X	X	X	X
9	Electric air source heat pump	150	NA										X	X	X	X				
10	Gas SWH (5 star)	170	NA	X	X	X														
11	Gas SWH (5 star)	135	NA				X	X	X											
12	Gas IWH (5 star)	NA	NA	X	X	X							X	X	X	X				
13a-f	Gas SWH (range 1 to 6 stars)	135	NA							X	X	X								
14a-f	Gas IWH (range 1 to 6 stars)	NA	NA							X	X	X								
15	Solar-elec thermosyphon	300	2 panel SE	X	X	X							X	X	X	X	X	X	X	X
16	Solar-elec thermosyphon	300	2 panel HE	X	X	X							X	X	X	X	X	X	X	X
17	Solar-elec thermosyphon	180	1 panel SE				X	X	X				X	X	X	X				
18	Solar-elec thermosyphon	180	1 panel HE				X	X	X											
19	Solar-elec split	300	3.9 m^2 evac	X	X	X														
20	Solar-elec split	300	2.5 m^2 evac	X	X	X														
21	Solar-elec split	250	22 tube evac										X	X	X	X	X	X	X	X
22	Solar-elec split	160	10 tube evac										X	X	X	X				
23	Solar-elec split	160	14 tube evac										X	X	X	X	X	X	X	X
24	Solar-elec split	250	2.5 m^2 evac										X	X	X	X				
25	Solar-gas IWH boost (in-line)	300	2 panel SE	X	X	X	X	X	X											
26	Solar-gas IWH boost (in-line)	300	2 panel HE				X	X	X											
27	Solar-gas SWH boost (in tank)	170	2 panel Sel	X	X	X	X	X	X											
28	Solar-gas IWH boost (in-line)	180	1 panel Dir				**X**	**X**	**X**				X	X	X	X				
29	Solar-gas SWH boost (in tank)	135	1 panel Sel	X	X	X	X	X	X											
30	Solar-gas IWH boost (in-line)	250	2 panel HE										X	X	X	X				

Figure 10 Greenhouse intensity factors from a range of sources



Source: DCC (2008a), Treasury (2008), GWA (2007)

Figure 11 Projected greenhouse intensity factors, CPRS and related scenarios



Source: Extracted from Treasury (2008)

Non-Mandatory Influences on Water Heater Design and Selection

The standards described in the previous section form the basis of a number of initiatives which try to influence water heater purchases towards certain types of water heaters – especially solar – or toward the more energy-efficient models within types.

Energy Labelling

At present only gas water heaters carry energy labels to indicate their relative efficiency on a scale of 1 to 6 stars. Electric water heaters do not carry labels, since there is a reasonably stringent MEPS level and very few models significantly exceed that level.

If more stringent MEPS are implemented for gas water heaters, as is currently proposed, all models on the market would rate 4 or 5 stars or more, so the effectiveness of labels in promoting more efficient purchases than the (high) minimum level may be limited.

For solar water heaters, the physical labelling of products is complicated by the fact that systems generally consist of several components, and the system performance can only be determined if the characteristics of each component are known. There would be very little value to a user in a label attached to a solar collector which said: 'performance level X when installed with storage tank A and booster B, performance level Y when installed with storage tank C and booster D…, etc, with possibly dozens of combinations (including options for continuous and off-peak electricity). However, it is feasible to label the performance of entire systems in product literature or on websites, and this is in effect the approach taken by the MRET scheme.

MRET

The Mandatory Renewable Energy Target (MRET) scheme was introduced by the Commonwealth Government in 2001 with the objective of increasing electricity generation from renewable sources by an additional 9,500 GWh of renewable energy per year by 2010.

In 2008 the Australian Government committed to implementing an expanded national Renewable Energy Target (RET) scheme that will:

- 'ensure the equivalent of at least 20 per cent of Australia's electricity supply—approximately 60 000 gigawatt-hours (GWh)—is generated from renewable sources by 2020
- increase the MRET to 45,000 GWh to ensure that together with the approximately 15 000 GWh of existing renewable capacity, Australia reaches the 20 per cent target by 2020
- bring both the national MRET and existing state-based targets into a single national scheme
- count only renewable energy towards the target and keep the same eligibility criteria as in the current MRET scheme
- phase out the RET between 2020 and 2030 as emissions trading matures and prices become sufficient to ensure a RET is no longer required.

- retain the eligibility of all renewable energy projects that have been approved under existing State-based schemes.' (COAG 2008)

The Office of the Renewable Energy Regulator (ORER), which is a statutory agency within the Department of Climate Change portfolio, administers the *Renewable Energy (Electricity) Act 2000* (the Act), the *Renewable Energy (Electricity) Charge 2000* and the *Renewable Energy (Electricity) Regulations 2001*.

MRET imposes obligations on wholesale purchasers and large users of electricity to acquire and submit annually a number of Renewable Electricity Certificates (RECs) corresponding to the ratio of the current annual target to total electricity purchases. For example, if this 'Renewable Power Percentage' is 1.6%, a liable party purchasing 20,000 GWh of electricity would need to acquit 320,000 RECs. Each REC represents 1 MWh of 'eligible renewable electricity'.

At present, solar-electric, solar-gas and heat pump water heaters are eligible to create Renewable Electricity Certificates (RECs) under the Commonwealth Renewable Energy (Electricity) Act 2000. Nearly 8,000 model configurations – combinations of tank sizes, collector types and collector numbers – are registered with the Office of the Renewable Energy Regulator (ORER).[7]

ORER allocates each model configuration a number of RECs in each of the 4 solar zones defined in AS/NZS 4234, in accordance with published rules (ORER 2008). In general, the highest number of RECs is for Zone 2, followed by Zones 1 and 3, which are equivalent in terms of the number of RECs created, and then Zone 4.

Rebates and Incentives

The value of RECs has become an important factor in the pricing and competitive position of solar and heat pump water heaters, in both the new building and replacement markets.

In addition, the Commonwealth, SA, NSW, Victoria and WA all offer incentive payments for the installation of solar and heat pump water heaters and, in some cases, for gas water heaters. (Currently, Queensland only offers incentives for the installation of gas water heaters and other gas appliances).

However, these incentive schemes are mostly available where an existing electric water heater is replaced. Therefore the cost of installing water heaters in new houses is either not or only in few occasions influenced by rebates and incentives, other than the value of the RECS created by the Renewable Energy Target scheme.

[7] Many of the listed configurations will have no sales at all in a given year, but need to be registered so that RECs can legally be created if there are sales.

Mandatory Requirements for New Houses

Current State Requirements

Five States and the ACT have requirements for the types of water heaters that may be installed in new dwellings (Table 11). Queensland, SA, WA and the ACT have all adopted a prescriptive approach, which excludes electric water heaters in areas where natural gas is available.

In Victoria, the current '5 Star' requirements permit any type of water heater so long as a rainwater tank (or recycled water supply) is installed, but if not, then only solar-gas is permitted in gas-available areas and solar-electric or heat pump in non-gas areas.

In NSW, BASIX permits any type of water heater, but the higher the associated greenhouse emissions the more compensating low-emission design features have to be incorporated (this is backed by a method of calculation which is not publicly available).

There are also differences with regard to the minimum performance of the permitted water heater types: eg:

- For gas water heaters: not less than 5.0 stars in Qld, WA, SA and ACT, but no limits in Victoria or NSW.

- For solar and heat pump water heaters, the minimum requirement may be expressed simply as registration with ORER, as a minimum RECs level, or as a minimum % solar contribution calculated in accordance with AS/NZS 4234 (in Victoria and WA). The details for each State are summarised in Table 12.

The rules proposed for the BCA allow either type of requirement: by RECS or by solar contribution. However, as every State's rules are different, it would be necessary for each of them to adopt the proposed rules if national harmonisation is to be achieved.

Table 11 Current mandatory water heater requirements for new houses (Class 1)

	Areas with natural gas available					Non-gas areas		
	Electric	Gas	Solar-electric	Solar-gas	Heat pump	Electric	Solar-electric	Heat pump
NSW	P	P	P_M	P_M	P_M	P	P_M	P_M
Vic	P_C	P_C	$P_{\%C}$	$P_{\%}$	P_C	P_C	$P_{\%}$	$P_{\%}$
Qld	X	$P_{5.0}$	P_R	P_R	P_R	X	P_R	P_R
SA	X	$P_{5.0}$	P_R	P_M	P_R	X	P_R	P_R
WA	X	$P_{5.0}$	$P_{\%}$	$P_{\%}$	$P_{\%}$	X	$P_{\%}$	$P_{\%}$
Tas	P	P	P	P	P	P	P	P
NT	P	P	P	P	P	P	P	P
ACT	X	$P_{5.0}$	P	P	P	P (b)	P	P
Proposed	**X**	$\mathbf{P_{5.0}}$	$\mathbf{P_{\%R}}$	$\mathbf{P_{\%R}}$	$\mathbf{P_{\%R}}$	**X**	$\mathbf{P_{\%R}}$	$\mathbf{P_{\%R}}$

P = permitted. X = not permitted. P_C = Permitted on condition that a rainwater tank or recycled water supply is installed. 5.0 = Minimum star rating where gas or LPG water heaters are installed. R = model must be eligible for minimum number of RECS in ORER list. M = model must be registered with ORER, but no minimum number of RECs specified. % = minimum standard based on % renewable energy contribution calculated under AS 4234. (a) From 1 October 2009 (b) If 80 litres or less.

Table 12 Performance requirements for solar and heat pump water heaters

<table>
<tr><td rowspan="4">SA
(a)</td><td></td><td>‘Small’ 220 litres storage or less</td><td>‘Medium’ 220 to 400 litres storage</td><td>‘Large’ 400 to 700 litres storage</td></tr>
<tr><td>Electric-boosted solar</td><td>At least 18 RECs</td><td>At least 28 RECs</td><td>At least 40 RECs</td></tr>
<tr><td>Heat pump</td><td>At least 18 RECs</td><td>At least 28 RECs</td><td>At least 40 RECs</td></tr>
<tr><td>Gas-boosted solar</td><td>Any number RECs</td><td>Any number RECs</td><td>Any number RECs</td></tr>
<tr><td rowspan="4">Qld
(b)</td><td></td><td>Less than 3 bedrooms</td><td>3 or more bedrooms</td><td></td></tr>
<tr><td>Electric-boosted solar</td><td>At least 14 RECs</td><td>At least 22 RECs</td><td></td></tr>
<tr><td>Heat pump</td><td>At least 14 RECs</td><td>At least 22 RECs</td><td></td></tr>
<tr><td>Gas-boosted solar</td><td>At least 14 RECs</td><td>At least 22 RECs</td><td></td></tr>
<tr><td rowspan="4">WA
(c)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Electric-boosted solar</td><td colspan="3" rowspan="3">“Complies with AS 2712/2002, has been tested in accordance with AS 4234-1994, achieves a minimum energy saving of 60% for a hot water demand level of 38 MJ/day in Zone 3.”</td></tr>
<tr><td>Heat pump</td></tr>
<tr><td>Gas-boosted solar</td></tr>
<tr><td rowspan="6">Vic
(d)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Electric-boosted solar</td><td colspan="3" rowspan="3">“must perform to a standard under which the energy savings relative to a conventional water heater calculated in accordance with AS 4234 must be 60% or more”</td></tr>
<tr><td>Heat pump</td></tr>
<tr><td>Gas-boosted solar</td></tr>
<tr><td></td><td>Less than 3 bedrooms</td><td>3 or more bedrooms</td><td></td></tr>
<tr><td></td><td>Peak daily energy load must be 25.2 MJ/day, Zone 4</td><td>Peak daily energy load must be 42 MJ/day, Zone 4</td><td></td></tr>
<tr><td rowspan="4">ACT
(e)</td><td></td><td>Less than 3 bedrooms</td><td>3 or 4 bedrooms</td><td>More than 4 bedrooms</td></tr>
<tr><td>Electric-boosted solar</td><td rowspan="3">At least 14 RECs in zone 7; and energy saving of 40% for ‘small’ system</td><td rowspan="3">At least 22 RECs in zone 7; and energy saving of 60% for ‘medium’ system</td><td rowspan="3">At least 28 RECs in zone 7; and energy saving of 60% for ‘large’ system</td></tr>
<tr><td>Heat pump</td></tr>
<tr><td>Gas-boosted solar</td></tr>
<tr><td rowspan="4">BCA
(f)</td><td></td><td>Less than 3 bedrooms</td><td>3 or 4 bedrooms</td><td>More than 4 bedrooms</td></tr>
<tr><td>Electric-boosted solar</td><td rowspan="3">At least 14 RECs in zone where installed; or energy saving of 40% for ‘small’ system</td><td rowspan="3">At least 22 RECs in zone where installed; or energy saving of 60% for ‘medium’ system</td><td rowspan="3">At least 28 RECs in zone where installed; or energy saving of 60% for ‘large’ system</td></tr>
<tr><td>Heat pump</td></tr>
<tr><td>Gas-boosted solar</td></tr>
</table>

(a) SA Performance Standards for Domestic Water Heater Installations, May 2008. (b) Queensland Plumbing and Wastewater Code, February 2009. (c) % Star Plus Energy Use in Houses Code, Water Use in House Code, WA Department of Housing and Works, May 2007. (d) Victorian Plumbing Regulations 2008, 24 November 2008. (e) ACT Water and Sewerage (Energy Efficient Hot-Water Systems) Legislation Amendment Bill 2009 (f) As proposed in this RIS.

Rationalisation of State Requirements

In 2007 the Commonwealth Government commissioned the Australian Building Codes Board (ABCB), in conjunction with the Australian Greenhouse Office, to develop options for specifying domestic water heaters in the Building Code of Australia (BCA), that:

1. require the heater to be solar, electric heat pump or gas;
2. in reducing State variations to the BCA, provide national consistency; and

3. provide a basis for developing national Performance Requirements, Deemed-to-Satisfy Provisions and if necessary, a Verification Method.

The report to the ABCB (GWA 2007) recommended the addition of new clauses to the BCA (see Appendix 1). In jurisdictions which adopt these rules, electric resistance water heaters could not be installed in new Class 1 dwellings, but natural gas and LPG heaters could be installed provided that they have a star rating of 5.0 or higher, and solar water heaters could be installed provided they had specified minimum efficiency or energy savings compared with conventional types, calculated in accordance with AS/NZS 4234. It was recommended that there be no differentiation based on whether the dwelling were constructed where natural gas was available or not.

If these jurisdictions adopted the proposed BCA provisions there would be additional benefits to water heater suppliers and to builders operating across jurisdictions, in terms of reduced compliance and information costs. These costs are presently being borne by State energy agencies (ie taxpayers), by water heater suppliers (who have to monitor the rules and indicate to builders, installers and other buyers which models may be installed in each State) and by builders. Supplier and builder costs are passed on in product and house prices.

It has not been possible to quantify the value of removing these costs. Therefore, the benefits modelled are considered conservative.

Commonwealth Government Policy on 'Greenhouse-intensive' water heaters

Prior to the November 2007 elections, the ALP stated its intention to :

> '…phase-out the installation of greenhouse-intensive electric hot water heaters in new and existing homes with access to reticulated natural gas by 2010, and as installations in all existing homes by 2012. Exemptions will be granted for dwellings where the installation of climate-friendly systems is impractical.'[8]

It also referred to the existing regulations in the following terms:

- 'Labor will work with industry to harmonise and accelerate State and Territory Government initiatives, implementing nationally consistent Greenhouse and Energy Minimum Standards for hot water heaters.
- These standards will allow for the gradual phase-out of greenhouse intensive hot water systems in new homes and areas with access to reticulated natural gas in 2010, before extension to all homes by 2012. This phase out will apply to new and replacement installations only, and will not require premature replacement of existing systems.
- Labor will provide exemptions for households where the installation of solar, heat pump and gas systems is impractical or uneconomical, including small homes and multistorey dwellings.'[9]

[8] *Labor's 2020 Target for a Renewable Energy Future*, October 2007

[9] *Labor's Solar Schools - Solar Homes Plan*, October 2007.

Ministerial Councils

The *National Hot Water Strategic Framework* endorsed by the Ministerial Council on Energy in December 2007 also includes the objective of preventing the installation of electric resistance water heaters in new homes, as does the *National Strategy on Energy Efficiency* endorsed by the Council of Australian Governments in July 2009.

The Problem

Of all the fixed equipment installed in houses at the time of construction, the water heater usually represents the largest single user of energy as well as the largest single contributor to greenhouse gas emissions.

The first choice of water heater tends to set the precedent for the life of the house, because the conditions of replacement favour like for like. This differs from plug in appliances or lighting, where the owners or occupants can change products more quickly in response to changing preferences or energy prices.

About half of initial water heater selections are made by the builder exclusively, and in the rest of cases the builder and plumber exert considerable influence. These market conditions favour the lower capital cost water options, irrespective of lifetime operating costs – electric water heaters in particular.

These failures in the market for water heating services could lead to the initial owners and occupants of new houses bearing significantly higher service costs for water heating than if they were fully engaged with the selection of the water heater and fully informed about the projected operating costs over the service life.

The disadvantage to occupants is now likely to rise significantly due to the effects of the proposed Carbon Pollution Reduction Scheme (CPRS), because the requirements to acquit permits to emit greenhouse gases will impact most heavily on the price of electricity. Treasury (2008) projects that the CPRS will add $4 to $5 per week to the average household electricity bill. Given that water heating accounts for about a quarter of household electricity use (Table 2) this implies that electric water heating costs could increase by about $1 per week, or nearly $670 over the typical 13 year service life of a water heater – nearly as much as the initial capital cost.

Furthermore, without regulation there is a risk that greenhouse gas emissions from water heaters installed in new homes will be significantly higher than otherwise, so increasing the demand for emissions permits under the CPRS and raising the overall adjustment costs to the Australian economy.

The half of new home buyers/occupants not involved in the initial choice of water heater are not in a position to respond to these expected price changes. Of the half that are theoretically in a position to respond, and consider a form of water heater other than the default type offered by the builder, few are likely to be aware of the projected energy consumption and costs, and so the great majority will make sub-optimal choices. Therefore, the extent of market failure is significant both in terms of coverage (i.e. the majority consumers are directly or indirectly affected by the market failure) and also in terms of consequence (i.e. the financial and environmental impacts that stem from the market failure could be significant for individual households).

These market failures have been addressed to some extent by a range of State regulations which either prohibit or constrain the installation of electric water heaters in new homes. Together with subsidies for solar and heat pump water heaters, these have succeeded in significantly changing the pattern of water heater installation in new houses, but not in the replacement market, where electricity still dominates (Figure 7).

While NSW, Victoria, Queensland, SA and WA all adopted requirements for water heaters in new houses between 2004 and 2007 the State regulations are all slightly different and have been implemented through different mechanisms. While most incorporate a list of water heater types deemed to satisfy (DTS) their provisions, the requirements differ. Only one (SA) has a method of calculating greenhouse performance so that suppliers of technologies and products not on the DTS list can demonstrate compliance with the objectives of the regulation. Furthermore, Tasmania and the Northern Territory have not yet adopted similar positions. The combination of jurisdictional differences in approach and inconsistent coverage across Australia suggests that market failures remain.

2. Objectives of the Regulation

The overarching objective of this proposal is to contribute to Australia meeting its obligations under the Kyoto Protocol and any subsequent agreements in the most efficient way, by:

- bringing about reductions in greenhouse gas emissions from water heating below what they are otherwise projected to be;

- reducing the cost of abatement; and

- helping businesses and households adjust to the impacts of an emissions trading scheme.

The specific problems which the proposed regulation are intended to address are:

- The demonstrated principal-agent market failures in the water heating market as it applies to new buildings. Without regulations, builders tend to adopt water heating options with the lowest capital cost, which in areas without natural gas is electric;

- The likely impact of the impending carbon pollution reduction scheme (CPRS) on energy prices, which will magnify the consequences of those market failures;

- The risk that greenhouse gas emissions from water heaters installed in new homes will be significantly higher than otherwise, so increasing the demand for emissions permits under the CPRS and raising the overall adjustment costs to the Australian economy.

- The inconsistencies in the present State building regulation regimes which seek to address those market failures.

3. Policy Options

The Proposal

The proposal is to amend Volume 2 of the Building Code of Australia to add provisions relating to the performance of water heaters installed in Class buildings.

This will involve:

- Modifying Part 2.6, to enable the existing objective ‘to reduce greenhouse gas emissions’ to be pursed by additional means, not just by ‘efficiently using energy’, as is the case at present;

- Adding the requirement that ‘A building’s domestic services, including any associated distribution system and components must, to the degree necessary, use energy from a renewable source or from a low greenhouse gas emitting source;

- Adding a method by which a water heaters compliance with the above requirements can be demonstrated;

- Adding a list of ‘acceptable construction practices’, or water heaters which are ‘deemed to satisfy’ the requirements.

The full text of the proposed provisions is set out in Appendix 6.

The following water heaters would be listed as ‘acceptable construction practices’:

- A solar or heat pump water heater which achieves a minimum number of RECs or a minimum solar contribution in accordance with AS/NZS 4234, with the number of RECs and solar contribution varying with the number of bedrooms;

- A gas heater rated at not less than 5 stars in accordance with AS4553; and

- An electric resistance water heater is only acceptable practice if (a) the electricity is generated entirely from a ‘renewable energy source’, or (b) the water heater serves a dwelling of not more than one bedroom; or (c) the water heater is a supplementary water heater where a complying water heater is also installed. In cases (b) and (c), the electric resistance heater must be either of the instantaneous type, or if of the storage type must have a hot water delivery capacity of not more than 50 litres.

It is noted that the provisions if inserted in BCA would not automatically be binding on individual States and Territories, who could choose to retain their present, separate requirements for water heaters installed in new buildings in their jurisdictions (or in the case of Tasmania and the NT, no requirements). .

The most direct way to achieve the objectives is via the BCA, which applies to all new construction in Australia.

Builders, home purchasers/owners, building certifiers, plumbers, water heater manufacturer and other stakeholders could be clearly informed of the acceptable construction practices, and these could be uniform throughout Australia (subject to jurisdictions accepting the main provisions and not seeking to depart from or modify them).

The process by which builders comply with the regulation would be straightforward:

1. Select the type of water heater: if the building is in an area where natural gas is available (or potentially available, subject to arrangement with the gas supplier), the practical options would be natural gas, solar-gas, solar-electric, heat pump or LPG. If the building is in an area where natural gas is not available, the practical options would be solar-electric, heat pump or LPG (unboosted solar water heaters and wood or other renewable fuels are also permitted).

2. If selecting a gas or LPG water heater, select one with a 5.0 star or higher rating (whether storage or instantaneous).

3. If selecting a boosted solar or heat pump water heater:

    a. Determine the number of bedrooms;

    b. Select a method of boosting (electric, natural gas or LPG);

    c. Consult the ORER website to determine whether the preferred model of solar or heat pump water heater achieves the minimum number of RECs specified in the regulation (14 for a building with 1 or 2 bedrooms, 22 for a building with 3 or 4 bedrooms, 28 for a building with 5 or more bedrooms), in the zone where the building is constructed (the ORER website publishes a concordance of postcodes with solar zones);

    d. If it is intended to use a model not listed on the ORER database, or one which does not achieve the required number of RECs, it is open to the builder (or supplier of the water heater) to demonstrate compliance via the use of the method of calculation in AS/NZS 4234.

Some States have different requirements according to whether mains natural gas is available (Table 11). However, this introduces additional compliance factors. It would be necessary to define ‘availability’ in terms of both space and time, and there would be considerable scope for confusion and legitimate request for exemption.

If the rule were ‘natural gas to be available at the boundary of the site’ there could still be many cases where the building is a long way from the boundary, or where the site is rocky or steep and connection would be prohibitively expensive. With new housing subdivisions, gas may not be available at the time of lodging the building or planning application, but may will be available by the time of construction. There could be rules or appeal procedures to handle these situations but the question is whether the benefits would outweigh the potential costs.

Adopting the same requirement irrespective of whether natural gas is available or not would leave it to the home builder to select the optimum response from the list of permitted options, according to their own investigations and assessments of the energy sources available. In most cases, the most cost-effective compliance option will be natural gas – especially if there is an intention to also use it for cooking and space heating – so a builder has every incentive to verify and to encourage gas availability, eg by negotiating with the gas supplier.

If builders in a gas-available areas wish to use a solar water heater they should be free to boost with electricity or natural gas. The capital cost of a solar-electric unit is nearly always lower than a solar-gas unit of equal efficiency (quite apart from any connection costs to gas) so by obliging the builder to use the higher cost solar option (solar-gas), the middle-cost option (solar-electric) would be excluded. This is likely to *reduce* the probability that solar will be used in gas-connected areas, since there will be no lower-cost solar option and the capital cost penalty of using solar compared with conventional gas will be higher.

Use of Electric Resistance Water Heaters in Limited Situations

A building, district or region not connected to the main grid may get its electricity supply from a renewable energy source such as photovoltaics, wind or hydro power. In these cases using an electric resistance water heater would meet the 100 g CO_2-e/MJ performance requirement. However, this option should only be available where the Class 1 building has its own electricity supply system, or is connected to a local supply grid that has a high enough renewable generation component for the proponent to be able to demonstrate an emissions intensity of less than about 80 gCO_2-e/MJ supplied to the water heater, to allow for storage heat losses in the water heater itself.

It would also be reasonable to permit electric resistance water heaters of a limited size where hot water needs are very low, and/or there are isolated points of hot water use a long way from the main water heater.

A building with one bedroom or no separate bedroom (ie a ‘studio’ or ‘bed-sitter’) will most likely have only one or two occupants, and hence household water use will be low. Electric resistance water heating is often the most cost-effective solution for very low hot water demand, and low hot water demand will also limit the greenhouse gas emissions. (Instantaneous electric water heaters will lead to lower emissions than storage water heaters because they avoid the electricity consumed by storage or ‘standing’ losses, but there is only one supplier at present). It is expected that there will be very few Class 1 buildings of this type.

In some buildings there may be a bathroom or laundry that is so remote from the other points of hot water use that supplying it from the main water heater would involve long waiting times before the water reaches an acceptable temperature, so resulting in both energy and water wastage. This clause can only be invoked if the main water heater is compliant, and for one additional water heater only.

The most efficient form of electric resistance water heating in these exceptional situations would be the electric instantaneous type, because it would not have standing losses. The heat loss for a 50 litre delivery storage tank is about 1.1 kWh/day, so the annual loss is about 400 kWh (1.44 GJ). The useful energy in hot water for a daily drawoff of 70 litres is 4.52 GJ (in Zone 3), so about a quarter of the electricity supplied to the water heater is lost. Using an instantaneous water heater would typically reduce the greenhouse emissions by at least a quarter, and a greater ratio where the water heater is rarely used. However, it is not advisable to prohibit the use of electric storage water heaters entirely, because:

- at present there is only one supplier of electric instantaneous water heaters in Australia; and

- some models of instantaneous water heater need a three-phase electricity supply, and requiring this additional metering and wiring cost would conflict with the objective of adding this provision, which is to allow a low-cost option in limited circumstances.

Alternatives to the Proposed Regulation

Separate State and Territory Regulations

It would be expected that the jurisdictions with requirements for water heaters in new houses (see Table 11) would retain them if the proposed general provisions are not included in the BCA. Some may choose to do so even if the provisions are included.

The State provisions have obviously been effective in changing the mix of water heaters installed in new dwellings roughly in line with the objectives of the proposed BCA provisions. However, there has been no consistent public assessment of whether they have been cost-effective.

Their continuation would mean:

- Builders and suppliers of water heaters would have to continue to observe different provisions in different jurisdictions;

- Whether a property or building is capable of being connected to natural gas would remain a compliance issue in some jurisdictions, with continuing differences in rules and in their interpretation.

Adding the proposed regulations to the BCA would offer the possibility of national consistency, and if adopted by some or all jurisdictions would reduce the costs to builders and water heater suppliers of complying with varying State provisions.

Energy labelling

The labelling of water heaters with their energy consumption or relative level of efficiency has had little impact on the general water heater market, and even less impact on the market for water heaters in new houses.

Buyers of whitegoods such as refrigerators usually inspect and compare models in showrooms, where they are exposed to energy labels, and they usually buy the products for their own use, so if they choose they can weigh capital cost against energy efficiency and other features.

Water heaters are generally purchased by or on the advice of builders, plumbers or other intermediaries who have little or no incentive to take the information on energy labels into account. Even where users order water heaters directly, they would rarely visit a showroom to inspect a physical sample.

These market conditions have led to the rejection of energy labelling as a workable energy efficiency measure for electric water heaters, in favour of minimum energy performance standards (MEPS) (GWA et al 1993). The fact that gas water heaters carry energy labels is a carryover from the time when the gas utilities and then the Australian Gas Association managed the program in the 1980s (MEA et al 2002). One of the reasons for now considering MEPS for gas water heaters is the limitations of the labelling program (E3 2008/07).

Even if energy labelling (either physical or on brochures or websites) were effective, it would only influence choice within the same technology and energy type. The achievement of the objectives of the proposal rely on influencing choice towards low greenhouse forms of water heating, whether of different technology (eg solar vs conventional, electric heat pump vs electric resistance) or different energy form (eg gas vs electric).

Therefore energy labelling alone would not achieve the objectives of the proposed BCA Provisions.

Minimum Energy Performance Standards

Minimum energy performance standards have been shown to be effective in increasing the level of efficiency of products of specific types and energy forms. In water heating alone, mandatory MEPS have been used to reduce heat losses in electric resistance water heaters. Higher MEPS are also being proposed as a means of raising the average energy efficiency of gas water heaters (the MEPS levels currently in place are so low they have no effect on the market).

MEPS have the advantage that, unlike energy labelling, they also impact on products purchased by intermediaries and other 'label-indifferent' buyers. However, they share the limitation that they operate only within technology and energy groups, not across them. The achievement of the objectives of the proposal rely on influencing choice towards low greenhouse forms of water heating, whether of different technology (eg solar vs conventional, heat pump vs resistance) or different energy form (eg gas vs electric).

Therefore MEPS alone would not achieve the objectives of the proposed BCA Provisions. In fact, the proposed provisions represent a means of overcoming the limitations of conventional MEPS, by applying a performance standard expressed in environmental impact terms – in this case g CO_2-e/MJ – rather than technical efficiency (Useful Energy/Delivered Energy).

Incentive schemes

The Commonwealth, SA, NSW, Victoria and WA governments offer incentive payments for the installation of solar and heat pump water heaters and, in some cases, for gas water heaters. The schemes vary significantly with respect to:

- The type of water heater which must be replaced;
- Whether available throughout the State, only in gas-connected areas or only in non-connected areas;
- Whether available for entire systems only, or for panels added to conventional systems;
- The performance requirements for models eligible to attract incentives, which may be expressed in terms of REC number eligibility or number of panels;
- The amount available and how the amount varies with performance or other conditions;
- The point and timing of payments: whether paid to the supplier to defray the cost of purchase, or claimable by the purchaser after the installation, in which case the purchaser must meet the full capital cost;
- The rules for combining the value of incentives with other incentive schemes or with RECs values;
- The administrative arrangements and verification rules.

These differences, and the various lists of complying models which they generate, are the source of considerable confusion and friction among water heater suppliers, builders and buyers.

Few of these incentive schemes are available for installations in new houses, ie where there is no replacement of an existing water heater. The price support from the sale of RECS is however available for all eligible solar and heat pump water heaters, wherever in Australia they are installed and whether on a new house (or indeed on any class of building) and as a replacement for an existing system.

In theory, jurisdictions could extend the eligibility for rebates and incentives to new houses. However, the main purpose of the rebates is to influence choice at times where it cannot be mandated, and where it is possible to specify conditions that increase the probability that the incentive will contribute to the desired outcome (ie the replacement of an electric resistance water heater with one of lower greenhouse impact).

Offering incentives for water heater installations in new houses, but not otherwise constraining the choice, would raise a number of issues:

- Very high incentives would need to be offered to completely overcome the initial capital cost advantage of electric resistance water heaters and so leave the builder better off. A lower amount is enough to motivate replacement purchasers, since they are in a position to capture the running cost advantages;

- Devising rules and amounts which had a reasonable chance of achieving the desired outcomes would be difficult: if rebates were only offered for solar and were high enough to be effective, then gas (the most cost-effective low greenhouse option) could be squeezed out in favour of less cost–effective options;

- There could be no prevention of ‘free-riding’ – ie the takeup of rebates by those who would have taken the desired action anyway;

- The administrative costs per transaction are high.

To sum up, the value of incentives offered by governments (ie the taxpayer) in the new home market would need to be very high, in order to even partially achieve the objectives of the proposed BCA provisions. If this course were pursued, it would probably end up diverting funding from incentives in the replacement market, where they are far more likely to be cost-effective and where there few regulatory alternatives (at least for the time being).

Therefore the offer of incentive payments would not achieve the objectives of the proposed BCA Provisions.

4. Cost-Benefit Analysis

Overview

The range of water heater types suitable for installation in Class 1 dwellings is fairly narrow, and although there is a wide range of sizes and models, their performance is fairly standardised. The responses of house builders/owners to the proposed provisions in the BCA is also relatively straightforward to predict. This lends itself to conventional cost-benefit analysis, in which the net present value (NPV) of the 'current regulations' (CR) or Business as Usual (BAU) cases can be directly compared with the NPV of the 'proposed regulation' (PR) cases.

Costs and benefits are accrued for new houses expected to be built in each State from 2010, when the proposed changes to the BCA would take effect, and 2020 inclusive, ie 11 years or 'cohorts' of buildings. As recommended in *Economic evaluation of energy efficiency standards in the Building Code of Australia: Standardising the cost-benefit analysis* (CIE 2008), a discount rate of 7% is used, with sensitivity tests at 3% and 11%.

Concepts and Methods

Private and social costs

Private cost of hot water

The private cost of hot water is generally defined as the sum of the dollar amounts that the user pays. It comprises:

(a) the capital cost of the water heater;
(b) the cost of installing the water heater;
(c) the cost of connecting the building to services other than water and electricity (which are always connected in any case) if such additional service (eg gas) are required by the water heater;
(d) payments for water, gas and electricity, and
(e) the cost of repairing and maintaining the water heater.

The prices paid by users may be affected by government interventions in markets for water heaters and energy, for example, the additional cost of energy under the Carbon Pollution Reduction Scheme (CPRS) or the value of renewable energy certificates (RECs) for water heaters that are certified under the RET scheme. The financial impact of such interventions on households is included in the assessment of private costs and benefits.

A more complete definition of private costs would include allowances for the quality of the hot water service as measured by waiting times, the incidence of interruptions, capacity to simultaneously supply multiple users, the ease of temperature control, and exposure to accidental scalding. These can be ignored where the options under consideration have broadly similar quality characteristics. However, exceptions should be acknowledged and the value of quality changes should be assessed where feasible.

Social cost of hot water

The social cost of hot water is the sum of costs incurred by all members of the community to supply hot water to a particular user. Social cost need not be the same as the private cost and may be significantly different in the presence of external costs and benefits or imperfect competition in the supply of relevant goods and services.

External costs and benefits

Up to now the main external cost associated with the selection of a water heater has been its contribution to greenhouse emissions. One important external benefit has been the potential to positively influence the direction and pace of technological change and learning and thereby reduce future costs, including the benefits of 'scaling up' and producing on a larger scale . However, these effects are no longer external now that government has implemented measures designed to internalise them and so bring private costs into alignment with social costs.

- The greenhouse externality is internalised in this RIS by assuming that the CPRS will impose an appropriate carbon price on energy users;

- The technological externality is internalised in this RIS by assuming that the market value of RECs reflects the beneficial technological effects of expanding the market for renewable technologies, and that at the majority of this value is passed on to buyers, rather than captured as higher profits by suppliers.

Supply of energy network services

Individual energy users should be able to look to their tariff schedules to calculate the value of energy savings. However, electricity and gas tariffs include charges to recover the cost of energy networks, that is, the costs of the poles, wires, transformers, pipes and pumps that transmit and distribute energy from generators to users. These charges are regulated and network regulators may increase network charges, or reduce them by less, in response to measures that reduce the amount of energy that the networks carry. They would do this if the networks cannot otherwise cover their costs, which are relatively fixed, as their revenue falls.

A considerable amount of information would be needed to calculate any upward pressures on network charges, which are paid by the broader community, and offset them against estimated value of energy savings. It would be necessary to take into account projections of network demand that allow for effects of the entire portfolio of energy efficiency and greenhouse gas abatement policies, not just those covered in this RIS

It would also be important to allow for the load profile (ie daily and seasonal variation) of the energy savings. Positive feedback effects are greater where the energy savings do little to reduce peak loads on energy networks, reducing the revenue to networks but leaving their costs relatively unchanged. Conversely, the effects are smaller where the energy savings are more concentrated in peak periods. Energy savings with a sufficiently 'peaky' profile may even have negative feedback effects, that is, reducing network charges.

To quantify these effects is clearly beyond the scope of this RIS. However, the possible impacts on networks and energy utilities of the proposed measures are discussed qualitatively in Chapter 5.

Gas Connection Costs

One likely effect of the proposed measure is a higher rate of connection of new houses to natural gas networks than would otherwise be the case. This will mostly be in areas that are or would have been supplied with natural gas anyway, so the marginal costs are the labour and materials associated with linking the building to the mains in the street (including the meter costs). These are estimated at about $1,000 per dwellings (ABCB 2007).

However, network price regulators generally allow gas network operators to subsidise the costs of connection and recover them in the network charges to all other gas users, because the higher the total throughput the lower the average network charge per MJ.. This is analogous to the government's policy to require all electricity users to subsidise individual purchasers of solar water and heat pump water heaters (via RECs) on the rationale that the higher the volume of production, the lower the average price. Therefore, just as the value of RECs to individuals water heater buyers is taken into account in the calculation of private costs and benefits, so is the value of the gas connection subsidy.

Energy price and greenhouse intensity projections

When the cost-benefit modelling was carried out, it was assumed that the Carbon Pollution Reduction Scheme (CPRS) would be implemented in mid-2010, and that energy prices and the greenhouse intensity of electricity supply would follow the profiles projected by The Treasury in *Australia's low pollution future: the economics of climate change mitigation* (The Treasury, 2008).

Just before the completion of this RIS, the Government announced that the start of the CPRS would be delayed until mid-2011 and that 'permits will cost $10 per tonne of carbon in 2011-12, with the transition to full market trading from 1 July 2012.'[10] The Government also announced 'a commitment to reduce carbon pollution by 25 per cent of 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of CO_2 equivalent in the atmosphere at 450 parts per million or less by 2050.'

Given this new uncertainty, the energy price increase and greenhouse gas reduction trends projected in Appendix 2, which form the basis of the modelling could be delayed by up to 2 years, and the B/C ratios based on these trends are on the high side. However, the potential impact will be small compared with that of a number of other variables, where the impact of uncertainty has been explicitly modelled via sensitivity testing, ie:

[10] http://www.environment.gov.au/minister/wong/2009/pubs/mr20090504.pdf. It is assumed that stated price cap is intended to be $10/tonne CO_2 ($10/tonne C is equivalent to $3.64/ tonne CO_2).

- Average household hot water demand;

- The capital cost of water heaters, including the impact of various levels of RECS prices on the cost of solar and heat pump water heaters.

The recent Government announcement raises the possibility of a ‘CPRS-25’ policy setting that would result in much higher upward pressure on energy prices than the ‘CPRS-15’ scenario, which was the previous upper extreme of potential reduction targets.

Given that the impacts of the policy change is within the range of uncertainties modelled in this RIS, and that there is now a potential for a more stringent policy setting that would drive energy prices higher, modelling based on the CPRS-5 scenario as it stood prior to the policy revision is still considered a robust basis for assessing the costs and benefits of the proposed policy measure.

The general residential household electricity energy prices for each State in Appendix 2 were developed by Syneca Consulting from the ‘CPRS-5’ projections in Treasury (2008). Off-peak electricity prices consistent with Treasury projections were also developed for the States which offer OP tariffs (both restricted hours and extended hours tariff were projected). Syneca Consulting also developed natural gas and LPG price projections consistent with Treasury modelling.

All energy prices are in constant (ie real) 2008 dollars, because they are based on Treasury’s 2008 modelling. If today’s (current) energy prices are to be compared with those in the modelling they should be deflated by CPI rises since mid 2008. Also, if current energy prices were used current capital costs should also be used (ie inflated from mid 2008) so the benefit/cost ratios would be much the same.

General Methodology

The analysis estimates the cost of supplying hot water services in new houses, under a range of scenarios:

- a No Regulations (NR) scenario, in which there are no special water heater requirements affecting new houses, whether in State regulations or the BCA (this scenario is detailed in Appendix 5 only);

- a Current Regulations (CR) scenario, in which those jurisdictions with regulations in place retain them, but other jurisdictions take no action;

- a Proposed Regulations (PR) scenario, in which those jurisdictions without regulations in place adopt the proposed BCA provisions.

The cost and benefits to the community of adopting the proposed BCA provisions for Class 1 buildings is calculated in the following steps:

1. Estimate the average lifetime capital cost, installation costs and energy costs for a single water heater of each main type (electric, gas, solar-gas, solar-electric and heat pump), based on assumed average efficiency, hot water demand, service life, capital cost and energy price. (Differences in service life are take into account by assuming a proportional capital replacement cost for water heaters with shorter service life than the maximum of 14 years);

2. For each State and Territory, estimate the percentage of new houses to be fitted with each water heater type under each of the NR, BAU and PR scenarios;

3. Estimate the number of new houses to be constructed each year in each solar Zone in each State and Territory, based on projected house completions (in CIE 2008) and the estimated share of completions in each Solar Zone (Table 13). It is assumed that future completions will be allocated to each Zone in proportion to the existing stock in each Zone;

4. Multiply the number of new homes to be constructed each year from 2010 to 2020 by the projected market share for each water heater type to give the number of water heaters of each type in each year's cohort of new houses;

5. Multiply the lifetime service costs (capital and energy) of each water heater type by the number installed in each cohort, to give the total net present value of the cost incurred by the community to provide water heating services for that cohort (Discounting future costs at a rate of 7%, with sensitivity at 11% and 3%);

6. For each jurisdiction and for Australia as a whole, compare the total community costs of water heating in the PR case with the CR case. If the PR costs are lower than the CR costs, there is a net community benefit. As is usual for BCA proposals, the PR case is also compared with the NR case, where there are no regulatory requirements for the measure under consideration;

7. Compare the projected greenhouse gas emissions from water heating in the PR with those in the CR and NR cases;

8. Consider the other impacts, costs and benefits from the changes in the water heater market that would occur under each policy scenario.

Table 13 Number of projected Class 1 building completions, Australia 2010-2020

	Zone 1	Zone 2	Zone 3	Zone 4	Total	Share
NSW			220.0		220.0	21.4%
Vic			40.0	262.4	302.4	29.4%
Qld		5.7	242.5		248.2	24.1%
SA		2.9	64.6		67.5	6.6%
WA		6.2	156.8		162.9	15.8%
Tas				4.8	4.8	0.5%
NT	8.8	6.2			14.9	1.5%
ACT			7.3		7.3	0.7%
Total	8.8	20.9	731.2	267.2	1028.1	100.0%
Share	0.9%	2.0%	71.1%	26.0%	100.0%	

Source: State estimates from CIE (2008). Zone breakdown by GWA. All values thousands.

Findings

Individual Costs and Benefits

The costs of water heating options for new houses in each of the 13 combinations of State and Solar Zone in Table 13 can be illustrated by a diagram, such as Figure 12 (for NSW, Zone 3) and Figure 13 (for Victoria, Zone 4; others are at Appendix 3).

Figure 12 illustrates the total lifetime costs of each option, if installed in 2010, the first year of impact of the proposed provisions. The lifetime cost is broken down by the capital cost and the NPV, at 7% discount rate, of the stream of projected energy costs, calculated by multiplying the estimated average energy use for a medium hot water delivery (36.1 MJ/day). Where water heaters use both electricity and fuel, the costs of each is shown separately. The share of the natural gas connection cost allocated to the water heaters is also shown.

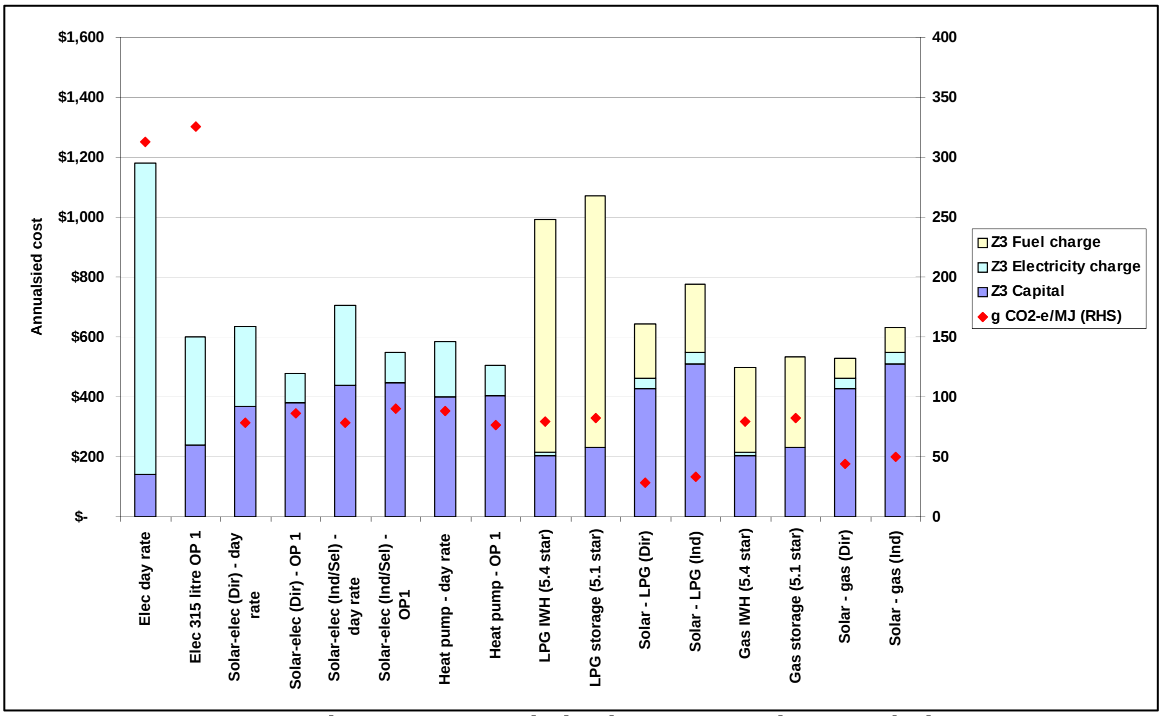
The water heater capital costs in Figure 12 are based on a water heater capable of ‘medium’ hot water delivery, of about 200-250 l/day, and the running costs are based on about 200 l/day. If the same water delivered less hot water, the capital costs would be the same, but the energy costs would be lower, so the additional capital costs of solar and heat pump options would take longer to recover.

The relative ranking of options by lifetime cost in each State and Zone is the same at low hot water delivery as at medium delivery. Figure 12 indicates that in NSW, the solar-electric (OP1 tariff), heat pump (OP1), 5 star gas and cheaper solar-gas option all have similar low lifecycle costs. The next group up is solar-electric and heat pump (day rate), the lower cost solar-LPG and the higher cost solar-gas. The highest cost group of the complying options is LPG..

In an area where natural gas is not available, the least cost options among the ‘acceptable construction practices’ would be solar-electric and heat pump, which are comparable in cost to off-peak, the least-cost of the excluded options. Therefore even in non-gas areas house builders are likely to be no worse off, and in most cases better off, through the exclusion of electric storage water heaters. LPG would also be a permitted option, but the very high running costs would make it uneconomic except where occupation was intermittent and/or water use was low. At lower hot water use the cost disadvantage of LPG compared with solar-electric is much reduced. LPG would also offer a fallback option in areas or buildings where for some reason solar or heat pump were unacceptable, or the local climate made them ineffective.

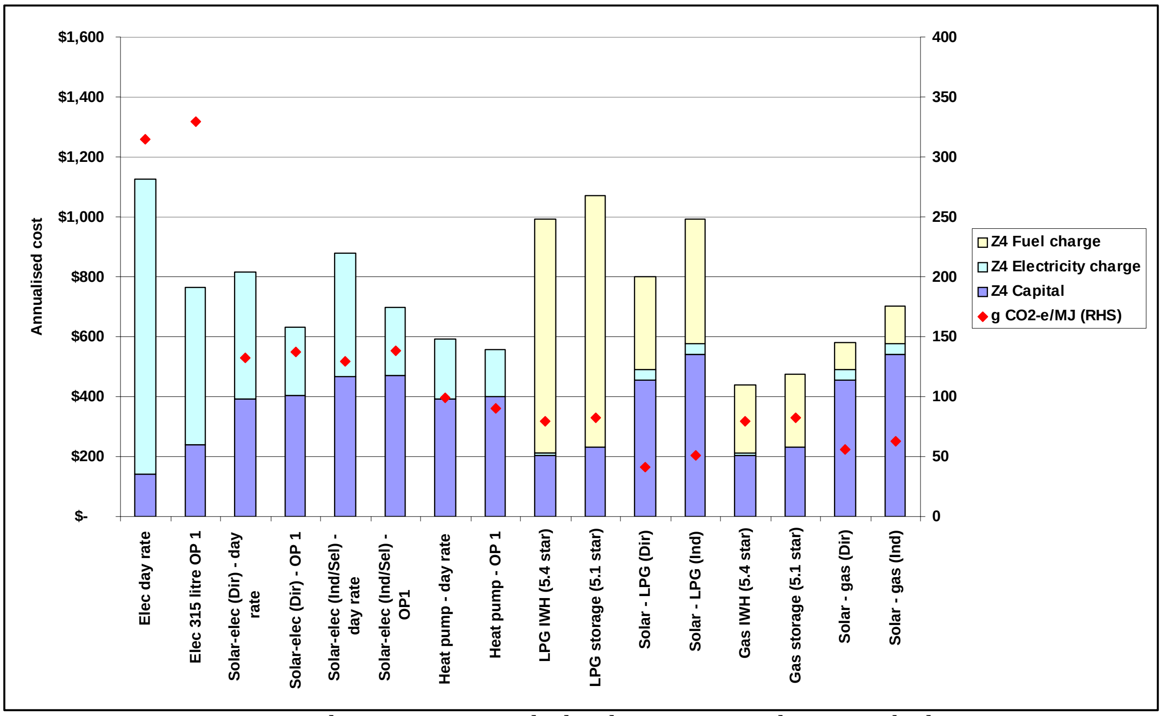
In Victoria, the cost advantage of conventional natural gas is even more pronounced. The next highest cost group is heat pumps and the lower-cost solar-gas, followed by higher cost solar-gas and the more efficient types of solar-electric. As in NSW, the highest cost group is LPG and day rate electric.

Figure 12 Estimated lifetime cost of water heating, NSW, Zone 3 (projected energy prices discounted at 7%), medium delivery



<NSW F.xls> g CO2-e/MJ calculated using proposed BCA method

Figure 13 Estimated emissions intensity and lifetime costs of water heating, Victoria, Zone 4 (projected energy prices discounted at 7%), low delivery



<NSW F.xls> g CO2-e/MJ calculated using proposed BCA method

Community Costs and Benefits – Compared with Current Regulations

The clearest way to quantify the impacts of the proposed BCA regulations is to compare the outcomes with a ‘No Regulations’ case. The modelling input assumptions for the analysis are detailed in Appendix 4. The outputs, with cost-benefit analyses and sensitivity tests, are at Appendix 5.

However, the ‘No Regulations baseline is an artificial one, since five states and the ACT already have requirements for water heaters in new Class 1 buildings. This section compares the Proposed Regulations case with the Current Regulations case in each State, and the implications for that State if it were to adopt the proposed BCA provisions in place of its current rules.

New South Wales

A recent review of BASIX approvals indicates that the incidence of electric water heaters in new houses has already fallen below 1% (BASIX 2008). Therefore there would be virtually no difference in water heater outcomes between the Proposed Regulations and the Current Regulations.

NSW could incorporate the proposed BCA provisions into the BASIX scheme, because even if electric water heating is removed from the list of possible BASIX choices, the remaining options still cover a range of greenhouse gas impacts, so tradeability of water heating against other house design options could still be retained.

Victoria

Victoria’s current ‘5 Star’ regulations require new Class 1 buildings to have either a solar water heater or a rainwater tank (or access to non-mains water supply). Where natural gas is available, the solar water heater must be boosted by natural gas. The Victorian Government advises that at present 68% of new houses take the solar water heater compliance option.[11]

If Victoria adopted the proposed BCA provisions in place of its current ‘5 Star’ regulations, it is likely that most builders and their clients would try to minimise the initial capital cost of water heating, and gas water heaters would again dominate the market in gas-available areas, as was the case before the ‘5 Star’ measures were implemented.

Therefore in the parts of Victoria where gas is available, the Proposed Regulations case would result in *higher* use of gas than under the current regulations, but the capital cost of water heaters would fall more than the increased expenditure on energy, so the benefits would outweigh the costs.

In the parts of Victoria where gas is not available, the Proposed Regulations would result in lower use of electricity than under current regulations, because solar-electric and heat pump water heaters would displace electric resistance. The lifetime costs of

[11] Victorian Department of Planning and Community Development, Comments on proposed energy efficiency provisions, Building Code of Australia 2010, October 2009.

solar-electric water heaters is lower than for electric resistance, so the benefits would outweigh the costs.

To sum up, if Victoria adopted the proposed BCA provisions in place of its current ‘5 Star’ regulations:

- Gas consumption for water heating in gas-connected areas would be somewhat higher;

- Electricity consumption for water heating in all areas would be somewhat lower;

- Combined greenhouse gas emissions for all cohorts of house built 2010-2020 would be about 25% (852 kt CO_2-e) higher than under current regulations; and

- The financial benefits in both gas and non-gas areas would outweigh the costs (even with greenhouse emissions permit prices internalised in energy prices). The B/C ratio at a discount rate of 7% would be over 3, and the average capital cost of new water heaters would fall by $847.

The decrease in average capital cost of new heaters is explained by a much lower assumed rate of installation of gas-boosted solar water heaters than under its current regulations, and a much higher rate of installation of 5 star gas water heaters. This would significantly lower the average cost of water heaters in new homes, but would result in higher greenhouse gas emissions and higher energy running costs. The financial benefit of the lower capital costs would significantly outweigh the higher energy costs (on a discounted cashflow basis). These impacts are illustrated in. Table 14 to Table 16.

The proposed BCA regulations, if adopted in Victoria, would require some change to the present ‘5 Star’ regulations, because the proposed regulation does not link the water heater selection to the installation of a rainwater tank or any other condition.

Queensland

The Proposed Regulations are identical to the current Queensland regulations, with the exception that the minimum solar and heat pump performance requirement for houses with 5 or more bedrooms would be 28 RECS rather than 22 RECS. As the share of new houses with more than 4 bedrooms is negligible, the Proposed Regulations would lead to virtually identical outcomes as the current regulations, so there would be no differences in capital costs, energy costs, energy use or emissions.

South Australia

The Proposed Regulations are similar to the current SA regulations, with the exception that the minimum solar-electric and heat pump performance requirements are expressed in terms of system size rather than number of bedrooms (Table 12). Also, there are no SA performance requirements for solar-gas, while the Proposed Regulations would impose the same requirements as for solar-electric.

The lowest number of permissible RECs for a complying water heater in SA is 18. The Proposed Regulations would allow 14 REC water heaters in up to 9% of new homes (assuming that the bedroom number share is the same in SA it is nationally). This may allow somewhat lower capital cost products, and lower energy savings in that segment, compared with current regulations.

However, the SA regulations also allow 18 REC water heaters in any size of dwelling, and it is quite likely that some 3 bedroom homes will have 18 REC water heaters, which would be a rational choice if the party building the home designed it for lower hot water use. The Proposed Regulations would require systems with a minimum of 22 RECs in 3 and 4 bedroom homes. This may require somewhat higher capital cost products, and higher lower energy savings in that segment, compared with current regulations.

The imposition of a minimum requirement for solar-gas would have little effect. A solar-gas water heater with in-tank boost will give a somewhat lower number of RECs than a comparable solar-electric model with the same number of solar collectors, but a solar-gas water heater with in-line boost will give somewhat higher number of RECs.

All in all, the Proposed Regulations would lead to very similar outcomes as the current regulations, although there may be small changes according to dwelling size.

Western Australia

The Proposed Regulations are very similar to current WA regulations, except that the criteria under the AS/NZS 4234 DTS compliance option are slightly different.

The WA requirement is '[when tested] in accordance with AS 4234-1994, achieves a minimum energy saving of 60% for a hot water demand level of 38 MJ/day in Zone 3' (Table 12).

- For houses of less than 3 bedrooms, the Proposed Regulations require a minimum energy saving of 40% for a hot water demand of 18 MJ/day, so are less stringent than the current WA requirements;

- For houses of 3 and 4 bedrooms (the largest market segment by far), the Proposed Regulations require a minimum energy saving of 60% for a hot water demand of 36 MJ/day, so are virtually identical to the current WA requirements;

- For houses of more than 4 bedrooms, the Proposed Regulations require a minimum energy saving of 60% for a hot water demand of 54 MJ/day, so are more stringent than the current WA requirements.

All in all, the Proposed Regulations would lead to very similar outcomes as the current regulations, although there may be small changes according to dwelling size.

Tasmania

Tasmania has no requirements for water heaters in new houses at present. ABS (2008) reports that 79% of existing water heaters in Tasmania are electric, 4.2% gas and 2.5% solar. Assuming that the great majority of the 14.2% of those who responded 'don't know' also have an electric water heater, electricity could account for about 90% of water heaters installed.

Judging by natural gas connection rates, about half the 'gas' water heaters would be using natural gas and half LPG. The natural gas market has developed rapidly since the introduction of natural gas to Tasmania in 2004. By May 2008 it was potentially available to 42,000 residential and small commercial customers, or about 25% of all households, and 4,550 (about 2.4%) were actually connected.[12]

It is expected that the natural gas share of the new home water heater market would increase in any case, but adoption of the proposed BCA provisions would accelerate this trend. Where gas is not available the options would be solar-electric, heat pump and LPG.

Some models of heat pump require electric resistance boosters for short periods for boosting in low temperatures and for de-icing, while others can meet these objectives without resistance heaters. The heat pump test standard currently being developed will clearly differentiate between these types and include appropriate performance penalties in the REC ratings.

Tasmanian conditions require that flat-plate solar water heaters have effective frost protection, such as indirect heating collectors. Also, either an additional panel or higher-efficiency collectors with selective surfaces would be necessary to achieve the number of RECs in Zone 4, as required in the proposed provisions. The evacuated tube design, which does not require additional frost protection, is probably the most cost-effective type of solar water heater for Tasmania. A higher average cost of solar water heaters in Tasmania has been taken into account in the modelling.

It is assumed that in the No Regulations case, the water heater mix in new houses would be 75% electric. 2% heat pump, 15% natural gas. 5% LPG and 3% solar-electric, and in the Proposed Regulations case 10% heat pump, 50% gas, 13% LPG and 27% solar-electric. This leads to higher capital costs (an average \$552 per house) but lower energy costs (an average saving of about \$ 1,893 per house NPV – see Table 25). The B/C ratio of the Proposed Regulation is about 3.6 at a discount rate of 7%.

A modest 9 kt CO_2-e reduction in greenhouse gas emissions compared with the No Regulations case is expected. The greenhouse intensity of electricity supplied, while low at present, is projected to rise, as new generation serving Tasmania (some of it located in Victoria) will be predominantly gas-fired rather than renewable.

The National Hot Water Strategic Framework states that 'the framework provides for the reduction of greenhouse gas emissions associated with water heating …except where the emissions intensity of the public electricity supply is low…' (MCE 2008). However, since the implications of this clause have not been tested in detail, for the purpose of this analysis it has been assumed that all jurisdictions with either no or less stringent regulations adopt the proposed regulations. If this clause is seen to be applicable in Tasmania, due to their historically high hydro component in their electricity supply, the overall impacts of the measure would reduced by 9 kt CO_2-e.

[12] http://www.dier.tas.gov.au/__data/assets/pdf_file/0017/33731/DIERAnnualReport07-08.pdf.

Northern Territory

The Northern Territory has no requirements for water heaters in new houses at present, but is unusual in that the majority of water heaters sold are already solar-electric.

While natural gas is available in parts of Darwin and other NT towns, there is little household demand for reticulated gas. It is estimated that in the No Regulations case the water heater share in new houses would be 28% electric, 4% HP, 4% HP, 5% gas, 4% LPG and 59% solar-electric. It is estimated that the Proposed Regulations would switch the entire electric market share to solar-electric, without affecting the gas share. This leads to higher capital costs (an average $111 per house) but lower energy costs (an average saving of $430 per house NPV – see Table 25). The B/C ratio of the Proposed Regulation is 3.2 a discount rate of 7%. There would be a reduction of about 48 kt CO_2-e in emissions.

Australian Capital Territory

The provisions in the ACT regulations, scheduled to take effect in October 2009, are very close to those proposed to the BCA. The main differences are:

- Solar and heat pump water heaters in the ACT will have to meet both performance criteria – minimum number of RECs *and* percentage energy – whereas the proposed BCA regulations require water heaters to meet either one of the performance criteria. In this respect the proposed regulations are somewhat less stringent;

- The ACT requirements allow electric water heaters only in non-gas areas (in limited situations), whereas the proposed regulations would allow electric water heaters in a slightly wider range of situations and in all areas. In this respect the proposed regulations are somewhat less stringent,

All in all, the Proposed Regulations would lead to very similar outcomes.

Combined costs and benefits – Jurisdictions without current regulations

It is assumed that the States with regulations already in place for water heaters in new houses will either retain them or adopt the proposed BCA provisions if these do not lead to a reduced greenhouse impact.

For NSW, Queensland, SA, WA and ACT, adoption of the Proposed Regulations in place of their current rules would give virtually identical outcomes, so would not lead to energy or greenhouse impacts beyond BAU. For Victoria, the Proposed Regulations would lead to higher greenhouse gas emissions than the current regulations, so it is assumed that Victoria will retain its present regulations.

Therefore the capital, energy and greenhouse impacts of the Proposed Regulation would be limited to those jurisdictions that do not currently have regulations: Tasmania and the NT.

The last row of Table 25 summarises the combined impacts of the Proposed Regulation for these two jurisdictions. The Proposed Regulations would lead to higher capital costs (an average $211 per new house) but lower energy costs (an average saving of $ 784 per house). The B/C ratio of the Proposed Regulation is 2.9 at a discount rate of 7%. There would be a reduction of about 58 kt CO_2-e in emissions over the period 2010-2020.

Table 14 Summary of costs and benefits PR vs CR, 7% discount rate (Medium hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	0.0	0.0	0.0	0	0	0	0	0.0
VIC	-256.2	80.6	-175.6	3.2	852	-847	267	2.8
QLD	0.0	0.0	0.0	0	0	0	0	0.0
SA	0.0	0.0	0.0	0	0	0	0	0.0
WA	0.0	0.0	0.0	0	0	0	0	0.0
TAS	2.5	-9.0	-6.5	3.6	-9	522	-1893	-2.0
NT	1.7	-6.4	-4.8	3.9	-48	111	-430	-3.2
ACT	0.0	0.0	0.0	0	0	0	0	0.0
Australia	-252.1	65.2	-186.9	3.2(a)	794	-245	63	0.8
Tas, NT	4.2	-15.5	-11.3	3.7	-58	211	-784	-2.9

(a) Note that in Victoria benefit is lower capital and cost is higher energy, whereas in Tasmnania and NT cost is higher capital and benefit is lower energy.

Table 15 Summary of costs and benefits, PR vs CR, 3% discount rate (Medium hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	0.0	0.0	0.0	0	0	0	0	0.0
VIC	-308.2	125.7	-182.5	2.5	852	-1019	416	2.8
QLD	0.0	0.0	0.0	0	0	0	0	0.0
SA	0.0	0.0	0.0	0	0	0	0	0.0
WA	0.0	0.0	0.0	0	0	0	0	0.0
TAS	3.1	-14.4	-11.3	4.7	-9	647	-3018	-2.0
NT	2.0	-9.8	-7.8	4.9	-48	132	-653	-3.2
ACT	0.0	0.0	0.0	0	0	0	0	0.0
Australia	-303.1	101.5	-201.6	2.5(a)	794	-295	99	0.8
Tas, NT	5.1	-24.1	-19.1	4.8	-58	257	-1225	-2.9

(a) Note that in Victoria benefit is lower capital and cost is higher energy, whereas in Tasmnania and NT cost is higher capital and benefit is lower energy.

Table 16 Summary of costs and benefits, PR vs CR, 11% discount rate (Medium hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	0.0	0.0	0.0	0	0	0	0	0.0
VIC	-216.6	54.5	-162.1	4.0	852	-716	180	2.8
QLD	0.0	0.0	0.0	0	0	0	0	0.0
SA	0.0	0.0	0.0	0	0	0	0	0.0
WA	0.0	0.0	0.0	0	0	0	0	0.0
TAS	2.0	-6.0	-3.9	2.9	-9	429	-1249	-2.0
NT	1.4	-4.4	-3.0	3.1	-48	95	-297	-3.2
ACT	0.0	0.0	0.0	0	0	0	0	0.0
Australia	-213.2	44.1	-169.0	3.9(a)	794	-207	43	0.8
Tas, NT	3.5	-10.4	-6.9	3.0	-58	176	-527	-2.9

(a) Note that in Victoria benefit is lower capital and cost is higher energy, whereas in Tasmnania and NT cost is higher capital and benefit is lower energy.

5. Other Impacts

Supplier Price Competition

No new types or models of water heater would need to be introduced for builders of new houses to comply with the proposed regulations. Many of the existing models and types would be permitted under the proposed regulations.

Of the 45 models of gas storage water heater registered with the AGA, 10 models offered by 3 separate manufacturers are rated 5 stars or higher (Table 7). However, none of these are suitable for internal installation.

Of the 92 models of gas instantaneous water heater registered with the AGA, 81 models offered by 8 separate manufacturers are rated 5 stars or higher (Table 7). Several are suitable for internal installation.

There are over 6,800 solar-electric, solar-gas and heat pump water heaters registered with ORER (Table 17). This is because each feasible permutation of tanks, boosters, panel types and panel numbers is registered as a separate ‘model’. The great majority of these exceed 28 RECs in all four solar zones, and so could be installed on any size house anywhere in Australia. Over 700 models exceed 14 RECs but not 22, so could only be installed on houses of up to 2 bedrooms in Zones 1, 2 and 3. Several hundred models which rate 22 or more RECs in Zones 1,2, and 3, and so would be suitable for houses of 3 or 4 bedrooms, will not achieve that rating in Zone 4, but could still be used on smaller houses in that Zone.

There are at least six suppliers of heat pumps in Australia. Most of the models on offer have the compressor integrated with the tank in a single unit, and have to be located outside. However, there are at least two split systems, where the tank can be located inside, and one unitary system that is capable of working indoors.

Given the wide range of water heater types that would comply with the proposed provisions, and the number of models and suppliers, it is not envisaged that there would be any reduction in competition or upward price pressure on each type.

Table 17 Registered solar and heat pump water heaters

Category of RECS	Can be used on houses with this number of bedrooms (a)	Number of models meeting RECS criteria for this Zone(c)			
		Zone 1	Zone 2	Zone 3	Zone 4
Less than 14	Not useable	45	1306(b)	45	185
At least 14	Up to 2 bedrooms	6825	5564	6825	6614
At least 22	Up to 4 bedrooms	5507	4722	5507	4736
At least 28	All houses	4834	4099	4834	3473
Total models		6870	6870	6870	6870

Derived by author from RECs database December 2008 (a) Under Proposed BCA Regulations (b) Many suppliers have opted not to calculate or register a RECS value in Zone 2 because the market is so small. (c) At time of writing ORER had not published REC values for Zone 7, to which ACT regulations refer.

Impacts on Manufacturers and Importers

Under the proposed regulations, manufacturers of electric storage water heaters would no longer be able to supply these products for installation in new Class 1 buildings, which account for 10-20% of the water heater market.[13] However, all manufacturers of electric storage water heaters also supply mains pressure storage tanks to the solar market, either via their own brands or via arrangements with specialist solar brands (Table 18).

It is estimated that current State regulations have already restricted electric water heaters from 35% in the No Regulations case to no more than 3% of the national new house market, so the further impacts on suppliers will be marginal With the elimination of those remaining 3%, the solar-electric share of the home market is projected to increase from 34% to 36%, and the heat pump share from 3% to 5%.

If the Proposed Regulation were adopted in Tasmania and the NT the total value to manufacturers of sales to the new home market in those areas would increase by about $1.2 m per year (32%) compared with the no regulations case.

Table 18 Complying product types made by electric water heater suppliers

Supplier and Brands	Solar-elect	Solar-gas	GIWH 5*	GSWH 5*	Heat Pump
Rheem,Vulcan, Aquahot, Panther, Paloma	✓	✓	✓	✓	✓
Dux, Radiant, Mercury	✓	✓	✓	✓	✓
Rinnai, Beasley, Suntech	✓	✓	✓	-	-
Everlast (supply tanks to others)	-	✓	✓	-	-
Everhot, Reece	-	✓	✓	-	-
Aquamax	-	✓	-	✓	-
Chromagen	✓	✓	✓	-	-

Source: Extracted by author from list of registered electric water heaters at www.energyrating.gov.au and supplier websites

All the storage pressure tanks used in larger electric, gas, solar-electric and solar-gas water heaters are made in Australia, so to the extent that the proposed regulation shifts market share between storage types there would be little impact on the locally made share of the water heater market.[14] The demand for gas instantaneous water heaters, all of which are imported, may either increase or fall slightly, depending on changes in conventional gas IWH sales and changes in the sales of solar water heaters boosted with gas IWHs.

In any case, the proposed regulation is expected to have only a small impact on the balance between locally made and imported water heaters.

[13] They could continue to supply the replacement market, which account for 80-90% of electric water heater sales, until such time as the Government policy to ‘phase-out the installation of greenhouse-intensive electric hot water heaters …in all existing homes’ is implemented (*Labor’s 2020 Target for a Renewable Energy Future*, October 2007).

[14] Chromagen appears to be the only importer of storage tanks, for the smaller volumes not used in solar configurations.

Building Design

Electric storage water heaters have particular advantages in a number of situations, so their exclusion could have implications for some current design approaches.

Over 80% of water heaters in existing Class 1 Buildings are located outdoors (Table 19) and the proportion in new buildings is probably much higher, given that solar is increasing its market share and low pressure 'in-ceiling' models are no longer available.[15] All new Class 1 buildings have some open area around them; even a terrace or row house has space at the front and back. It should be possible to design for an external gas, solar, heat pump or LPG main water heater in all situations. The only possible exception is a design with small attached dwellings in a high-density configuration, and the Proposed Regulations permit an electric resistance water heater to be used so long as the house has no more than 1 bedroom.

The effectiveness of solar water heaters depend partly on roof orientation. As solar water heaters become more common in new homes, it is likely that a favourable solar orientation will assume greater importance in roof design. For this RIS, solar water heater performance and running costs have been based on the assumption that collectors are oriented at 45° west of north. It is assumed that in situations with an even less favourable solar orientation than 45° west, the builder will select an alternative water heater option, or perhaps use frames or an extra panel to compensate – so incurring somewhat higher capital costs. On the other hand, the majority of solar installations should be at a more favourable orientation than 45° west, so enjoying somewhat higher energy savings.

Table 19 Location of water heater, Existing Class 1 Buildings

Type	Location	% of houses
Gas IWH	Outdoor	21.5%
Gas SWH	Outdoor	24.7%
	Indoor	2.6%
	Ceiling	0.5%
Elec SWH	Outdoor	25.8%
	Indoor	12.9%
	Ceiling	3.9%
Solar SWH	Outdoor	8.1%
Total		100.0%
Total outdoor		80.6%
Total indoor		15.5%
Total in ceiling		4.4%

Source: Extracted by author from BIS (2008)

Difficulties could occasionally arise where the design has remote hot water draw-off points, where water may be run to waste while users wait for it to run hot enough to use. The Plumbing and Drainage Code, AS/NZS 3500, specifies a maximum pipe volume between the water heater and each draw-off point. If these could not be achieved

[15] There are no low-pressure electric storage water heaters registered for sale in Australia on www.energyrating.gov.au

through planning alone, it may be necessary to install secondary water heaters for remote bathrooms or laundries. The Proposed Regulations would allow the use of an electric resistance water heater in these situations (limited to one per building), provided a complying water heater were also installed.

The supplementary electric resistance water heater could be either of the storage type (up to 50 litres) or alternatively a tankless electric instantaneous water heater. As the electric option would only be permitted where there was also a complying main water heater, it would increase the capital cost of providing for poorly located remote drawoff points. This would create an incentive to avoid them through better initial design of the hot water system.

Builders, Plumbers and Installers

Builders pass on the cost of water heaters to owner/buyers, as they do the cost of all other materials and components. It is estimated that the current average capital and installation cost of the water heater is about $ 2,694 (Table 20). The average value per new house approval in 2008 was $238,700 (ABS 8731.0) so the water heater represents about 1.1% of this. The effect of the proposed regulations could be either no change or an increase in the cost of water heaters, depending on jurisdiction, but in all cases the impact would below 0.5% of average new house construction cost. This is not considered significant in comparison with much larger fluctuations in the cost of labour and materials.

Builders, plumbers and installers could be affected by the proposed regulations in other ways. They need to be aware of the regulations and the compliance obligations. All parties should be familiar with the Building and Plumbing Codes, and take steps to keep up to date with changes, including State variations. Special regulations for water heaters already apply or have been announced in 5 States and the ACT, so interested parties should be able to adjust to the proposed provisions without trouble, provided there is sufficient lead time and information. The State planning and building regulators usually publicise relevant changes in the BCA, and could readily use the same channels to promote these provisions.

Finally, plumbers and installers need to have the skills to deal with any likely change in the pattern of water heater types and the installation practices. Again, these are likely to be minor: greater demand for gas connections and installations in some States (or parts of States) and greater demand for solar and heat pump in others. Nearly all water heater installations require an electrical connection, so the exclusion of electric storage water heaters would not reduce the demand for electrician skills and qualifications among water heater installers.

Housing Affordability

The impact on water heater costs and hence on total cost of new house varies from State to State. Table 20 indicates that there would be no change in costs in NSW, Victoria, Queensland, SA and WA if the proposed regulations took effect in 2010. In Tasmania there would be an increase of $902 (0.4% of average new house construction cost) and in the NT an increase of $213 (0.1%). In the jurisdictions where water heater and hence housing costs increase, the compensation for home owners is that the extra cost would be more than recovered in lower energy costs.

In Victoria, average new water heater costs under the proposed regulations would be over $1,000 lower than under the current regulations.

Table 20 Estimated average cost to home builder/buyer of water heaters installed in new Class 1 Buildings, 2010 (undiscounted)

	No Regulations $/house	Current Regulations $/house	Proposed Regulations $/house	Change $/house	Average construction cost $/house(a)	Increase in average cost
NSW	2108	2666	2666	0		
VIC	2195	3396	2373	-1023		
QLD	2386	2986	2986	0		
SA	2311	2828	2828	0		
WA	2618	2783	2783	0		
ACT	2276	2345	2345	0		
Tas	1860	1860	2762	902	206100	0.4%
NT	2623	2623	2836	213	301200	0.1%
Aust	2301	2982	2683	-299		
Tas, NT	2482	2482	2823	340	265590	0.1%

Energy utilities

By excluding electric water heaters, the proposed regulations would reduce the average consumption of electricity in new homes in favour of natural gas, solar and ambient energy. This would represent a small reduction in energy supplier revenues from the sale of electricity, but partially compensated by a (smaller) increase in the sales of natural gas.

The impact on electricity networks could be more significant. Off-peak electric resistance water heaters have enabled network operators to reduce the domestic water heating load at peak periods, when cooking, lighting and seasonal space heating and cooling loads are heaviest. The proposed provisions would mean that this capability would be reduced in new Class 1 buildings, but the impact on the electricity networks could be mitigated by the following:

- day-rate electric water heaters, which are free to operate during peak periods, would also be excluded;

- much of the diversion would go to natural gas water heating, which would not affect peak loads. Many of the extra houses that connect to gas in response to the proposed regulations would also divert their cooking and space heating loads from electricity to gas, so *reducing* the potential peak load contribution;

- summer peak period operation from solar-electric and heat pump water heaters is likely to be low, because these are the times when inlet cold water temperatures, solar radiation and ambient temperatures are at their maximum;

- There is more potential for winter peak period operation from solar-electric and heat pump water heaters. This can be managed by ensuring that the water heaters are adequately sized (as the proposed BCA provisions require) and, where possible, connected to a restricted hours tariff or a time-of-use tariff that discourages operation during peak periods. Although operation on a restricted hours tariff will somewhat reduce the solar contribution (especially in households where hot water use peaks in the evening) the lower tariff will more than compensate for the higher electricity use, compared with day-rate tariffs.

Ultimately, the best way to manage electricity demand from any source is through a combination of dynamic electricity pricing and the ability of appliances to respond automatically to price signals ('demand response'). Standards Australia is developing a suite of demand response standards (the AS 4755 series). A standard for a demand response interface in air conditioners has been published, and work has begun on similar standards for electric and electric-boosted water heaters.

Announcements and Consultations

The current State requirements for water heaters in new houses in NSW, Victoria, Queensland, SA and WA came into effect between July 2004 (the NSW BASIX) and September 2007 (the WA '5 Star Plus' Code). The ACT provisions are scheduled to take effect in October 2009. As the provisions have much in common with the regulation proposed for the BCA, stakeholders in those States will be well aware of the issues.

The intention of the present Commonwealth Government to adopt these requirements nationally was first announced in October 2007.

On 10 December 2008, the Ministerial Council on Energy adopted a *National Hot Water Strategic Framework*, which stated:

> The framework provides for the reduction of greenhouse gas emissions associated with water heating, through the specification of minimum energy performance standards for water heaters and the phasing out of conventional electric resistance water heaters (except where the emissions intensity of the public electricity supply is low), together with a range of information and education measures.
>
> This initiative will deliver lifetime cost savings to households at times of rising energy costs as well as significant CO_2 reductions.
>
> The phase-out of conventional electric resistance water heaters is intended to cover all new homes and established homes in gas reticulated areas from 2010,

and new flats and apartments in gas reticulated areas and established homes in gas non-reticulated areas from 2012.[16]

On 30 April 2009 the Council of Australian Governments endorsed the draft *National Strategy on Energy Efficiency*, which included the measure: *Phase-out of inefficient and greenhouse-intensive hot water systems*, of which the key elements are:

- A set of measures (including energy efficiency standards) to phase-out conventional electric resistance water heaters (except where the greenhouse intensity of the public electricity supply is low) and increase efficiency of other types.
- Appropriate regulatory mechanisms in each jurisdiction, (for example plumbing regulations in conjunction with the National Construction Code when developed), will be used to prevent installation of high emission electric systems.
- MEPS to regulate remaining technologies.
- Education and industry development measures.
- Jurisdictions to work to better integrate, simplify and reduce red tape associated with incentive schemes, such as by offering rebates as point of sale discounts and offer one-stop shop approach for rebate applications.

Mandatory labelling of gas, solar and heat pump water heaters will also be introduced.[17]

In addition to these actions and announcements by governments and ministerial councils, it is understood that DEWHA has kept the water heater industry informed about the development of the measure, including the preparation of this RIS. The most recent such event was an industry meeting in Melbourne on 11 March 2009, attended by representatives of all water heater manufacturers and their industry associations.

Responses to Consultation RIS

The Consultation RIS was published on the BCA website on 17 September, as an appendix to the larger RIS on the BCA 2010 revisions. This is the usual form and timing of publicity for BCA proposals, and all building industry participants are familiar with it. Submissions were invited up to 30 October. Stakeholders were made aware of the RIS by the Australian Building Codes Board newsletters, subscriber email alerts and also during the Australian Building Codes Board conference held from 21-23 September – as well to the website notifications (details are provided in the overarching RIS for the combined proposals). In addition, stakeholders have been aware of the hot water policy proposal for over 2 years, through the Labor Party's 2007 election platform and the development of Stage 2 National Framework on Energy Efficiency.

[16] http://www.ret.gov.au/Documents/mce/_documents/17th_meeting_communique20081212163223.pdf
[17] http://www.coag.gov.au/coag_meeting_outcomes/2009-04-30/docs/National_strategy_energy_efficiency.pdf

Submissions on the Consultation RIS were received from the Australian Institute of Architects (AIA), Rheem Australia Pty Ltd, the Tasmanian Department of Premier and Cabinet (DPC), the Victorian Department of Planning and Community Development (DPCD) and MicroHeat Technologies Pty Ltd and the Victorian Centre for Advanced Materials Manufacturing (VCAMM).

Australian Institute of Architects

The AIA supports the proposed regulations (and, by implication, the current regulations).

Rheem

Rheem questions the justification for the proposed benchmark of 100 g CO2-e/MJ.

Response: The level was first proposed in the report paper *Specifying the Performance of Water Heater Heaters for New Houses in the Building Code of Australia*, November 2007 (GWA 2007a), which stated:

> 'A benchmark value of 100 g CO_2-e/MJ would be met by gas water heaters rated 5.0 stars or higher, and by the majority of solar-electric, solar-gas water and heat pump water heaters.'

GWA was not aware of any negative comment on that value at the time of preparing the consultation RIS, and it still of the view that the benchmark is appropriate.

Rheem states that:

> 'The industry's [actually only Rheem and Dux] benchmark AusWHIP review of the future of water heating in Australia identified the new home market as a key sector where lower emissions water heaters could be mandated, with little corresponding disruption to the market and'

Response: Rheem objects to 5 stars being mandated as the minimum 'deemed to supply' (DTS) level for gas water heater in new homes, vs a general MEPS level of 4 stars, precisely on the grounds that the installed cost would be lower costs than would be the case for replacement situations, which is why a higher MEPS level is cost-effective.

The point of cost-benefit analysis is that the NPV of the reduction in energy costs (which now include an explicit carbon price) needs to be weighed against the capital cost. Otherwise any measure which reduces greenhouse gas emissions might be implemented irrespective of how costly the reductions were.

Rheem states that 'the RIS does not adequately address the limited availability of natural gas reticulation' and that its 'analysis of the market suggests that substantially less than 50% of Australian households have access to natural gas'.

Response: Independent analysis carried out by the National Institute of Economic and Industry Research indicates that 47% of existing homes are connected and up another 22% are connectable. However, the critical value is the share of *new* dwellings that would be built in gas-available areas. This present RIS estimates that 70% of new dwellings will be in this category, and 60% will be connected.

Rheem states that the RIS ‘does not address water wastage issues associated with 5 star instantaneous water heaters’ and refers to a document *Water Wastage of Instantaneous Gas Water Heaters: a report for the Water Efficiency Labelling and Standards Scheme* (WELS) (APIC 2008).

Response: The document that Rheem refers to acknowledges that:

> ‘Not all of the water will be wasted, as some end-uses (such as for bathtub filling or washing machines) will retain and use initial, below-temperature flows. For the purposes of the study, all wastage is assumed to go to drain.’ (APIC 2008)

Therefore the so-called ‘water wastage’ values which Rheem quotes are likely to be exaggerated, perhaps by a factor of 2.

In any case, if WELS decides to required ‘water wastage’ labelling, buyers can make up their minds about its relative importance. If WELS eventually mandates maximum levels of ‘water wastage’ then the RIS for that proposal will need to take into account the dual impact of WELS and energy MEPS.

Rheem states that ‘the RIS does not appear to use like for like comparisons in the calculation of running costs’, because it shows 5 star gas instantaneous water heaters to have lower emissions than 5 star gas storage water heaters.

Response: It is agreed that a 5.0 star storage water heater (SWH) would have the same annual gas consumption as a 5.0 star instantaneous water heater (IWH). However, the average star rating of all 107 IWH models rated 5.0 stars or higher is 5.4, whereas the average star ratting of all 22 SWHs on the market with a star rating of 5.0 or higher is 5.1 (Table 7). Therefore if a MEPS level of 5.0 is set for new homes then a randomly selected gas IWH will be 0.3 stars more efficient than a randomly selected gas SWH.

IWHs are treated fairly, in that their annual electricity use for standby and fans (which SWHs do not have) is taken into account in calculating emissions.

Rheem states that the RIS ‘attempts to make a case for the Victorian building code to be amended to move backwards to 5 star gas water heaters in preference to existing solar applications’.

This is not the case. The RIS simply applies to same analysis to all jurisdictions and compares the outcomes with both No Regulations and Current Regulations

Tasmania

The only part of Tasmania’s submissions (3 November 2009) which is relevant to water heaters is:

> ‘Further COAG’s decision on phasing out of conventional electric hot water systems allowed for exemption for those jurisdictions where the greenhouse intensity of the public electricity supply is low. This enables Tasmania to follow a strategy more suited to its special circumstances. This exemption has not been taken into account in the analysis of the Consultation RIS nor in the separate report examining the impacts of the water heating provisions’.

A more complete discussion has been added to the executive summary to highlight this issue.

Victoria

Victoria’s main point is that the RIS should more clearly show the increase in greenhouse emissions that would occur of Victoria abandoned its current regulations in favour of the proposed regulations. This has been done. (
Other points are :

- The current share of new homes complying with the Victorian ‘5 Star’ regulations via solar water heaters is 68%, not the 50% used in the RIS. Response: This has been updated.

- The energy prices appear to low. Response: All energy prices are in constant (ie real) 2008 dollars, because they are based on Treasury’s 2008 modelling. If today’s (current) energy prices are to be compared with those in the modelling they should be deflated by CPI rises since mid 2008. If all analyses were revised to use current energy prices we would also use current capital costs (also inflated from mid 2008) so the benefit/cost ratios would be much the same. Therefore no change is necessary;

- REC prices other than $40 should be modelled: Response: there is no reason to model any REC price other than $40. The sensitivity tests in the modelling are intended to cover a number of uncertainties, including REC and energy prices. There is no need to separately model a higher RECs price (and if this were done, it would also be necessary to model a lower price as well).

- Service life estimates should be revised to reflect more recent assumptions. Response: this has been done.

MicroHeat Technologies Pty Ltd and the Victorian Centre for Advanced Materials Manufacturing (VCAMM)

MicroHeat describes its alternative electric instantaneous water heating technology, and advocates for this technology to be exempt from the restrictions on electric resistance water heaters under the proposed regulation.

Under the performance-based structure of the BCA and without change to the proposed regulations manufacturers of alternative technologies can show compliance with the 100g CO_2-e/MJ benchmark under the alternative verification method. It is not necessary to specifically address all possible technologies under the acceptable construction practice.

Water heaters that do not meet the performance benchmark should not be given any special exemption other than the general exemption for electric water heaters in 3.12.5.6 (d). The MicroHeat technology qualifies for this exemption because it meets the definition of an electric resistance water heater."

6. Conclusions

In the Minimum Regulation scenario the capital, energy and greenhouse impacts of the proposed regulation would be limited to those jurisdictions that do not currently have regulations: Tasmania and the NT. Adoption of the proposed regulations would lead to higher capital costs (an average $211 per new house over the period 2010-2020) but lower energy costs (an average lifetime energy saving of $784).

The overall results for the Minimum Regulation scenario show an estimated net benefit of $11.3 million, at a B/C ratio of 3.7:1. For Tasmania, the net benefit would be $6.5 million, at a B/C ratio of 3.6. For the NT, the net benefit would be $4.8 million, at a B/C ratio of 3.9 (at a discount rate of 7%). There would be a total *reduction* in the greenhouse gas emissions from water heating energy in Tasmania and the NT of 58 kt CO_2-e for houses constructed between 2010 and 2020.

The National Hot Water Strategic Framework states that 'the framework provides for the reduction of greenhouse gas emissions associated with water heating …except where the emissions intensity of the public electricity supply is low…' (MCE 2008). However, since the implications of this clause have not been tested in detail, for the purpose of this analysis it has been assumed that all jurisdictions with either no or less stringent regulations adopt the proposed regulations.

If this clause is seen to be applicable in Tasmania, due to the historically high hydro component in its electricity supply, under the minimum regulations scenario the overall impacts of the measure would change to the results for the Northern Territory only.

The net financial benefit would be greatest if the same rules were adopted in all jurisdictions (the National Consistency scenario). However, this is likely to raise greenhouse gas emissions from water heating in new homes by a moderate amount, compared with the Current Regulations scenario. The results for the National Consistency scenario show an estimated net benefit of $186.9 million, at a B/C ratio of 3.2:1. However, there would be a total greenhouse gas emission *increase* of 794 kt CO_2-e for houses constructed between 2010 and 2020.

The results summarised above show that the National Consistency scenario is estimated to have a larger net benefit (of $186.9 million compared to $11.3 million from the Minimum Regulation scenario), but a lower B/C ratio of 3.2:1 compared to 3.7:1 from the Minimum Regulation scenario). The National Consistency scenario is also estimated to *increase* national greenhouse gas emissions, while the Minimum Regulation scenario would lower emissions from water heating in new homes by a small amount, while still achieving a small net financial benefit.

The estimated financial benefits are based on the projected cost to new home owners of water heaters and of the energy required to operate them. The benefit estimates are conservative, because there would be an additional benefit to industry from rationalising requirements between jurisdictions. This benefit has not been quantified in this analysis, and it is uncertain how it would be shared between water heaters suppliers, builders and homebuyers.

In summary, the adoption of the rules in the proposed text of Volume 2 of the Building Code of Australia shows net economic benefits for Australia, for either the Minimum Regulation scenario or the National Consistency scenario - with the National Consistency scenario showing the largest net economic benefit, but higher greenhouse gas emissions.

7. Review

The proposed measure would be subject to review in the same way as any other provision of the BCA. The Australian Building Codes Board (ABCB) allows any interested party to initiate a Proposal for Change (PFC). This is a formal process which requires proponents to explain and justify their proposal.

PFCs are considered by the ABCB's Building Codes Committee (BCC), which consists of representatives of all levels of government as well as industry representatives, and provides advice, guidance, and make recommendations relating to technical matters relevant to the BCA. If the PFC is considered to have merit, the BCC may recommend that changes be included in the next public comment draft of the BCA, or for more complex proposals, it may recommend that the proposal be included on the ABCB's work program for further research, analysis and consultation.

This process means that if the proposed measures in this RIS are found to be difficult to administer, more costly than expected or deficient in some other way, it is open to affected parties to initiate a PFC. The fact that he BCA is reviewed and, if necessary, amended every year means that the lead time for changes can be relatively short.

Apart from review of the technical content of the BCA, the States and Territories can review which parts of the BCA are called up in their building regulations and whether they wish to substitute their own jurisdictional appendices for certain general provisions. Alternatively, they may decide that new general provisions – such as the ones proposed in this RIS – make it unnecessary to maintain separate provisions. In some cases State or Territory building regulations may themselves be subject to 'sunset' or regular review clauses.

As with all other aspects of the BCA, the impact of the proposed measures should be monitored by Governments. Certain compliance patterns have been assumed, based on the best information currently available, and it will be necessary to check how the building industry and water heater suppliers do in fact respond. For example, if the rate of installation of LPG water heaters increases rapidly in project homes (as distinct from commissioned houses) this may be evidence that buyers are being unknowingly committed to high energy prices, and specific policy responses may be warranted.

To sum up, the structure of building regulations in general and the BCA framework in particular offer many avenues and regular opportunities to review the effectiveness of the proposed measure.

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Appendix 1 Recommendations of 2007 Report to ABCB

Assessment Method

The following method of assessment is proposed for the determination of compliance with BCA requirements for greenhouse gas emissions from water heaters installed in new houses, which do not meet the Deemed to Satisfy provisions (see next section).

1. The requirement ('benchmark') should be expressed as a maximum quantity of carbon-dioxide equivalent per MJ of heat added to the water by the water heater (g CO_2-e/MJ).

2. The annual energy requirement of a water heater should be calculated in accordance with AS/NZS 4234 *Heated Water Systems – Calculation of Energy Consumption* (forthcoming).

3. The appropriate climate zone for the analysis is the climate zone in which the house is to be built. The appropriate delivery is determined from the number of bedrooms and the floor area (using the same rules as for the DTS Provisions in Table S1).

4. The benchmark value (being determined under a separate Preliminary Impact Analysis) should be the same in all 4 climate zones, for all 3 deliveries, and the same value irrespective of whether the house is constructed in an area where natural gas is available or not. A benchmark value of 100 g CO_2-e/MJ would be met by gas water heaters rated 5.0 stars or higher, and by the majority of solar-electric, solar-gas water and heat pump water heaters.

5. The calculated annual energy requirement should indicate the water heater's annual consumption of electricity, gas, LPG and any other fuels separately.

6. The annual emissions should be calculated by multiplying the annual consumption of each type of energy by the standard emissions factors to be incorporated in the BCA. These following uniform values are recommended, for use in all zones, States and Territories:
   - electricity: 272 g CO_2-e/MJ.
   - natural gas: 61 g CO_2-e/MJ.
   - LPG: 65 g CO_2-e/MJ.
   - wood or biomass: 4 g CO_2-e/MJ.

7. The total emissions from all fuels (in grams CO2-e) should be divided by the annual energy delivered by the water heater (in MJ) to give g CO_2-e/MJ.

8. If the calculated g CO_2-e/MJ is equal to or lower than the benchmark value the water heater meets the greenhouse performance requirements of the BCA.

9. If the annual energy use of a water heater cannot be calculated using AS/NZS 4234, or it uses a form of energy for which an emissions factor is *not* included in the BCA, other methods of calculation and appropriate emissions factors may be

proposed. However, any such factors must be based on physical emissions, and not on contractual or accounting concepts (eg ‘GreenPower’ or ‘carbon offsets’).

Deemed to Satisfy Provisions

Two sets of DTS Provisions have been developed, in recognition of the impending transition from the use of the current standard AS 4234:1994 to the revised AS/NZS 4234, which has yet to be finalised.

For solar and heat pump water heaters, DTS can be determined in two ways – either by direct reference to AS 4234 (and, eventually AS/NZS 4234), or by reference to the number of RECs registered for that model with ORER.

Table A1 summarises the proposed Interim DTS Provisions, that would apply prior to finalisation of AS/NZS 4234 and publication of RECs values based on AS/NZS 4234. [

Table A2 summarises the proposed Final DTS Provisions, that would apply prior to finalisation of AS/NZS 4234 and publication of RECs values based on AS/NZS 4234.

There may also need to be transitional rules between the Interim and the Final, depending on how ORER handles the transition for model registrations (eg whether old registrations based on AS 4234 can appear alongside newer registrations or re-registrations based on AS/NZS 4234).

Timing and Other Considerations

It is understood that considering the ABCB regulatory change process, provisions could not be ready before BCA 2009. It may take some further time for those States with their own requirements, or with no requirements, to decide to adopt the BCA provisions and make the necessary regulatory and administrative arrangements.

Disruption to the building, plumbing and water heater industries would be minimised if all these regulatory changes could be harmonised.

This will also give time for the finalisation and publication of the forthcoming standard AS/NZS 4234, *Heated Water Systems – Calculation of Energy Consumption,* which is a foundation of the proposed approach.

It will also give time for the performance of solar water heaters to be modelled to the new standard, if necessary; and the product registration and data publication arrangements to be finalised. Stakeholders have an expectation that ORER will have a central role, as this would build on existing processes and arrangements.

It is therefore important that, once the ABCB has decided its preferred direction, it investigate with ORER the possibility and extent of its involvement. If there are barriers to this, other avenues will need to be explored.

Table A1 Summary of proposed *Interim* Deemed to Satisfy Provisions, Water Heaters installed in new houses, anywhere in Australia (Prior to finalisation of AS/NZS 4234 and publication of RECs values based on AS/NZS 4234).

Type of water heater	Climate zone (AS 4234:1994)	1 to 2 bedrooms	3 or more bedrooms, NCFA<= 200m2	3 or more bedrooms, NCFA> 200m2
Natural gas	All zones	5.0 or more stars as calculated using AS 4552		
LPG	All zones	5.0 or more stars as calculated using AS 4552		
Solar, boosted by electricity, natural gas or LPG; Electric heat pump	Climate Zone 1	14 or more RECS for this *and all other* zones, OR Not less than 40% energy saving for 'small' hot water delivery in zone 1, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'medium' hot water delivery in zone 1, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'large' hot water delivery in zone 1, as calculated using AS 4234:1994
	Climate Zone 2	14 or more RECS for this *and all other* zones, OR Not less than 40% energy saving for 'small' hot water delivery in zone 2 zone, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'medium' hot water delivery in zone 2, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'large' hot water delivery in zone 2, as calculated using AS 4234:1994
	Climate Zone 3	14 or more RECS for this *and all other* zones, OR Not less than 40% energy saving for 'small' hot water delivery in zone 3, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'medium' hot water delivery in zone 3, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'large' hot water delivery in zone 3, as calculated using AS 4234:1994
	Climate Zone 4	14 or more RECS for this *and all other* zones, OR Not less than 40% energy saving for 'small' hot water delivery in zone 4, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'medium' hot water delivery in zone 4, as calculated using AS 4234:1994	22 or more RECS for this *and all other* zones, OR Not less than 60% energy saving for 'large' hot water delivery in zone 4, as calculated using AS 4234:1994
Wood or solar, no electric, natural gas or LPG boosting		No restrictions (provided the system is incapable of being retrofitted with an electric boost)		
Electric, solar-electric or heat pump water heaters installed in houses supplied entirely by on-site stand-alone renewable electricity generating systems, not connected to the grid and without fossil fuel backup		No restrictions		

Table A2 Summary of proposed Final Deemed to Satisfy Provisions, Water Heaters installed in new houses, anywhere in Australia (Following finalisation of AS/NZS 4234 and publication of RECs values based on AS/NZS 4234).

Type of water heater	Climate zone (AS/NZS 4234)	1 to 2 bedrooms	3 or more bedrooms, NCFA<= 200m2	3 or more bedrooms, NCFA> 200m2
Natural gas	All zones	5.0 or more stars as calculated using AS 4552		
LPG	All zones	5.0 or more stars as calculated using AS 4552		
Solar, boosted by electricity, natural gas or LPG; Electric heat pump	All zones	Registered with ORER OR Not less than 40% energy saving for 'small' hot water delivery in zone 1, as calculated using AS/NZS 4234	Registered with ORER OR Not less than 60% energy saving for 'medium' hot water delivery in zone 1, as calculated using AS/NZS 4234	Registered with ORER OR Not less than 60% energy saving for 'large' hot water delivery in zone 1, as calculated using AS/NZS 4234
Wood or solar, no electric, natural gas or LPG boosting		No restrictions (provided the system is incapable of being retrofitted with an electric boost)		
Electric, solar-electric or heat pump water heaters installed in houses supplied entirely by on-site stand-alone renewable electricity generating systems, not connected to the grid and without fossil fuel backup		No restrictions		

It will not be necessary for manufacturers to introduce any new water heater models. The proposed DTS provisions would be met by a large number of existing solar and gas water heaters. The installation of electric water heaters in new houses would be excluded, but suppliers would still be free to sell electric water heaters, and all other models not meeting the DTS provisions, to the replacement water heater market.

Because of the absence of a test standard, the treatment of air-source heat pumps in AS/NZS 4234 is not as soundly based as other water heater types. While this need not hold up the inclusion of these product in DTS provisions, based on the current methods of calculating RECs for them, a test standard should be developed as a matter of urgency.

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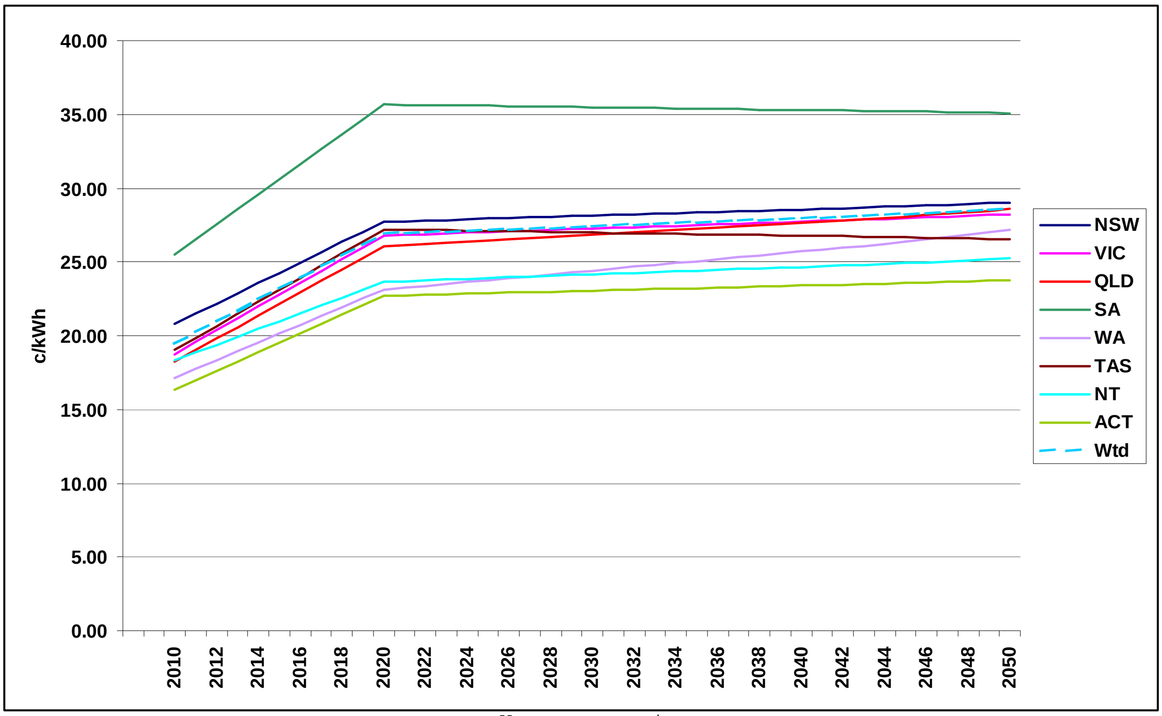
Appendix 2 Energy Price and Greenhouse Gas Intensity Projections

Figure 14 Electricity Day rate Price Projections, CPRS-5

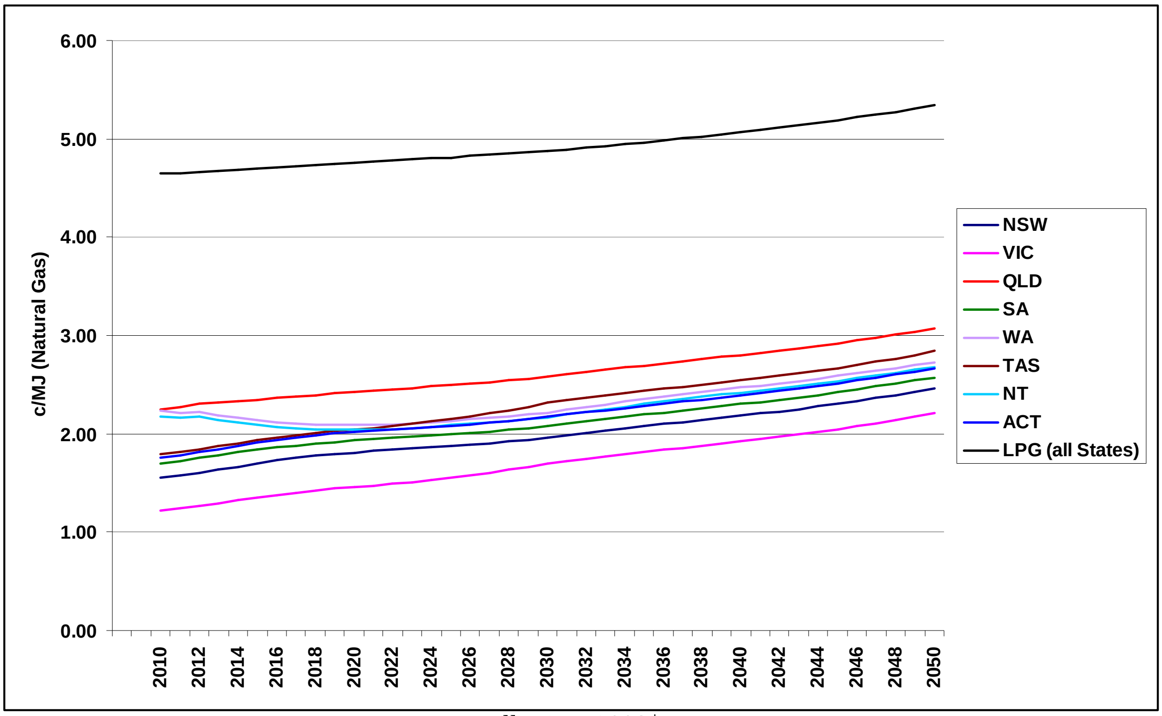


All prices 2008 $

Figure 15 Electricity Off-peak Price Projections, CPRS-5

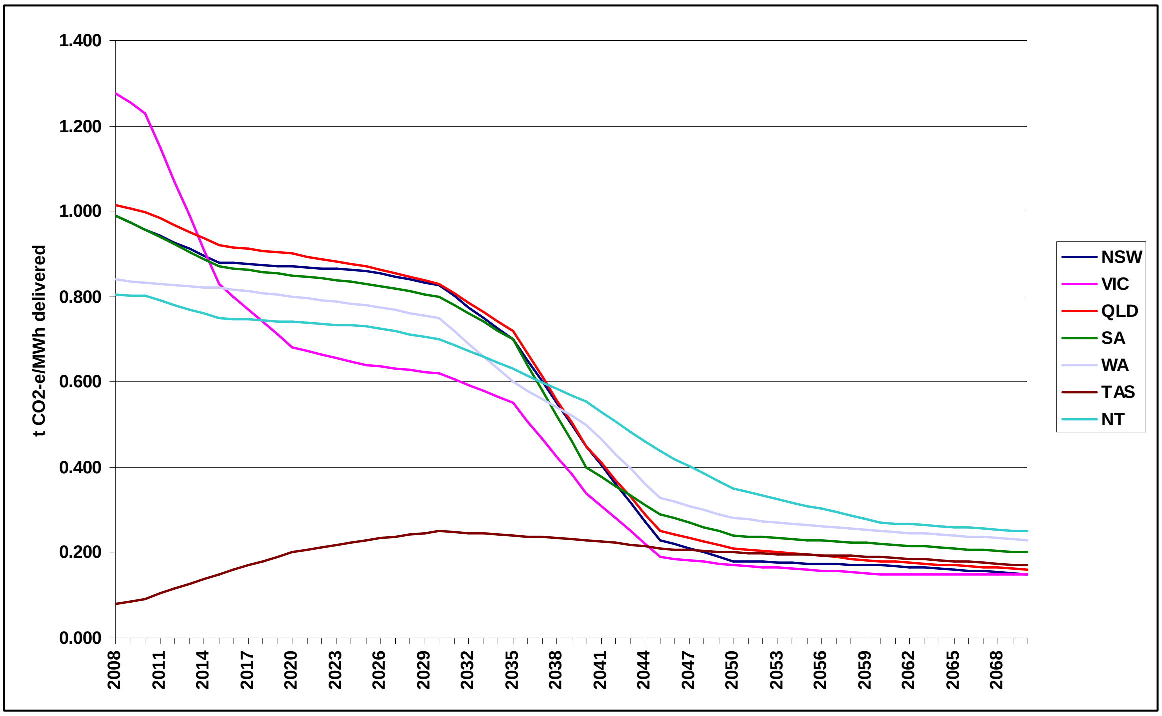
All prices 2008 $

Figure 16 Natural Gas and LPG Price Projections, CPRS-5



All prices 2008$

Figure 17 Projected average greenhouse gas intensity of electricity supply, CPRS-5



Appendix 3 Water Heater lifetime cost (annualised) and greenhouse gas intensity (BCA factors), all States and Zones

Percentages indicate share of new houses projected to be built in this zone, 2010-2020. Projected energy prices and greenhouse gas intensity from Appendix 2.

Figure 18 NSW, Zone 3 (21.8%)

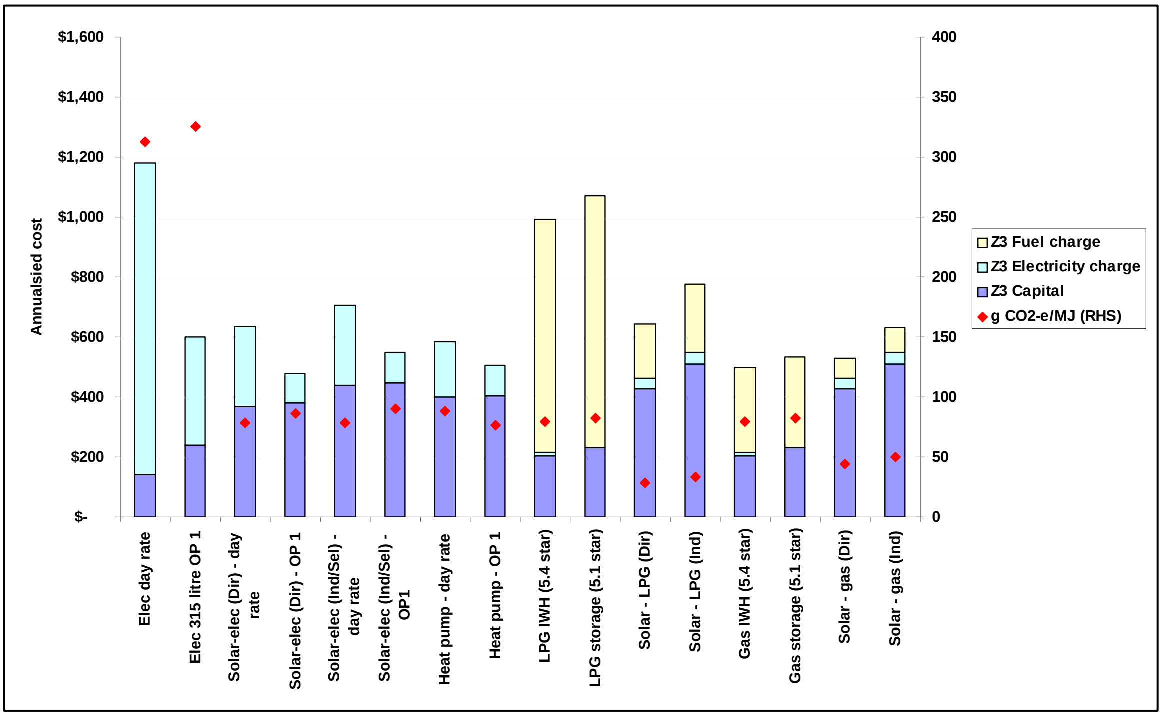


Figure 19 Victoria, Zone 3 (4.0%)

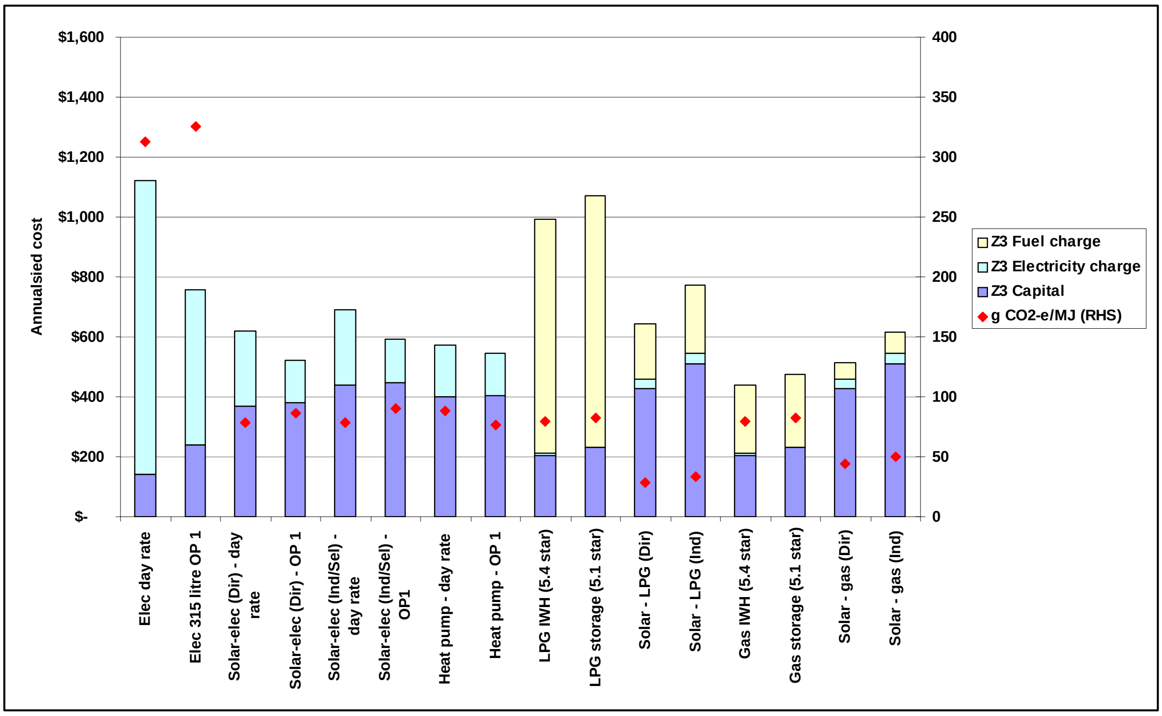


Figure 20 Victoria, Zone 4 (25.9%)

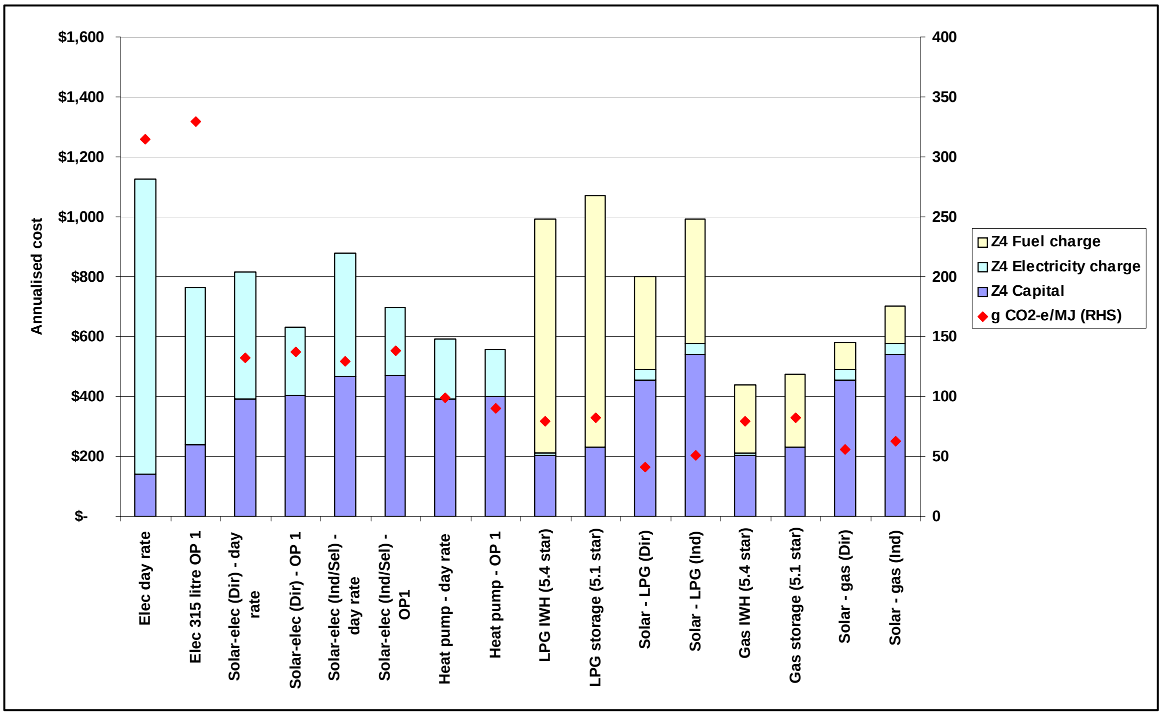


Figure 21 Queensland, Zone 3 (22.3%)

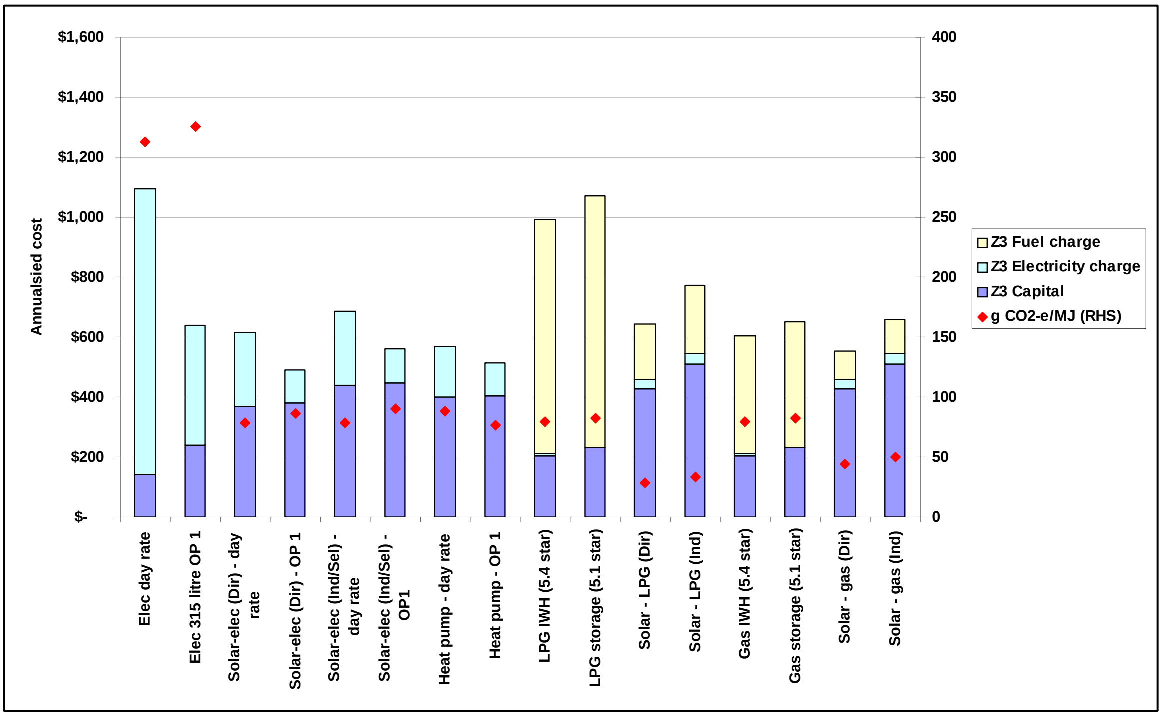


Figure 22 Queensland, Zone 2 (0.5%)

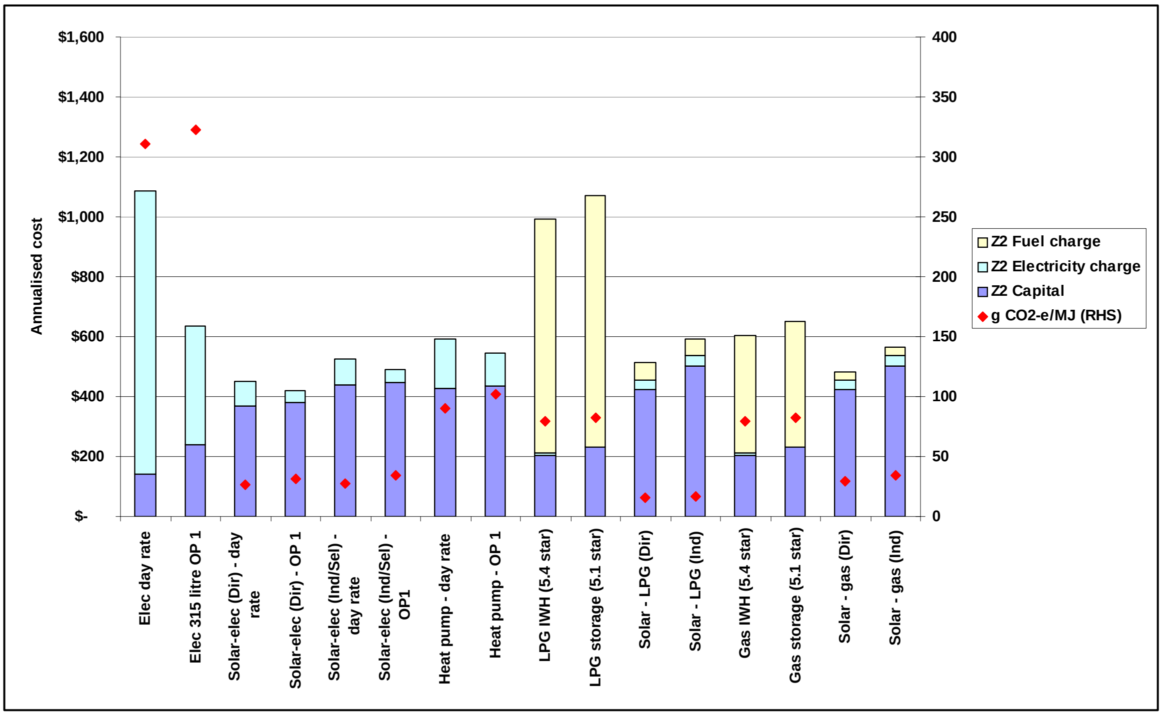


Figure 23 South Australia, Zone 2 (0.3%)

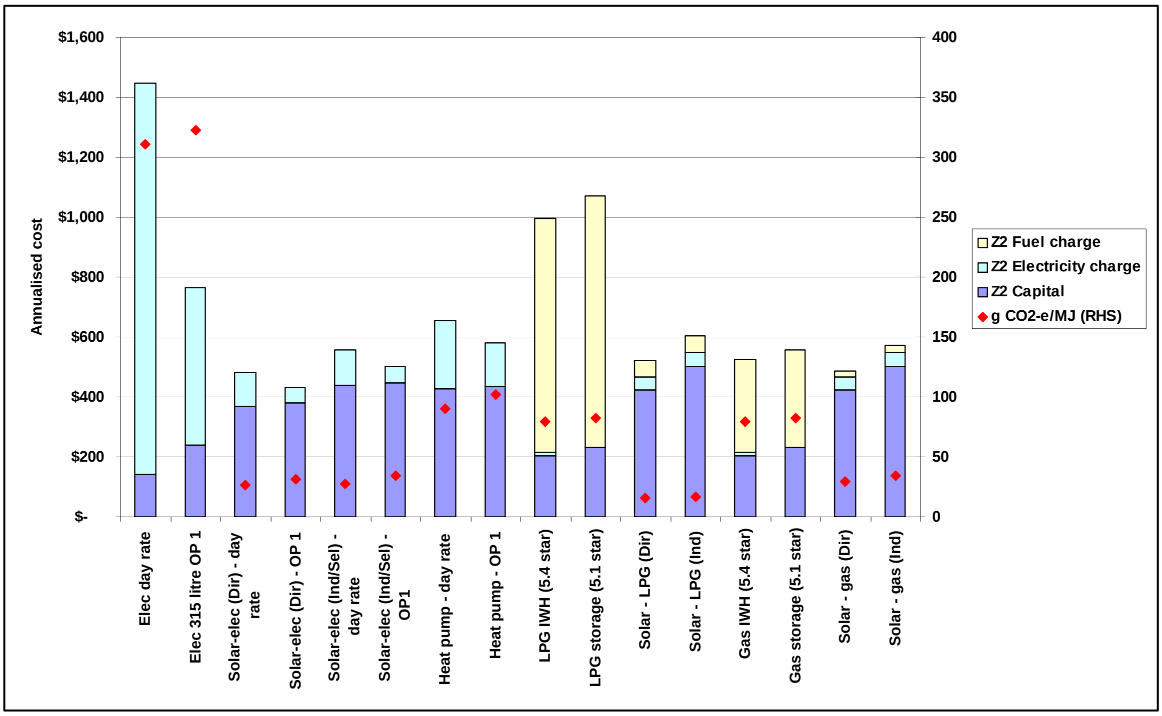


Figure 24 South Australia, Zone 3 (6.9%)

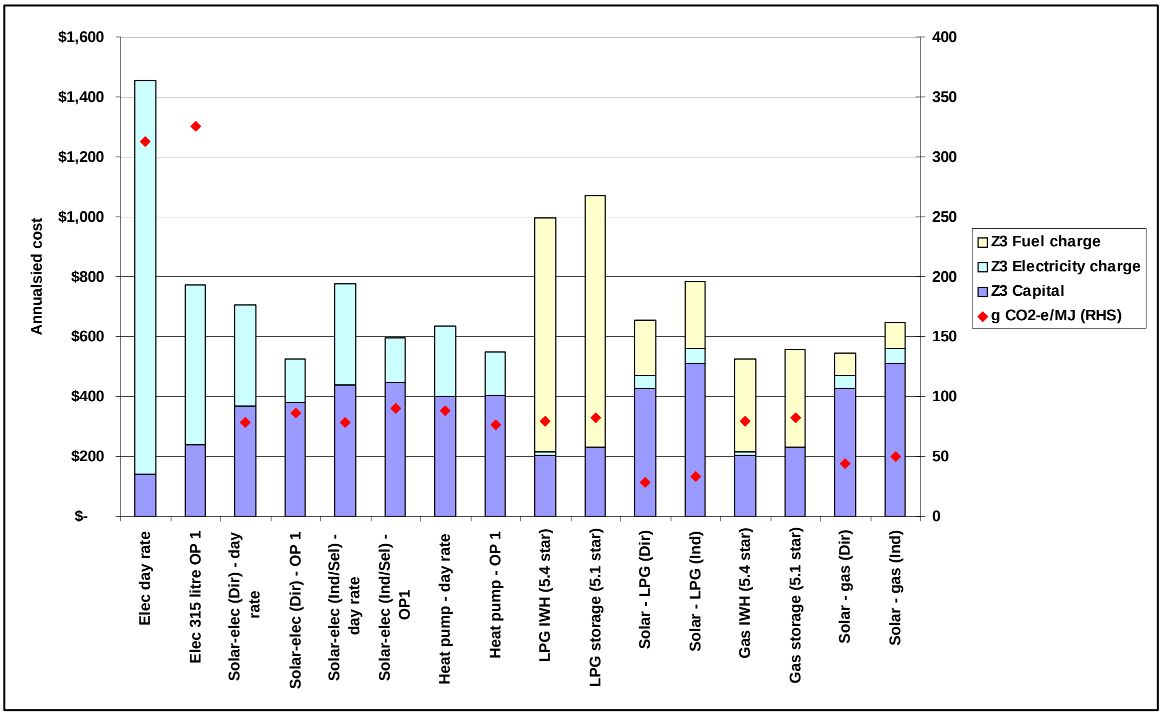


Figure 25 Western Australia, Zone 3 (15.2%)

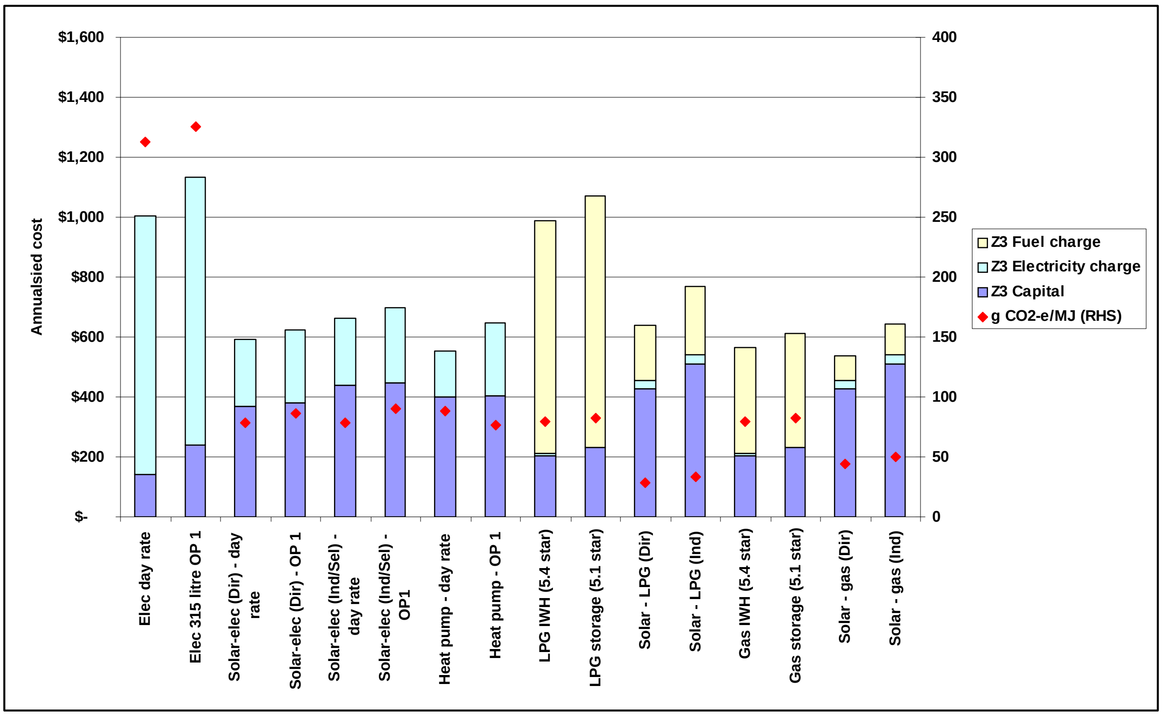


Figure 26 Western Australia, Zone 2 (0.6%)

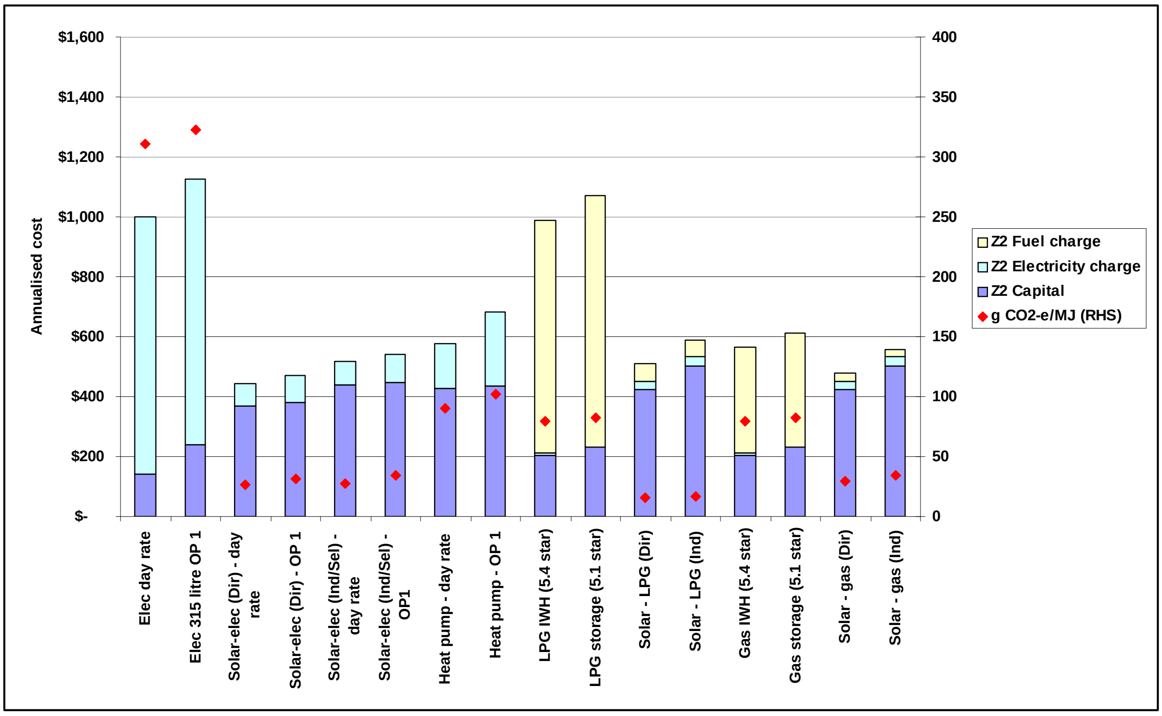


Figure 27 Tasmania, Zone 4 (0.4%)

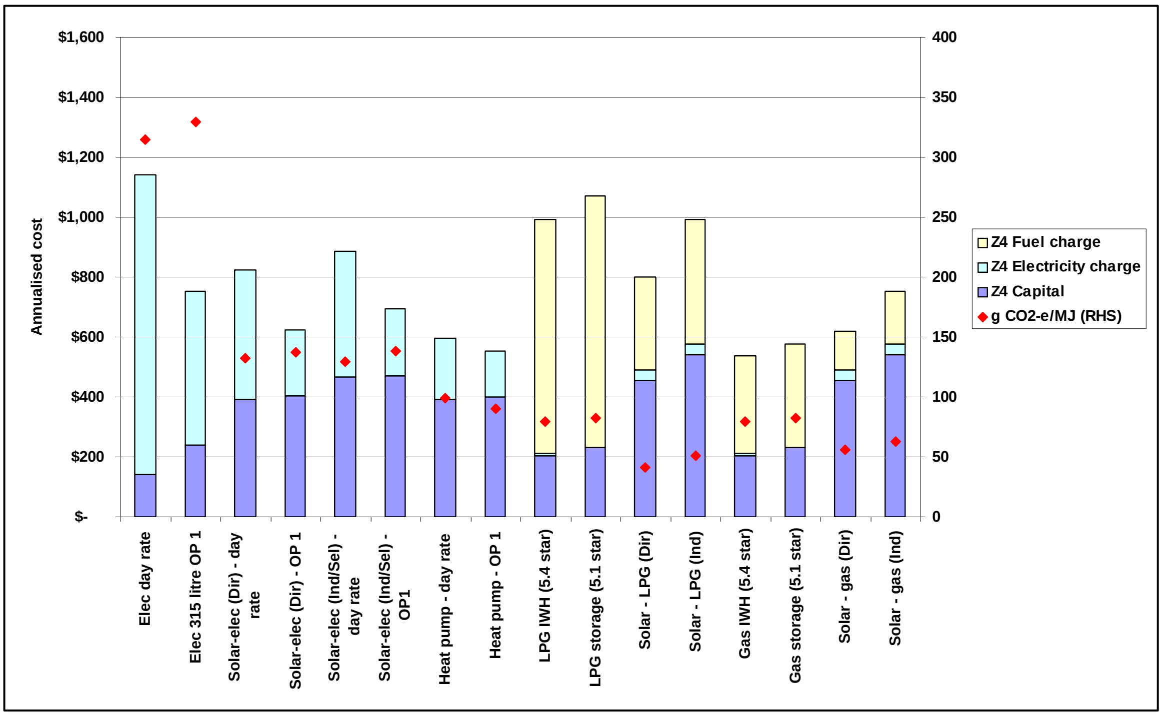


Figure 28 Northern Territory, Zone 1 (0.9%)

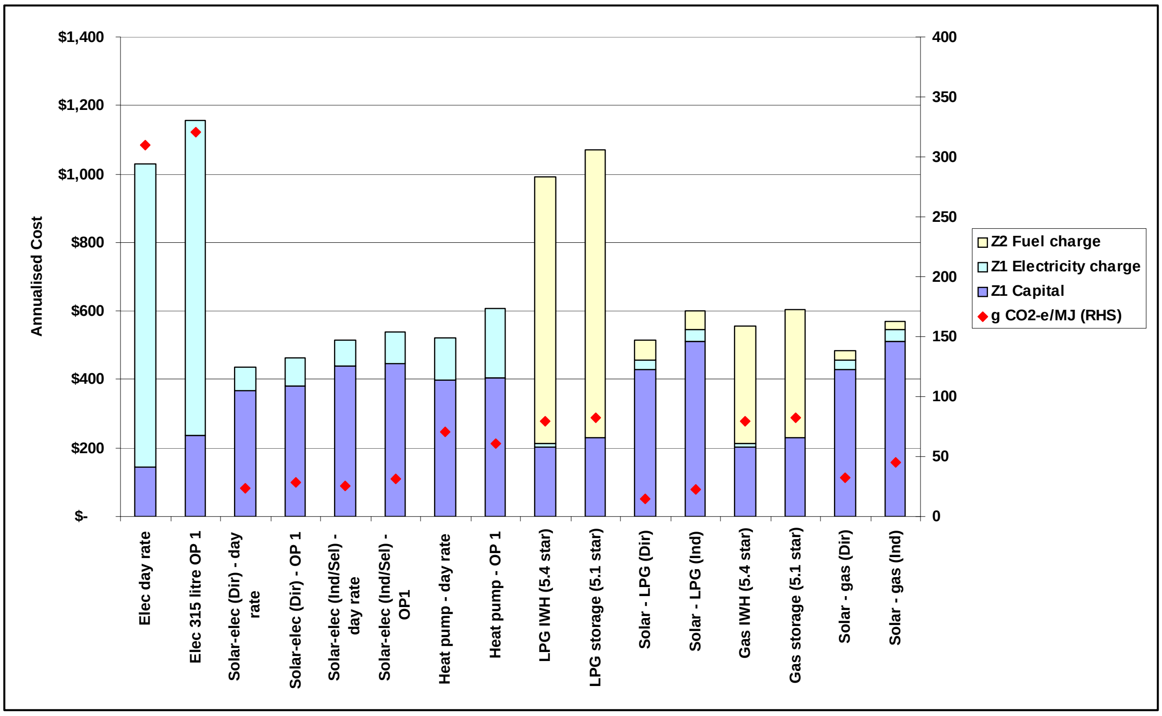


Figure 29 Northern Territory, Zone 2 (0.6%)

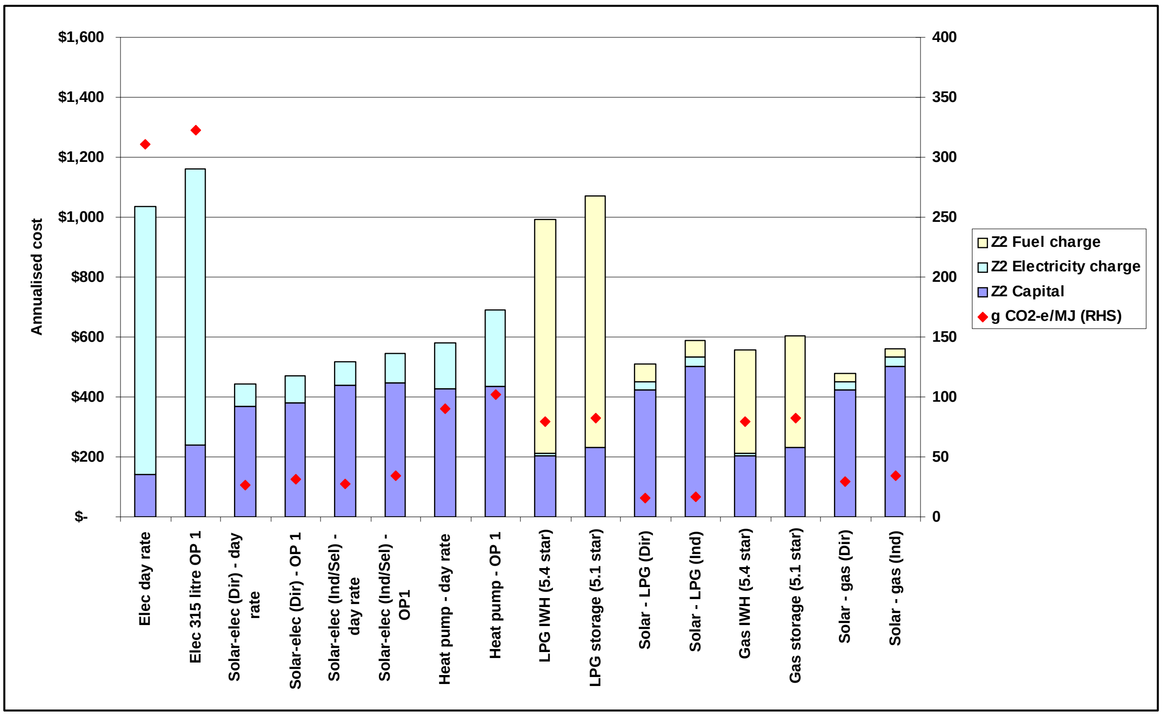
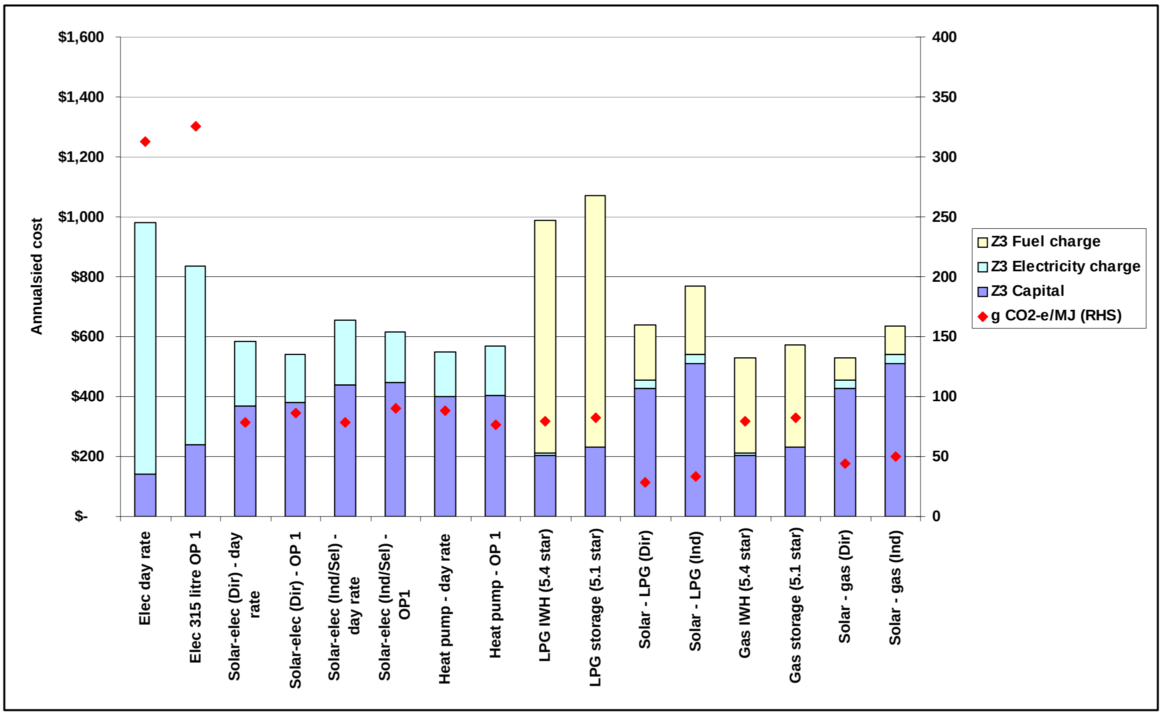


Figure 30 Australian Capital Territory, Zone 3 (0.6%)



Appendix 4 Modelling Assumptions

Water heater purchase and installation

The capital costs to new home owners of different types of water heaters have been estimated by the author from a range of actual prices and installation costs compiled by Energy Strategies for DEWHA (ES 2007, 2008) and from data collected by the administrators of the NSW and Victorian solar rebate programs.

The capital costs of conventional electric and gas water heaters can be determined from general market data, since they are supplied as single complete units and the price is not influenced by RECs. The capital costs of heat pumps can also be determined with reasonable accuracy, since they are also supplied as complete units (or, if a 'split' design, as a tank matched with a specified compressor unit), and given that there only are about 20 models on Australian market, the average number of RECs per purchase can be estimated.

The capital costs of solar-electric and solar-gas water heaters, however, are more difficult to determine. The ORER website lists over 6,800 distinct solar models, so even if the capital costs of all of these were available it would still be impossible to estimate average prices without extensive market share data. Therefore the solar water heater costs have been built up from market surveys (ES 2007, 2008) with further cost modelling, and verified from external data from the NSW and Victorian solar hot water rebate programs.[18]

There are four basic solar collector types:

- 'direct heating' panels; as the water for delivery is heated in the panels, these are not recommended for frost-prone areas;

- 'indirect heating' panels: the water for delivery is heated indirectly by glycol or other heat transfer medium circulating through the panels. These are resistant to frost damage, but are less efficient than direct heating panels (ie they have a lower solar contribution);

- 'selective' surface panels: again, the water for delivery is heated indirectly by glycol or other heat transfer medium, but the more advanced surface material characteristics make up for the loss of efficiency suffered by ordinary indirect heating panels;

- evacuated tubes – these have performance comparable to selective surface panels, in that they heat indirectly and are relatively efficient.

[18] GWA is grateful to the NSW Department of Environment and Climate Change for access to the database of grants by the NSW Government solar and gas water heater rebate scheme (totalling 16,600 records) and to Sustainability Victoria for access to the database of grants by the Victorian Government solar water heater rebate scheme (totalling 7,500 records). Although these grants are for replacement installations rather than for water heaters in new construction, the databases provide invaluable information on consumer preferences (where there is choice between solar-gas, solar-electric, heat pump and conventional gas), solar water heater capital and installation costs, the value of RECS to purchasers, and the tariff classes of electric water heaters replaced and heat pumps and solar-electrics installed.

GWA derived a generalised algorithm to model water heater prices based on the typical costs of individual components (Table 21). Solar and heat pump water heaters of various performance levels are also assigned a number of RECs according to the Zone in which they are installed. This makes it possible to estimate the pre-RECs and post-RECs price of a generic water heater of any type suited for a particular delivery task in a particular climate zone. The algorithm gives price estimates within 1% of the average prices reported for solar-electric water heaters compiled by ES (2008), and within 2% for solar-gas water heaters.

Table 21 Estimated costs to home owner/buyer (all values inc GST)

Component	$/system	Collector type	$/panel(f)	WH type	Installation $/system(d)
SEWH Fittings, pumps	660	Direct heating (e)	638	Electric day rate	440
SGWH Fittings, pumps	220	Indirect heating (e)	902	Electric Off peak	495
50 l storage tank	528	Selective surface, indirect(e)	1155	Heat pump	622
125 l storage tank	704	Evac tubes (20)	1320	Solar-elec (1-2 items)(b)	1430
200 l storage tank	880	Evac tubes (30)	1980	Solar-gas (2-3 items)(c)	1650
250-275 l storage tank	1045			Gas SWH	550
300-315 l storage tank	1265			Gas IWH	660
Gas IWH 20 l/min (a)	990				
Gas IWH 26 l/min(a)	1210				
4 star gas SWH	1155				
5 star gas SWH	1210				
Heat pump	3520				

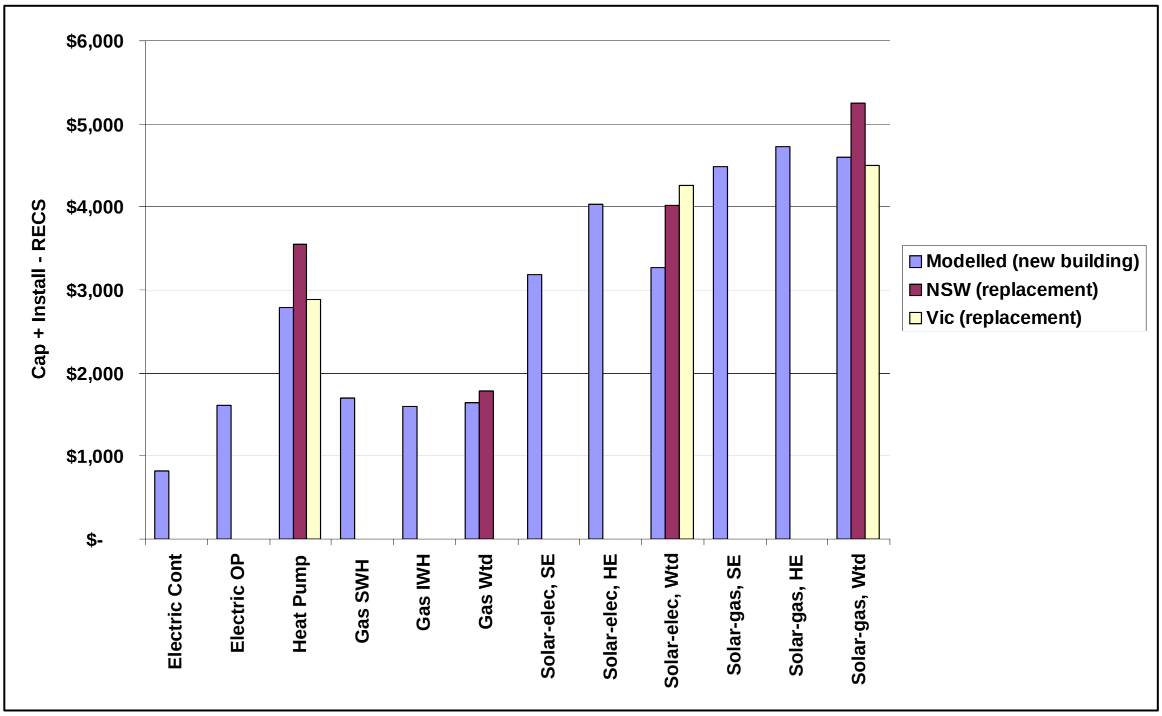
(a) Gas Instantaneous water heater, whether used as stand-alone water heater or as in-line booster with solar preheat. (b) Covers thermosyphon (1 item) and split (2 item). (c) Covers split with in-tank boost and split with storage tank and IWH boost (3 item). (d) Where services already available at dwelling. (e) Cost difference between 'indirect' and 'direct' also used as proxy for costs of frost protection by other means. (f) Nominal 1.95m^2 panel.

The cost-benefit modelling deals with 9 distinct water heater types, each representing a sales-weighted average of its class:

- A continuous tariff electric storage water heater and an off-peak electric storage water heater. Even though these types would be effectively prohibited under the proposed regulations, it is necessary to include them in the BAU scenario, so the impacts of their exclusion can be modelled;
- An electric heat pump water heater
- A gas storage water heater (SWH) and a gas instantaneous water heater (IWH);
- A solar-electric water heater of standard efficiency (corresponding to half 'direct' and half 'indirect' panels) and a solar-electric water heater of higher efficiency (roughly corresponding to selective surface panels or good quality evaluated tubes.
- A solar-gas water heater of standard efficiency and one of high efficiency. Both types have an in-line boost configuration, since in-tank gas boost systems tend to have significantly lower efficiency for the same size and quality of collectors.

The Australia-wide weighted average capital cost (purchase plus installation less value of RECs to user) for each of these 9 types is illustrated in Figure 31. The two gas, two solar-electric and two solar-gas types are also combined into weighted ('Wtd') prices so that the estimates can be compared with the corresponding values reported from the NSW and Victoria rebate schemes, also indicated in Figure 31.

Figure 31 Modelled and actual water heater capital costs, 2008



The modelled data fit very well with the reported data, given that the latter are for replacement installations. As indicated in Figure 31, the model assumes that the costs for water heaters in new homes are somewhat lower than for the same type of water heater installed as a replacement in an existing home, because:

- the plumbers and electricians will already be on site, so there are no additional call-out costs;
- work can be scheduled with greater flexibility and phased with the building process when homes are unoccupied;
- material and labour costs can be reduced by integrating cable and pipe runs in the building fabric, and optimal location of the water heater and collectors, if any; and
- builder may have access to bulk purchasing.

This does not assume that all cost savings and economies will be passed on to the home owner. Some will be retained by the builder as profit (not a factor in replacement installations) and some may be retained as higher profits by suppliers and installers.

Similarly, it cannot be assumed that the full market value of RECs will be passed on to the purchaser of a solar or heat pump water heater or the buyer of a home where such a water heater is installed. In many (probably most) transactions where a water heater is replaced the buyer assigns the rights to the RECs to the supplier in return for an up-front discount, rather than going to the trouble of retaining the RECs to sell them to a broker or via the ORER registry. The water heater supplier will naturally factor in the RECs price risk and transaction costs into the total package price, even if the purchaser is given a nominal discount that seems to reflect the full current market value of the RECs, as is implied by the ‘REC value calculator’ which many suppliers have on their websites.

The Victorian solar water heater rebate scheme collects data on the stated value of RECs in every transaction which receives a government rebate. The average REC value in each transaction period of records made available for this RIS (to the end of 2008) was $ 37.40. The average market price of RECs over the same period was $ 49.30. This implies that 76% of the nominal RECs value reaches replacement water heater purchasers, and the rest is retained by water heater suppliers, brokers, dealers and others. The share of RECs value reaching new home buyers may well be even lower, because the builder will be an additional intermediary.

For modelling purposes, it is projected that the *effective value* of RECs to home buyers will be $40 per REC (real). This corresponds to a market value of about $52.60 per REC, which is slightly higher than the latest reported spot price, $50.90.[19]

In December 2008 the Commonwealth Government confirmed that solar water heaters would remain eligible to create RECs, with a 10-year deeming period, until the scheme is wound up in 2030 (DCC 2008b). Depending on future supply and demand balance, the price of RECs could decline or increase. The Victorian Department of Sustainability and Environment has advised that it uses three RECS price trends for cost-benefit analysis[20]: a base scenario of $50.90 (which corresponds to an effective value to home buyers of $ 38.70 per REC), a low scenario of $38.20 ($29.0 effective) and a high scenario of $60.0 ($45.60 effective).

There is no reason to model any REC price other than $40. The sensitivity ranges in the modelling are intended to cover a number of uncertainties, and there is no need to separately model a higher or lower RECs price.

Gas Connection Costs

The installation costs in Table 5 and the capital costs in Figure 31 are for buildings where services (electricity, water and gas if applicable) are already connected. It is assumed that all new houses built within reach of the electricity distribution network will be connected as a matter of course, so connection costs need not be separately taken into account for electric or solar-electric water heaters. However, not all new houses built within reach of the gas distribution network will be connected. The impacts of natural gas connection costs (whether subsidised or not) may be taken into account in various ways.

When gas is connected to a new house it is generally used for cooking and space heating as well, so the connection cost should not be allocated solely to the water heating service. One possible basis for allocation is the share of residential gas delivered in each State used for water heating (Figure 33) although this applies to all gas-using households, not just new dwellings.

[19] REC Price for March 2009, reported in Ecogeneration, May-June 2009.
[20] DSE pers. comm. Feb. 2009.

Alternatively, it may be assumed that the largest end use of gas in each State indicates the main motivation for gas connection and should bear the connection cost, and the other end uses are supplementary. On this 'main use' basis, gas connection charges would be allocated to water heating NSW, Queensland, SA, WA and NT, and to space heating in Victoria, Tasmania and the ACT.

In practice, the treatment of gas connection costs has only a minor impact on the projected benefit/cost ratios (Figure 45). The treatment selected for the main modelling is a 'main use' allocation of a subsidised connection charge of $400.[21] However, the gas connection will last the life of the house, not just the life of the first gas water heater, and there is a high probability that all subsequent water heaters will also be gas (Table 4). With more precise data on service lives and costs, the initial charge could be expressed as an annualised cost, but given the uncertainty of the estimates it is simpler to, say, halve its contribution to the initial capital cost.

[21] This corresponds to a typical $600 subsidy by the utility, as advertised, for example, in http://www.multinetgas.com.au/industryinformation/downloads/gastoyarra/alnta_incentive.pdf

Figure 32 Estimated household natural gas consumption by end use, 2008

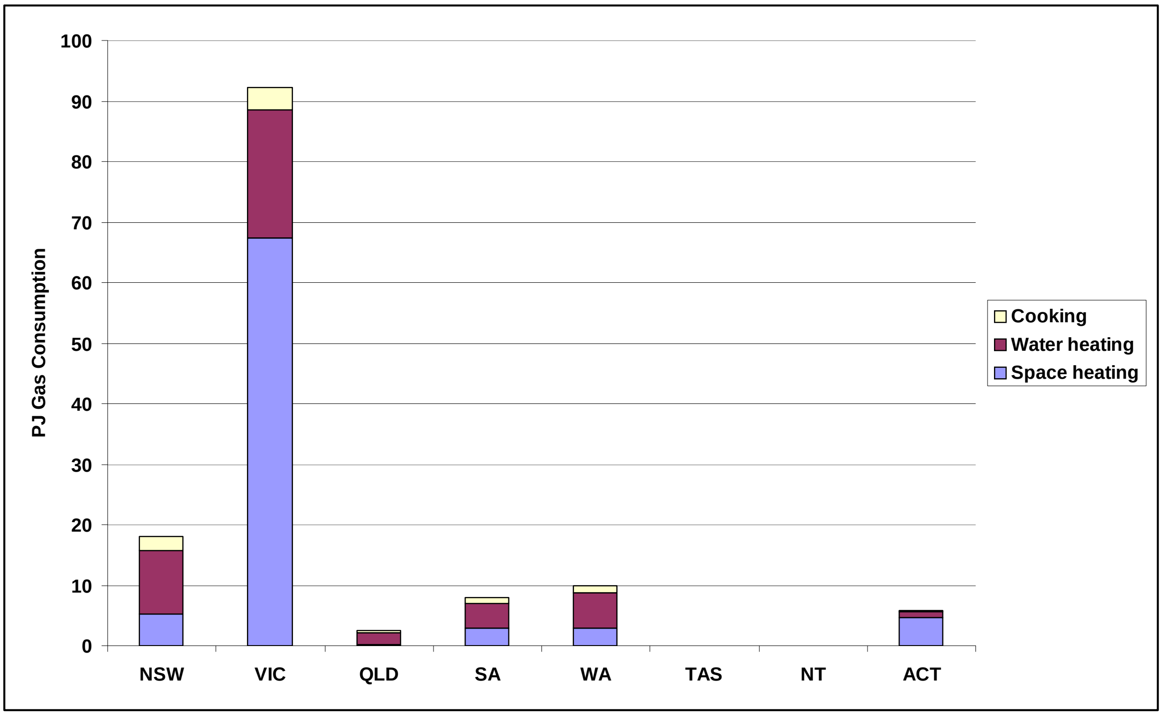
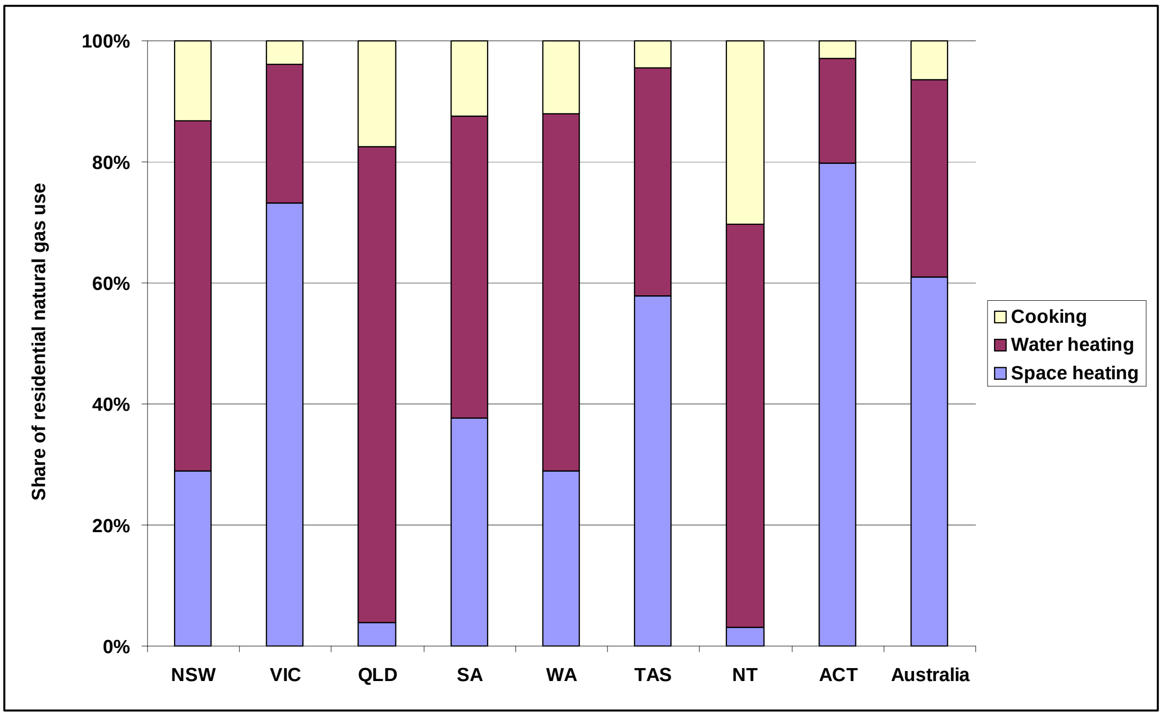


Figure 33 Estimated share of household natural gas consumption by end use, 2008



Service Life

The average service life of water heaters is subject to some uncertainty. While there are some estimates of age at failure for water heaters being replaced now, caution is required in drawing conclusions about future service lives, especially for solar water heaters, because of changes in product styles and manufacturing.

The materials, overall quality of water heater construction and the quality of the water where the water heater is installed all have a major influence. Stainless steel or copper storage tanks are better able to withstand high water pressures and temperatures than are steel tanks lined with vitreous enamel (or 'glass'), and thicker or multiple-layer vitreous linings are more resistant than thinner ones.

Water heater suppliers need to be able to estimate the service life of their products with some accuracy so they can offer warranties which match or better those offered by their competitors, but do not impose high warranty costs due to early failures. Table 22 indicates that all product categories and components now tend to offer the same warranty ranges: 5 years for lower-cost products and 10 years for high-cost. In general, the longer warranty products have more durable materials such as stainless steel or extra thick vitreous enamel, and cost up to $500 more.

The only product class where suppliers offer somewhat longer warranties (10-12 years) is gas instantaneous water heaters, which do not have a pressure vessel, but have heat exchangers which are subject to high thermal stress.

Table 22 Warranties offered for various water heater types

Type	Component	Range of warranties offered
Electric	Storage tank	5-10 years
Electric	Heat pump	5-10 years
Solar	Storage tank	5-10 years
	Collectors	5-10 years
	Gas booster	5-10 years
Gas	Storage tank	5-10 years
Gas	Instantaneous (heat exchanger)	10-12 years

Source: Supplier brochures

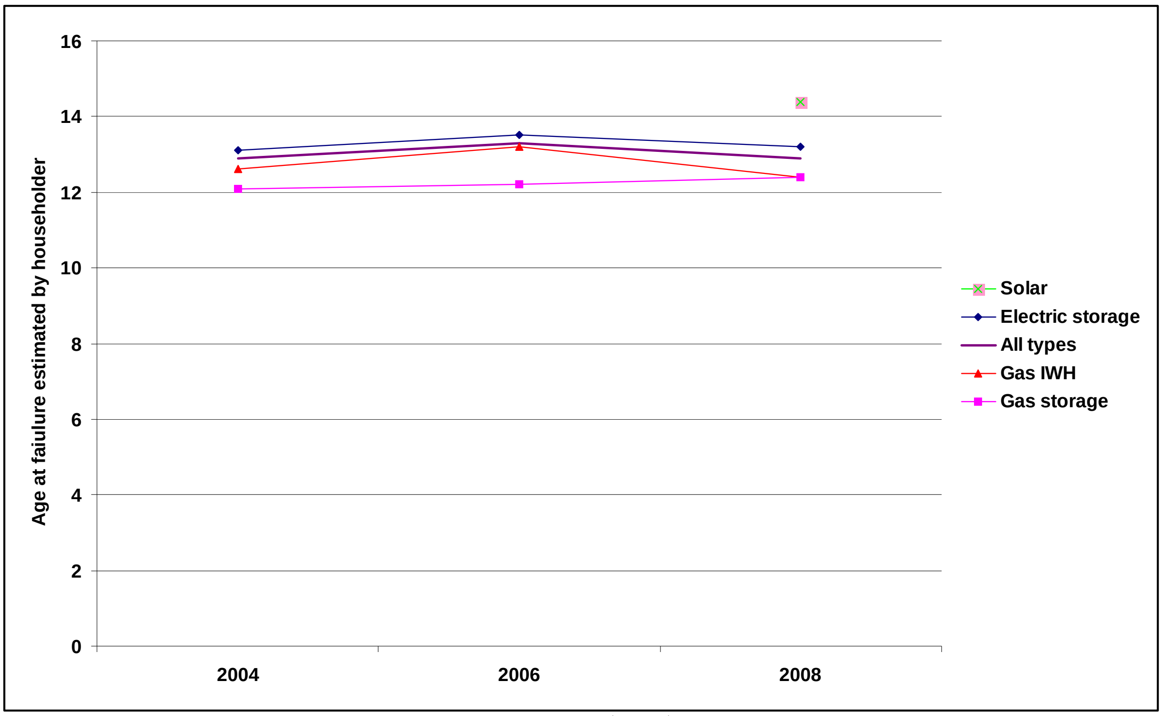
Warranty periods indicate current expectations of service life for the water heaters being installed today, and are also reasonably consistent with the reported service lives of the previously installed units which are failing today.

BIS Shrapnel (2008) reports householder estimates of the age of the replaced water heater at the time of failure. Figure 34 illustrates the responses in the 2004, 2006 and 2008 surveys. The average reported age at failure for all types was 12.9 years. The reported difference between electric (13.2 years) and solar-electric (14.4 years) suggests a service life advantage of about 1.2 years for solar.

BIS (2008) also estimates that the number of water heaters sold annually for replacements, as distinct from new dwelling installations, average 547,500 over the period 2004-08. A rough indication of mean service life can be estimated by comparing the number replaced in a given year with the numbers in use about half the estimated service life (say 6 to 7 years) earlier. According to ABS 4602.0 there were about

7,135,000 water heaters in use in 1999. This would be consistent with a mean service life of about (7,135,000/547,500) =13.0 years.

Figure 34 Water heaters: age at failure estimated by home occupant



Source: BIS (2008)

While neither the recalled age at failure nor the market to stock ratio are conclusive on their own, together they support the assumption that conventional water heaters are failing after a mean service life of about 13 years.

Conventional water heater technology has remained fairly constant, but the expansion of the solar water heater market in recent years has led to changes which may well have an effect on service life.[22] In the past, solar water heaters were a niche product where many manufacturers made their own high-quality tanks, but they have now become a mainstream product. Nearly all storage tanks used in solar systems are made by the manufacturers of conventional water heaters, who now offer both short and long warranty tanks for both solar and conventional use.

Given storage tanks of similar quality, are there factors which would enable a tank used in a solar configuration to outlast a tank used as a conventional water heater, eg do solar water heaters operate in a way that places less stress on critical components?

The opinions of experts contacted for this study were divided about whether a solar water heater with boosting in the storage tank would fail earlier or later than a conventional storage water heater – in other words, some in the industry think it is possible that a modern solar water heater could have a *shorter* life, because in many cases it is subject to higher maximum storage temperatures and greater diurnal temperature ranges. On the other hand, some argue that the components of a solar water

[22] BIS (2008) estimates that solar water heaters accounted for 13% of the market in 2008, and the present study projects that the market share reaches 16% by 2010 (Figure 42).

heating system would have less conventional energy inputs over time (none at all, in the case of unheated storage) and hence less thermal stress around electric elements or, for gas boosting, at the points of external heat application.

Based on review of the literature and discussions with manufacturers of all types of water heaters, it is estimated that, for systems of comparable materials and build quality:

- For a solar heater with an instantaneous gas booster, installed today, the time between first installation and failure of a major component (probably the pressure tank) could be 2 to 3 years longer than the life of a unitary gas storage water heater, and 1 to 2 years longer than the life of a gas instantaneous water heater;

- For a solar water heater installed today that has in-tank boosting, the time between first installation and failure of a major component (probably the pressure tank) could be 1 to 2 years longer than the life of a unitary storage water heater using the same energy form;

- Whether only failed components of a solar system, or the entire system, is replaced depends on a wide range of unknowns, including relative costs, intermediary advice and motivation and user attitudes. Even if the collectors have a potentially longer service life than the tank, users may still elect to replace the entire system to avoid the risk of another component failure happening soon.

Given these uncertainties, the following service lives are assumed for modelling purposes:

- Electric storage, Gas/LPG storage, heat pump storage: 10 yrs
- Gas/LPG instantaneous, solar-electric storage, solar-gas with in-tank boost: 12 yrs
- Solar-gas with in-line boost: 14 yrs.

Hot Water Demand

The selection of the size or capacity of a water heater for a particular application is usually based on the highest daily hot water output likely to be required of that water heater, under the most severe winter operating conditions, when the input water temperature is lowest, standing heat losses the highest and solar availability lowest. Building regulations commonly use the number of bedrooms as a proxy for the number of occupants, which in turn determines the likely peak water heating load.

The minimum RECs number and solar contribution requirement in the proposed BCA provisions are intended to ensure that solar water heaters meet the likely peak load of the dwellings where they are installed. However, the actual average hot water use, which determines energy consumption, is less than the peak load.

Table 23 indicates the estimated number of existing houses and new houses being built according to number of bedrooms. The share of houses with 2 bedrooms or fewer has fallen from 19% of the stock to 16% in 10 years, while number with 4 or more bedrooms has risen from 25% to 32%. Allowing for demolitions (of which a disproportionate share are smaller houses), it is estimated that houses of 4 or more bedrooms now make up over half of new house construction. This is consistent with

ABS reports that the average floor area of new houses increased by 35% between 1986 and 2007[23]

The proposed DTS provisions for the BCA would mean that where a solar water or heat pump heater is installed in a house of 2 or fewer bedrooms it will require a REC rating of at least 14, and if the house has 3 or 4 bedrooms it will require a REC rating of at least 22. It is not known what proportion of new houses have more than 4 bedrooms, but a solar or heat pump water heater in such houses will need at least 28 RECS.

Table 23 Share of houses by number of bedrooms

	Stock 1998 (a)	Stock 2008 (a)	Constructed 1998-2008(b)	Recommended Minimum RECs
Bedsit/1 Bed	3%	2%	<1%	14
2 Bedroom	16%	14%	9%	14
3 Bedroom	56%	52%	34%	22
4+ bedroom	25%	32%	57%	22-28(c)
Total	100%	100%	100%	

Source: (a) ABS *Yearbooks of Australia* (b) Derived by GWA from ABS 4102.0 - Australian Social Trends, 2005; Housing Stock: Supply of Housing (c) 22 RECs if 4 bedrooms, 28 RECs if more.

The ORER RECs ratings for solar and heat pump water heaters are calculated by first classifying a water heater as suitable for 'small', 'medium' or 'large' on the basis of its storage tank capacity. The performance of the entire system, including the solar collectors (if present) and other components is then modelled. For a 'small' system the modelling simulates a worst case (Zone 4) winter peak load of 22.5 MJ/day and an annual load of 6.6 GJ (ie an average of 18.1 MJ/day), for a 'medium' system a peak load of 42 MJ/day and an annual load of 13.2 GJ (an average of 36.1 MJ/day) and for a 'large' system a peak load of 63 MJ/day and an annual load of 19.8 MJ (an average of 54.2 MJ/day).

Table 24 indicates the average daily hot water load (delivered at 60°C) corresponding to these standard annual deliveries in each solar Zone. The hot water volume reduces as the average cold water temperature falls, because more energy is needed to get each litre up to the target temperature.

Table 24 Hot water delivery corresponding to Standard heat loads

Annual thermal load (GJ)	Average litres/day hot water			
	Zone 1	Zone 2	Zone 3	Zone 4
6.6	123	108	102	95
13.2	246	217	204	190
19.8	369	325	306	285

Source: derived from TD (2009a)

[23] Floor areas have stabilised in the last 3 years, possibly because they are now constrained by lot sizes. See http://www.abs.gov.au/ausstats/abs@.nsf/featurearticlesbyCatalogue/3E12D6C335EF3618CA25745C001489F1?OpenDocument

It is necessary to consider whether the modelled hot water use corresponds to likely hot water use in new houses. If the modelled hot water use is higher than actual water use, the projected energy savings compared with conventional water heaters would be overstated, and the solar options would be less cost-effective against conventional water heaters.

There is no information specifically on the hot water use of new house, but EES (2008) estimates that the average hot water use of all households is trending down as illustrated in Figure 35. According to these estimates the national average energy used in hot water was 18.7 MJ/day in 2008, ranging from 22.5 MJ in the ACT down to 14.2 MJ in the NT. These differences reflected a range of factors, including average household size, cold water inlet temperature and actual volume of hot water used. (These values are the actual energy embodied in the hot water used; the energy losses in heating the water and standing losses from storage tanks are additional).

These average hot water loads are well below the values used to calculate RECs for 'medium' systems (indicated as the middle horizontal red line in Figure 35). It is not known whether new house would have average hot water loads higher or lower than the whole stock. The number of occupants in new houses may be higher than the average for all dwellings (which includes apartments as well). On the other hand, new houses have higher levels of water use efficiency, since low-flow showers, taps and dual-flush toilets are mandatory in most jurisdictions. Given these uncertainties, the cost-benefit analyses in the following sections are tested for both 'medium' and 'low' hot water use.

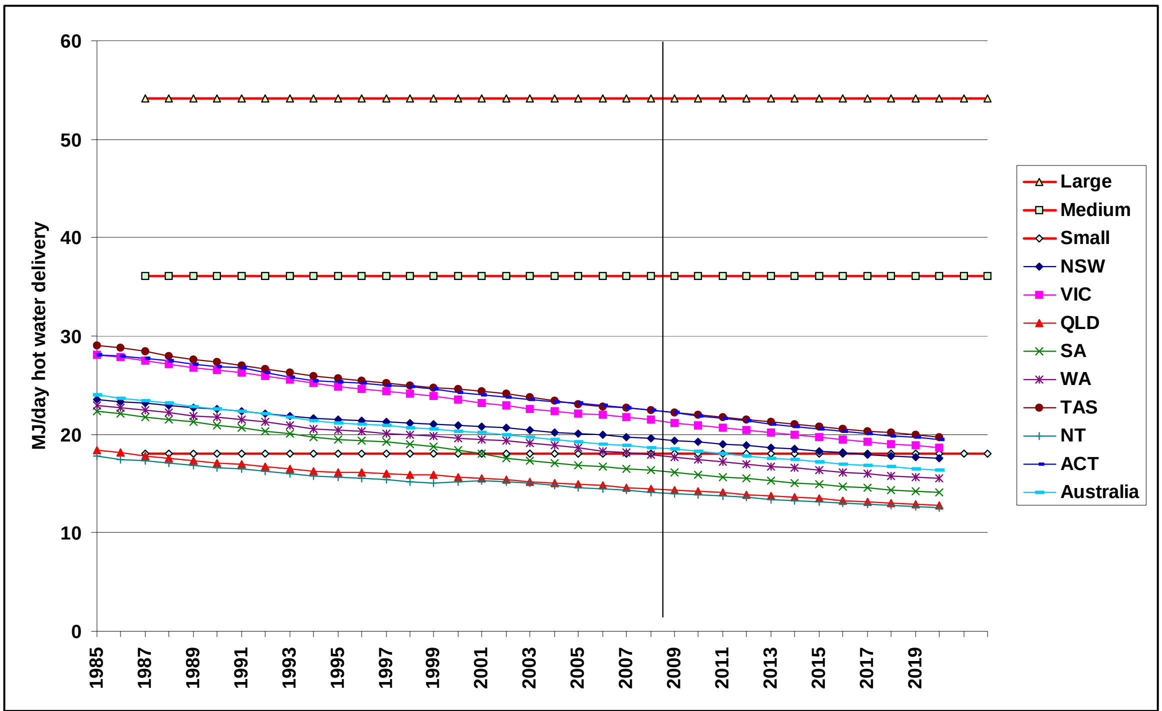


Figure 35 Estimated average daily energy use in hot water

Source: EES (2008)

Modelled Water Heater Efficiencies

Source A is TD(2007), B is TD(2007a), C is TD(2009), D is TD (2009a). Z3, Z4 are Solar Zones 3 and 4; 5 and 6 are energy ratings for gas water heaters. SE is standard efficiency collector for solar water heaters; HE is high efficiency. OP is off-peak boost.

Figure 36 Gas Instantaneous Water Heaters

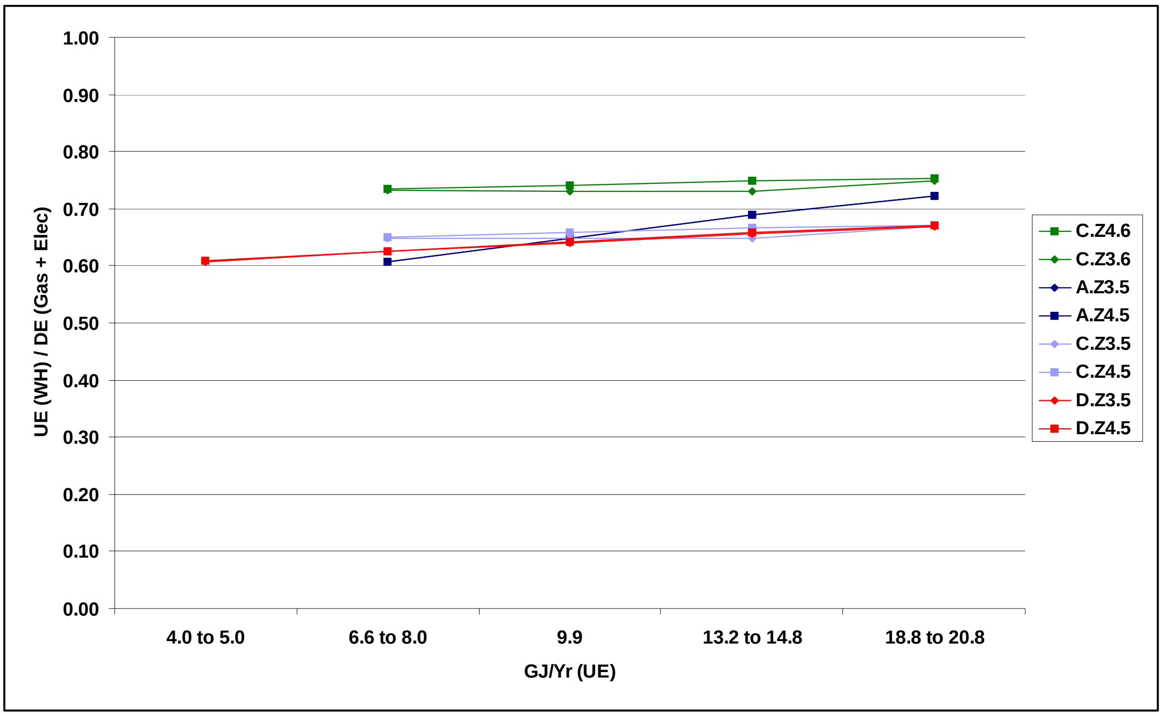


Figure 37 Gas Storage Water Heaters

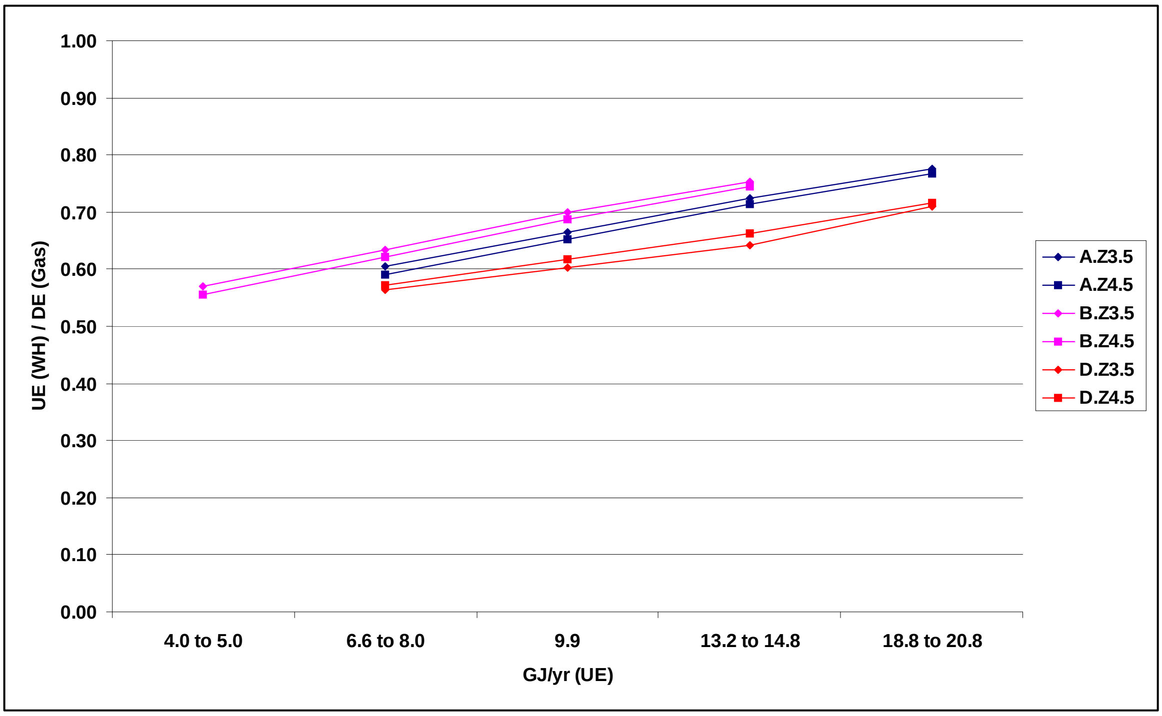


Figure 38 Solar-electric (thermosyphon, 2 panel)

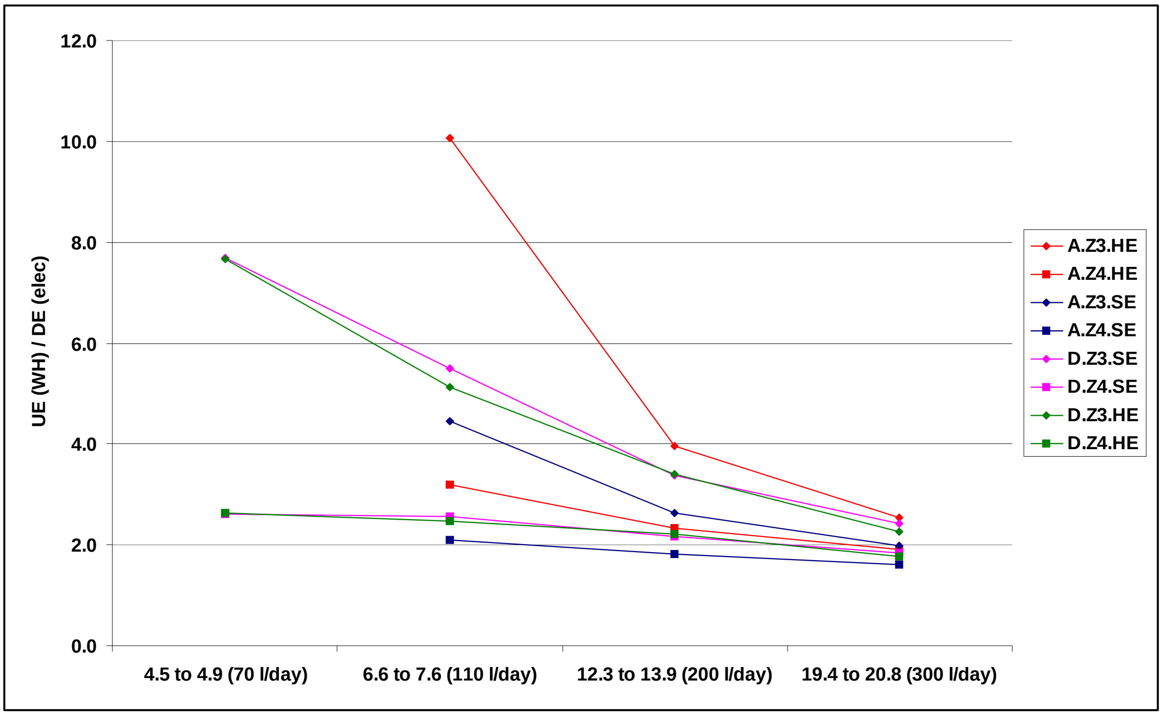


Figure 39 Solar-gas (in-line boost, 2 panel)

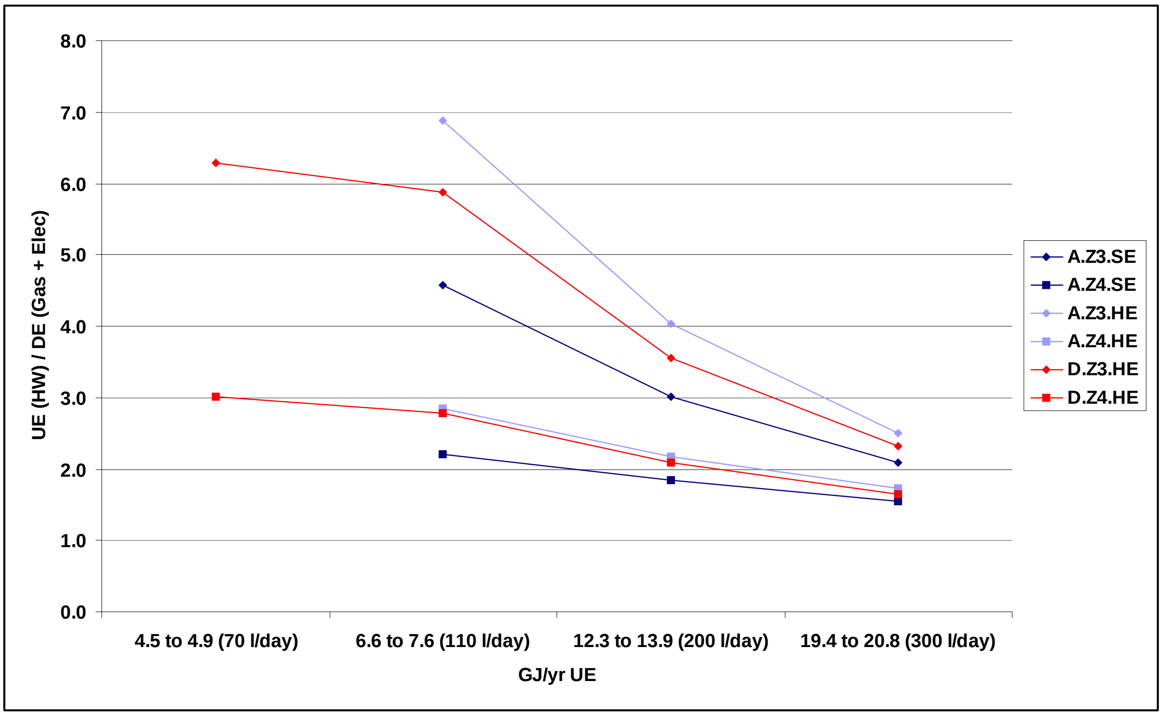


Figure 40 Solar-electric (2.5 m^2 aperture area evacuated tube – 22 tubes)

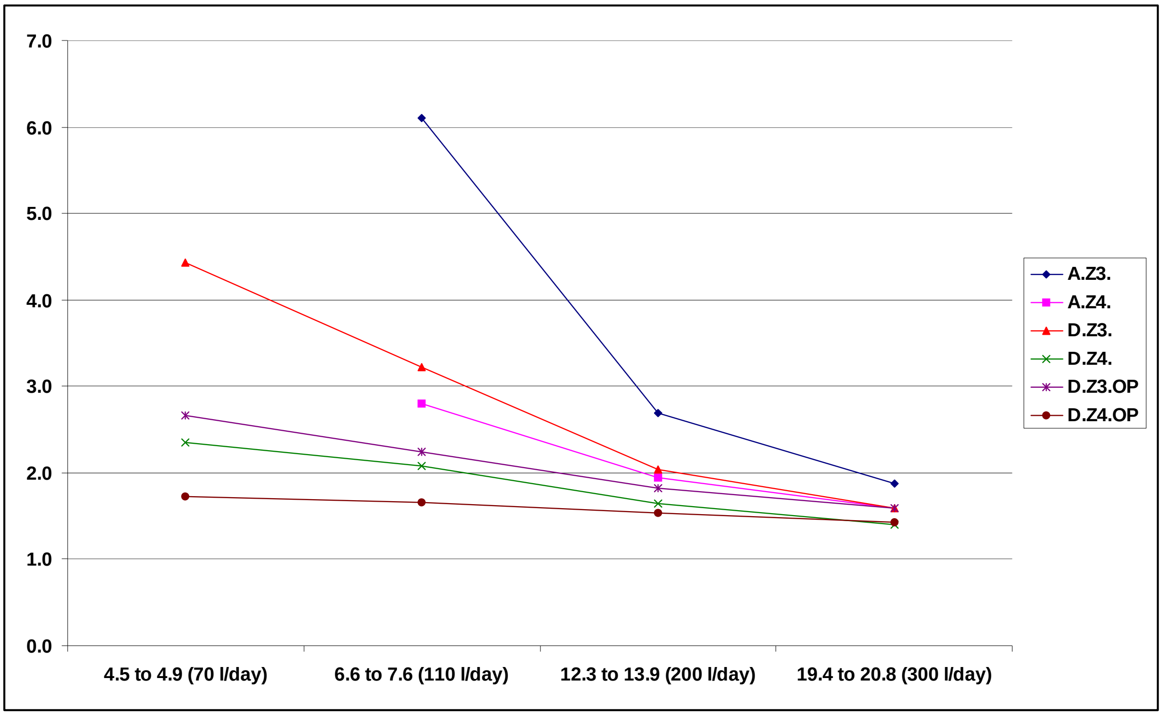
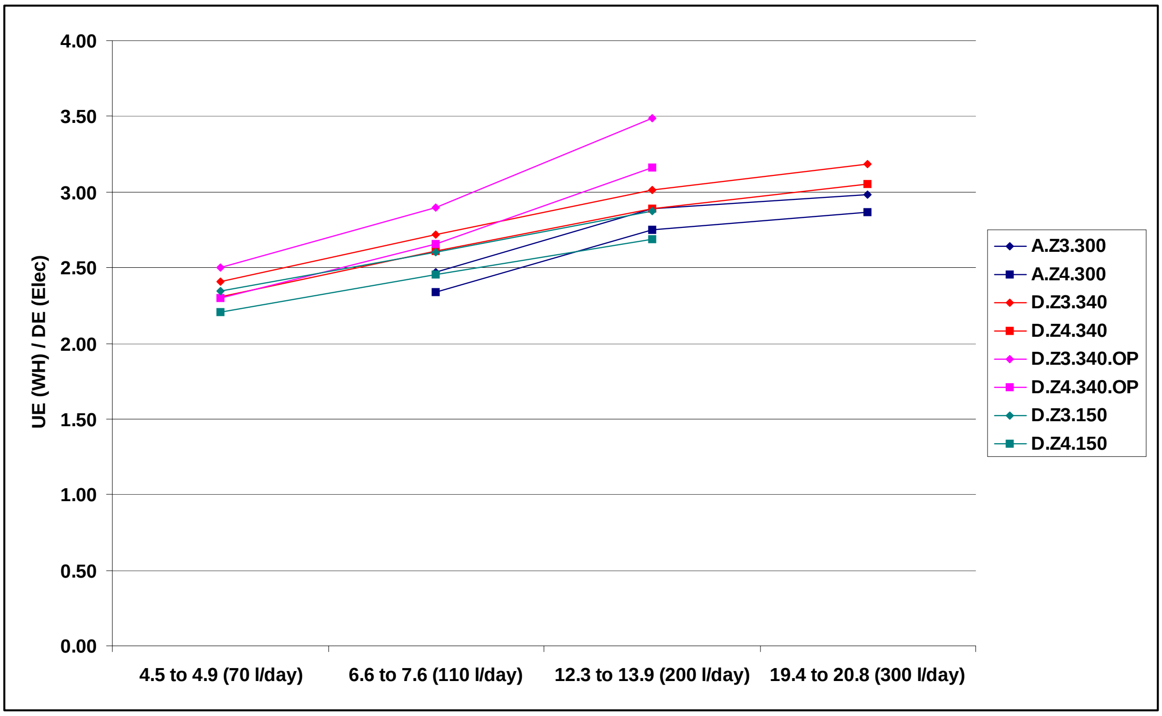


Figure 41 Electric Heat Pump



Appendix 5 Community Costs and Benefits Compared with No Regulations

For each State and Zone combination, a 'no-regulation' (NR) baseline mix of water heaters has been estimated for new houses built each year, from 2010 to 2020. As the NR baseline excludes the effect of current State regulations, it was assumed that the composition of new house water heater sales would be similar to the composition of the water heater market as a whole for that State.

A 'proposed regulations' (PR) case was developed for each State by reallocating the sales that would have gone to electric resistance water heaters in the NR case to other types: mainly to gas (where gas is available) but otherwise to heat pump and solar. Figure 42 sums the individual State markets as a national NR market share, and Figure 43 illustrates the PR market share, which again is the sum of separate State cases.

The 35% of water heater sales to new houses in 2010 that would have been electric storage in the NR case are reallocated as follows: 3% to heat pump (increasing the heat pump market share from 2% to 5%), about 9% to gas (increasing the gas market share from 48% to 57%), and 23% to solar (nearly tripling the solar market share from 16% to 40%). It is assumed that the PR market shares in each State remain constant between 2010 and 2020 – the changes in market share at the national level in Figure 43 reflect the fact that State shares of national house construction change over time

Table 25 summarise the impacts, cost and benefits in each jurisdiction with:

- A 7% discount rate;
- The Treasury CPRS-5 trend in energy prices and greenhouse gas intensity;
- An upper bound average hot water delivery (36 MJ/day);
- REC prices steady at around $50/REC, giving an effective value of $40/REC to new home buyers purchasing houses with solar and heat pump water heaters;
- The cost of electricity supplied to solar-electric water heaters and heat pumps mid-way between the day-rate and the off-peak rate, to reflect a mix of tariff classes and time-of-use rates.

Table 25 indicates the projected capital cost and energy costs for water heaters under the No Regulations and Proposed Regulations scenarios. Nationally, total water heater capital costs are projected to increase by $M 210 (NPV) but total running costs are projected to decline by $M 527, giving a net benefit of $M 317. The extra capital cost of water heating will be $205 per house constructed over the period 2010-2020, but this will be more than outweighed by the NPV of energy savings: $513 per house.

The national Benefit/Cost ratio of the Proposed Regulations compared with No Regulations is 2.5. The provisions would be cost-effective in each jurisdiction, with benefit/cost ratios ranging from 7.5 in the ACT to 1.9 in Qld. The national B/C ratio increases to 3.3 at a discount rate of 3% (Table 26) and falls to 2.0 at a discount rate of 11% (Table 27).

Table 28 to Table 30 indicate the corresponding findings for the same water heaters (ie the same capital costs) but with a lower bound hot water delivery (18 MJ/day). This is less cost-effective because energy savings are lower.

Figure 42 Projected water heater share of new house market, No Regulations case

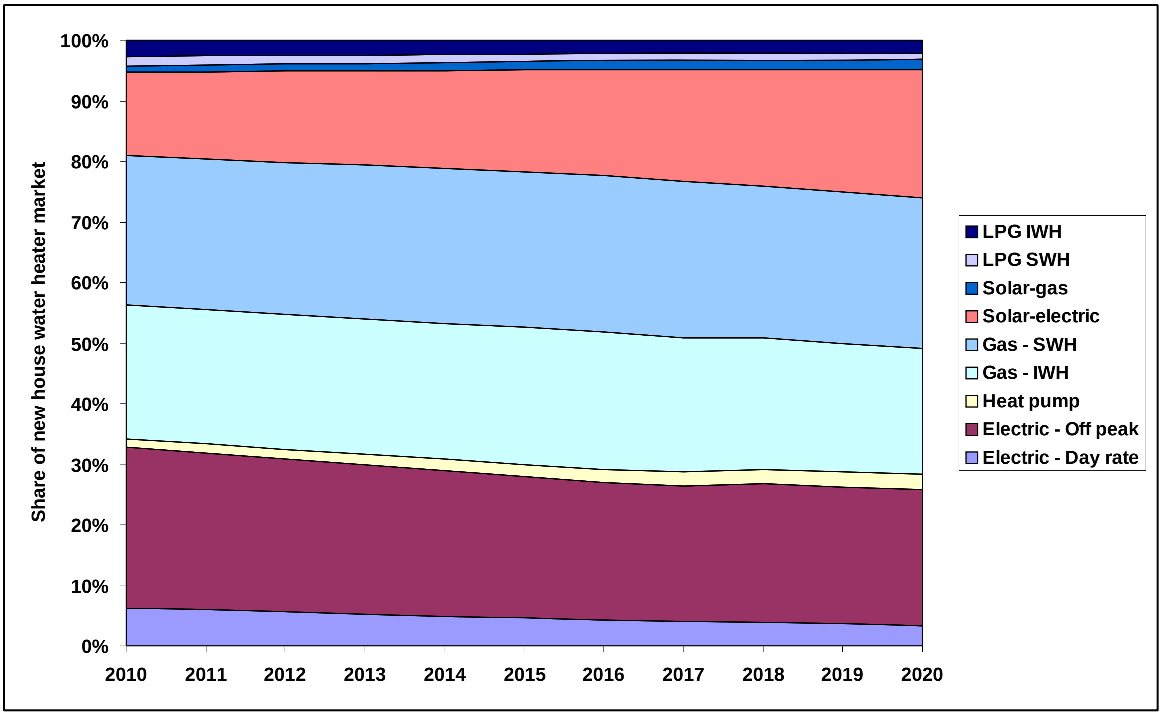


Figure 43 Projected water heater share of new house market, Proposed Regulations case

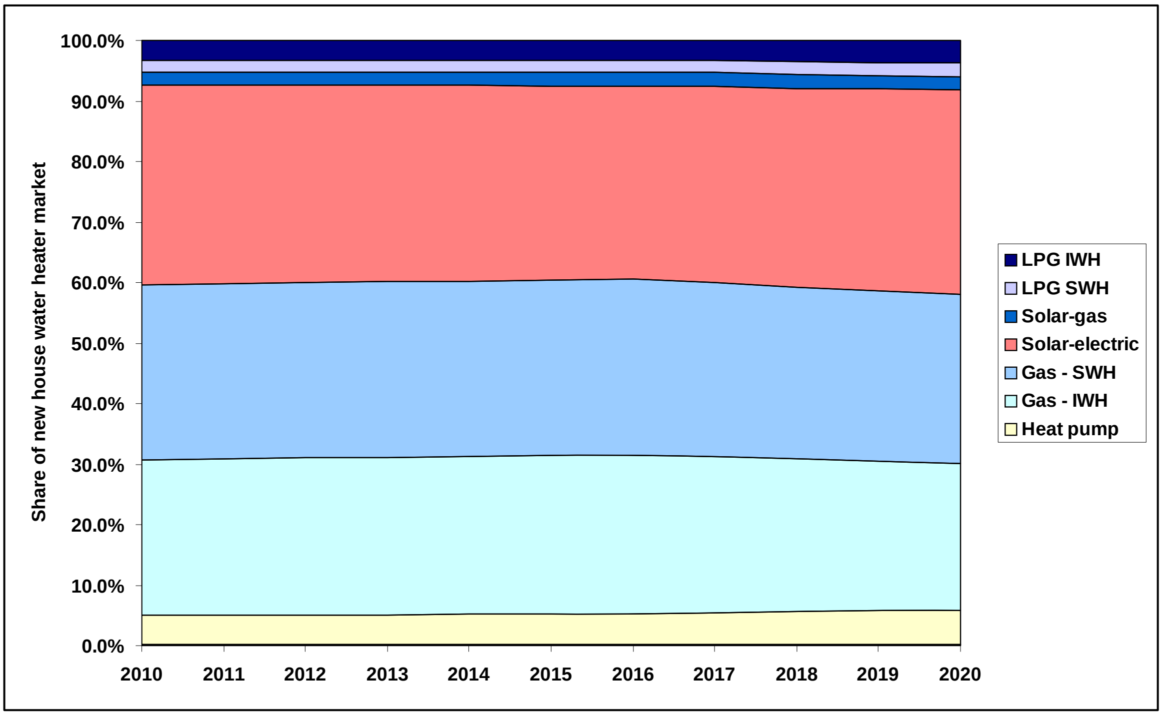


Table 25 Summary of costs and benefits PR vs NR, 7% discount rate (Medium hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	67.5	-161.8	-94.3	2.4	-3512	307	-735	-16.0
VIC	26.1	-83.1	-57.0	3.2	-945	86	-275	-3.1
QLD	77.5	-144.4	-66.8	1.9	-4804	312	-582	-19.4
SA	20.5	-54.7	-34.2	2.7	-826	303	-810	-12.2
WA	14.2	-65.4	-51.2	4.6	-499	87	-401	-3.1
TAS	2.5	-9.0	-6.5	3.6	-9	522	-1893	-2.0
NT	1.7	-6.4	-4.8	3.9	-48	111	-430	-3.2
ACT	0.3	-2.6	-2.2	7.5	-35	46	-351	-4.9
Australia	210.3	-527.4	-317.1	2.5	-10680	205	-513	-10.4
Tas, NT	4.2	-15.5	-11.3	3.7	-58	211	-784	-2.9

Table 26 Summary of costs and benefits, PR vs NR, 3% discount rate (Medium hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	77.0	-247.5	-170.5	3.2	-3512	350	-1125	-16.0
VIC	29.2	-126.4	-97.2	4.3	-945	97	-418	-3.1
QLD	90.2	-223.1	-132.9	2.5	-4804	364	-899	-19.4
SA	23.6	-83.0	-59.3	3.5	-826	350	-1228	-12.2
WA	16.4	-100.7	-84.4	6.2	-499	100	-618	-3.1
TAS	3.1	-14.4	-11.3	4.7	-9	647	-3018	-2.0
NT	2.0	-9.8	-7.8	4.9	-48	132	-653	-3.2
ACT	0.4	-4.0	-3.6	10.4	-35	53	-552	-4.9
Australia	241.9	-808.9	-567.1	3.3	-10680	235	-787	-10.4
Tas, NT	5.1	-24.1	-19.1	4.8	-58	257	-1225	-2.9

Table 27 Summary of costs and benefits, PR vs NR, 11% discount rate (Medium hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	59.4	-111.0	-51.6	1.9	-3512	270	-504	-16.0
VIC	23.3	-57.3	-34.0	2.5	-945	77	-189	-3.1
QLD	67.1	-98.0	-30.9	1.5	-4804	270	-395	-19.4
SA	17.9	-37.8	-19.9	2.1	-826	265	-560	-12.2
WA	12.4	-44.6	-32.2	3.6	-499	76	-274	-3.1
TAS	2.0	-6.0	-3.9	2.9	-9	429	-1249	-2.0
NT	1.4	-4.4	-3.0	3.1	-48	95	-297	-3.2
ACT	0.3	-1.7	-1.4	5.8	-35	40	-234	-4.9
Australia	183.8	-360.7	-177.0	2.0	-10680	179	-351	-10.4
Tas, NT	3.5	-10.4	-6.9	3.0	-58	176	-527	-2.9

Table 28 Summary of costs and benefits PR vs NR, 7% discount rate (Low hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	67.5	-128.4	-60.8	1.9	-2438	307	-583	-11.1
VIC	26.1	-57.0	-30.9	2.2	-634	86	-189	-2.1
QLD	77.5	-122.2	-44.7	1.6	-3164	312	-492	-12.8
SA	20.5	-38.8	-18.3	1.9	-535	303	-575	-7.9
WA	14.2	-46.1	-31.9	3.2	-356	87	-283	-2.2
TAS	2.5	-5.8	-3.3	2.3	-8	522	-1224	-1.6
NT	1.7	-3.9	-2.3	2.4	-30	111	-264	-2.0
ACT	0.3	-1.8	-1.4	5.2	-23	46	-243	-3.1
Australia	210.3	-404.0	-193.7	1.9	-7187	205	-393	-7.0
Tas, NT	4.2	-9.8	-5.6	2.4	-38	211	-496	-1.9

Table 29 Summary of costs and benefits, PR vs NR, 3% discount rate (Low hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	77.0	-195.7	-118.7	2.5	-2438	350	-889	-11.1
VIC	29.2	-86.6	-57.4	3.0	-634	97	-286	-2.1
QLD	90.2	-186.7	-96.5	2.1	-3164	364	-752	-12.8
SA	23.6	-58.4	-34.7	2.5	-535	350	-864	-7.9
WA	16.4	-71.1	-54.8	4.3	-356	100	-437	-2.2
TAS	3.1	-9.2	-6.1	3.0	-8	647	-1933	-1.6
NT	2.0	-6.0	-4.0	3.0	-30	132	-399	-2.0
ACT	0.4	-2.8	-2.4	7.1	-23	53	-379	-3.1
Australia	241.9	-616.5	-374.6	2.5	-7187	235	-600	-7.0
Tas, NT	5.1	-15.2	-10.1	3.0	-38	257	-770	-1.9

Table 30 Summary of costs and benefits, PR vs NR, 11% discount rate (Low hot water delivery, medium water heater capacity)

	By jurisdiction					By new house built		
	Additional capital $M	Energy saving $M	Net benefit $M	Benefit/ cost ratio	Saving kt CO2-e	Additional capital $	Energy saving $	Saving t CO2-e
NSW	59.4	-88.4	-28.9	1.5	-2438	270	-402	-11.1
VIC	23.3	-39.3	-16.1	1.7	-634	77	-130	-2.1
QLD	67.1	-84.0	-16.9	1.3	-3164	270	-339	-12.8
SA	17.9	-27.0	-9.1	1.5	-535	265	-400	-7.9
WA	12.4	-31.4	-19.0	2.5	-356	76	-192	-2.2
TAS	2.0	-3.9	-1.8	1.9	-8	429	-815	-1.6
NT	1.4	-2.7	-1.3	1.9	-30	95	-183	-2.0
ACT	0.3	-1.2	-0.9	4.0	-23	40	-164	-3.1
Australia	183.8	-277.9	-94.1	1.5	-7187	179	-270	-7.0
Tas, NT	3.5	-6.6	-3.1	1.9	-38	176	-336	-1.9

At the higher hot water delivery, total CO_2-e emissions from water heating for the cohorts built between 2010 and 2020 are projected to be 14,855 kt, compared with 25,535 kt for the No Regulations case – a reduction of 10,680 kt. At the lower hot water delivery, the CO_2-e reduction over the same period would be 7,187 kt. The annual reduction from these cohorts actually peaks in 2023 and then tapers down to whenever the last water heater installed in 2020 retires – some time after 2034, which represents the point of mean service life for water heaters installed in 2020 (although some will fail earlier and some later).

Nearly 45% the projected reduction in emissions would occur in Queensland, which is projected to have about a quarter of the housing completions over the period, and where a high proportion of water heaters in the No Regulations case would have been electric. In the Proposed Regulations case these are all diverted to solar-electric or heat pump, and because of the high average solar contribution in Zones 1, 2 and 3 the energy savings from each electric water heater displacement are high.

The capital cost increment per house built generally reflects the expected electric share of the new house water heater market in the No Regulations case, and hence the average cost increase required to install natural gas (if available), solar-electric or heat pump. It is highest in Tasmania (where the NR electric ratio is estimated at 75%) followed by Queensland (65%). However, the B/C ratios are higher in Tasmania than Queensland, because higher electricity prices are projected.

Sensitivity Tests - Energy Prices

One cause of uncertainty is the electricity tariff to which solar and heat pump water heaters will be connected. At present there is a choice of day rate (where energy for heating is available at all time), off-peak (re-heat restricted to about 8 hrs overnight) and extended hours (reheat at any time except the period of peak demand on the electricity network, which is usually about 2 pm to 8pm on weekdays).

Water heater manufacturers, installers, energy utilities and government energy agencies give differing and often conflicting advice on the preferred tariff for solar-electric and heat pump water heaters in various locations. In general, the larger the system capacity and the more favourable the solar climate zone, the less boost energy required and the more restrictions on re-heating times can be tolerated. Under certain patterns of water use however, overnight reheating can reduce the effective solar contribution because the tank starts off the day fully heated, and solar heat must be dumped. Also, some installers favour day-rate connection irrespective of the need or the higher energy costs to the user because it ensures that they will not be called out in the event that the user runs out of hot water.

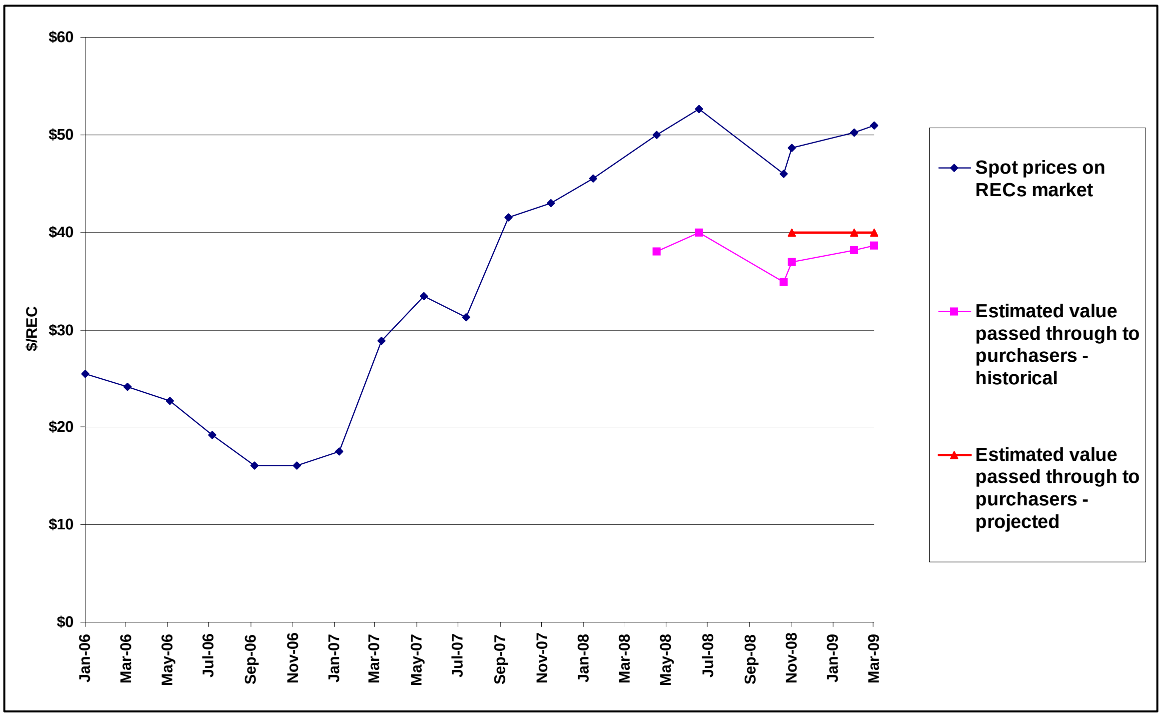
To err on the conservative side, the cost-benefit modelling has assumed that the cost of energy supplied to solar-electric and heat pump water heaters is mid-way between the highest and lowest standard tariff available in each State. This roughly corresponds to the restricted hours tariff where available. It is also roughly consistent with a dynamic pricing case, ie where energy is purchased on a time of use basis.

If all solar-electric and heat pump water heaters were connected to the off-peak tariff the benefit/cost ratio (at 7% discount rate) would increase from 2.0 to 2.4, and if all were connected to the day-rate tariff it would fall to 1.4 (Table 31).

RECs and Capital Costs

The cost-benefit modelling assumes that the value of RECs to new home purchasers will remain at $40/REC (real). Nevertheless REC prices vary over time, and the proportion passed through as a benefit to solar and heat pump water heater purchasers may also vary. If RECs had zero value to home buyers (ie if *all* the benefit were captured by water heater suppliers, builders or other intermediaries) the benefit/cost ratio (at 7% discount rate) would fall from 2.0 to 1.2 (Table 31), and would still be 1.0 or higher in all jurisdictions.

Figure 44 Historical RECs prices and estimated impacts on purchase values



System Size and Hot Water Delivery

The average hot water demand in new houses is estimated to be in the range 110 to 200 litres per day, but trending closer to the lower bound. The modelling was run with medium capacity water heaters (ie rated 22 RECS or more) delivering both a medium delivery task (Table 25 to Table 27) and a low hot water delivery task (Table 28 to Table 30). This would drop the benefit/cost ratios as indicated in Figure 46

It is estimated that about 9% of new houses have 2 bedrooms or less, which would allow smaller solar water heaters to be installed under the DTS provisions (Table 23). This cohort of '14+ REC' water heaters were not separately modelled (nor was the cohort of '28+ REC' water heaters which would be required in houses of 5 or more bedrooms), but examination of their capital and running costs indicates that:

- At low hot water delivery, small solar water heaters are even more cost-effective against conventional water heaters than is the case with medium delivery solar vs medium delivery conventional. The running cost savings fall (because of generally lower solar contributions) but the capital costs fall by even more. This represents the case where small water heaters are correctly matched to low hot water demand.

- in Zones where small solar water heaters are capable of a medium hot water delivery they are about equally cost-effective against conventional small water heaters as are medium solar compared with medium conventional (even though the solar contribution is lower for small solar water heaters). This represents the case where a household with unusually high hot water use occupies a 2 bedroom house.

All heat pumps on the market at present are designed for medium to high hot water delivery, and would be less cost-effective (but still cost-effective) for low demand. It is understood that some suppliers are considering introducing smaller heat pumps better suited for small deliveries.

The most cost-effective option where low or infrequent water use is anticipated would be an instantaneous natural gas water heater. Where gas is unavailable, the most cost-effective option would be LPG. This has low capital costs but high running costs, so is similar in cost profile to the electric water heaters which would be excluded by the proposed regulations.

Gas Connection Costs

The treatment of gas connection costs was discussed in a previous section. Figure 45 illustrates the impact of alternative treatments on the benefit/cost ratio (at 7% discount rate). The ratio is relatively insensitive to the way gas connection costs are treated, compared with the impacts of energy prices, discount rates and hot water delivery (see Figure 46, which has an identical vertical scale).

Combination Worst Case

The severest combination of assumptions tested is if builders were to comply with the requirements in a way least consistent with the interests of the home buyer:

- If the household has low hot water use, but the builder is forced (by the regulations) to install a water heater with the capacity to meet the higher hot water delivery;
- None of the RECs value is passed on the purchaser, but it is all captured by the builder or other intermediary; and
- Solar and heat pump water heaters are all connected to day rate tariffs (as may occur if builders were unconcerned about running cost but wanted to ensure that the supply of hot water were unconstrained, in order to avoid complaints).

Under these conditions the proposed regulations would not be cost-effective nationally, or in NSW or Queensland, but would still be cost-effective in the other States and Territories (Table 31).

Table 31 Summary of sensitivity test impacts on Benefit/cost ratios

	Medium hot water delivery			Solar tariff Min	Solar tariff Max	No RECs	Low hot water delivery			Worst case(a)
Discount rates	3%	**7%**	11%	7%	7%	7%	3%	7%	11%	7%
NSW	3.2	**2.4**	1.9	3.1	1.7	1.2	2.5	1.9	1.5	0.9
VIC	4.3	**3.2**	2.5	3.6	2.7	1.8	3.0	2.2	1.7	1.1
QLD	2.5	**1.9**	1.5	2.4	1.3	1.0	2.1	1.6	1.3	0.8
SA	3.5	**2.7**	2.1	3.1	2.2	1.5	2.5	1.9	1.5	1.0
WA	6.2	**4.6**	3.6	4.6	4.6	2.4	4.3	3.2	2.5	1.7
TAS	4.7	**3.6**	2.9	4.0	3.2	2.5	3.0	2.3	1.9	1.5
NT	4.9	**3.9**	3.1	3.9	3.9	2.3	3.0	2.4	1.9	1.4
ACT	10.4	**7.5**	5.8	7.7	7.4	4.5	7.1	5.2	4.0	3.1
Australia	3.3	**2.5**	2.0	3.0	2.0	1.4	2.5	1.9	1.5	0.9

(a) All solar-elec and heat pump at continuous rate, RECS values = 0, lower hot water delivery

Impact of LPG Use

Where natural gas is available, the most cost-effective way for a new home builder to comply with the proposed regulation is generally to install a 5 (or more) star gas water heater. As this option nearly always has the lowest capital cost as well as the lowest service life cost, it is likely to be adopted.

Where natural gas is not available, the most cost-effective way for a new home builder to comply is with a heat pump or a solar-electric water heater. The LPG option has higher lifetime costs for medium and low daily hot water usage (see Figure 12 and Figure 13) but significantly lower capital costs, which will make it attractive to many home builders. However, where hot water demand is expected to be low or intermittent, as in holiday homes, LPG could be the most cost-effective option, despite the high energy costs. The issue is to what extent the adoption of LPG in new homes extends beyond those where hot water use is low to those where it is average to high.

Syneca Consulting[24] contacted a number of project home builders in Queensland and SA, which already have regulations similar to those proposed for the BCA (Table 11), and found that:

- LPG water heaters (usually instantaneous) have a significant minority share of the market and sometimes a majority share. The only exceptions are where LPG is prohibitively expensive, particularly in remote areas. These circumstances seem to favour solar, which has a very large market share in the NT and in places like Broome and Geraldton in WA;
- In most areas solar has a minority share, and takeup depends on local conditions, familiarity with the technology and suppliers; and
- heat pumps have the rest of the market.

If new homes with LPG water heaters are continuously occupied (as distinct from holiday homes), this could impose a higher lifetime cost on their occupants than electric

[24] Syneca Consulting, pers. comm. *Issues relating to take-up of LPG for water heating in areas without mains gas– 20/02/2009*

resistance, solar-electric or heat pump water heating. This may result from an informed decision by the occupant commissioning the home, possibly taking into account the offsetting cost savings or utility value of also using LPG for cooking and space heating. Alternatively, it could be a decision imposed by the builder without consultation. This would increase lifetime costs compared with other permitted water heater types, and reduce the benefit-cost ratio of the measure, particularly in Tasmania.

'Forced' compliance (ie without home buyer consent) with LPG is likely to be negligible in the ACT, because natural gas is so widely available, and low in the NT, where LPG prices are high and the electric boost energy needed for solar is so low. The Proposed Regulations should have little impact on LPG use in new homes in the other States, because the outcomes will be much the same as under those States' current regulations.

Figure 45 Impact on benefit/cost ratio of gas connection costs, Australia

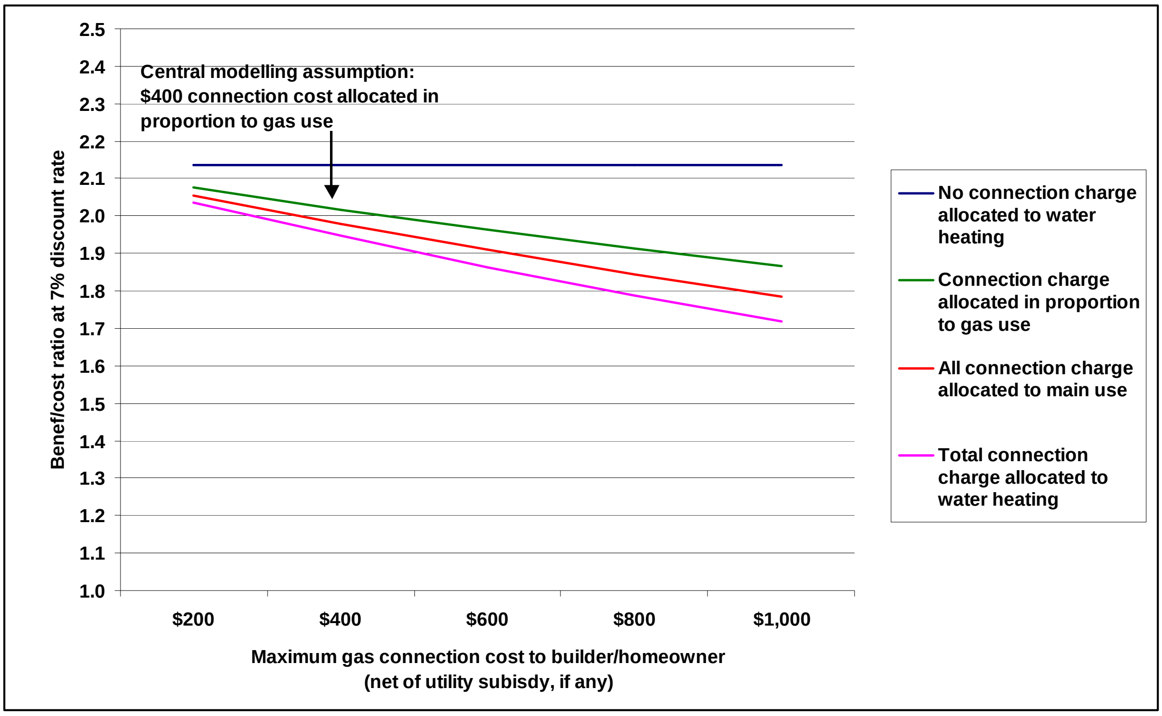
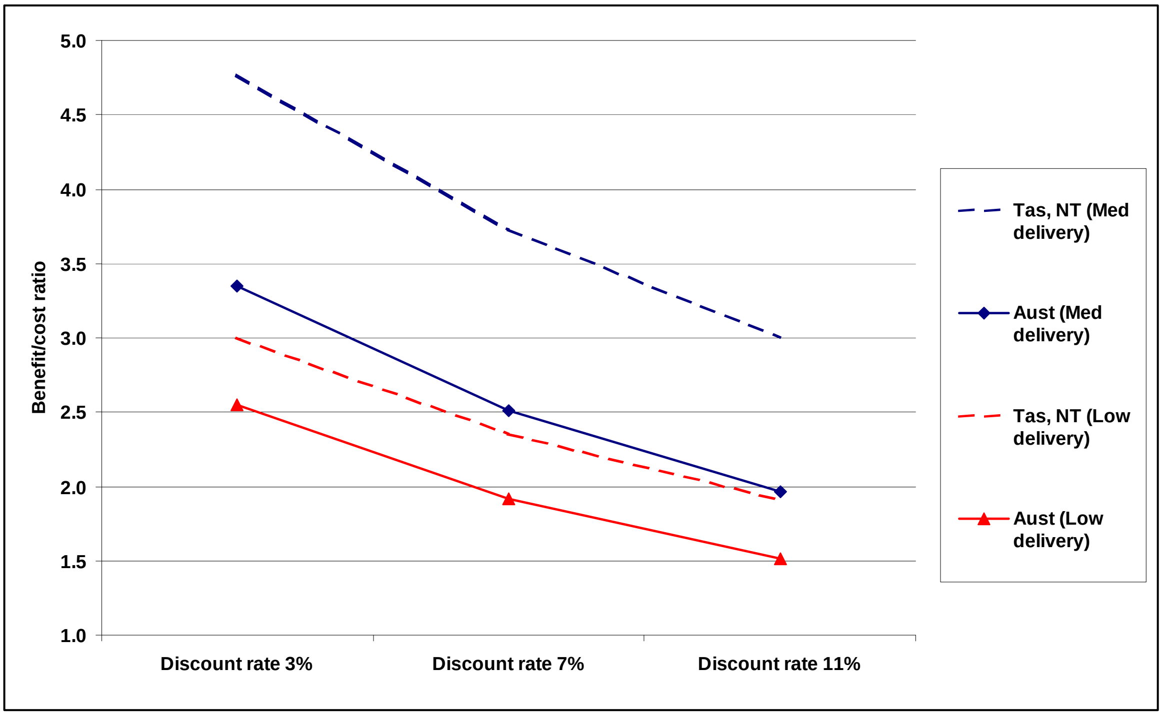


Figure 46 Impact on benefit/cost ratio of alternative price and water use assumptions, Australia and jurisdictions without current regulations

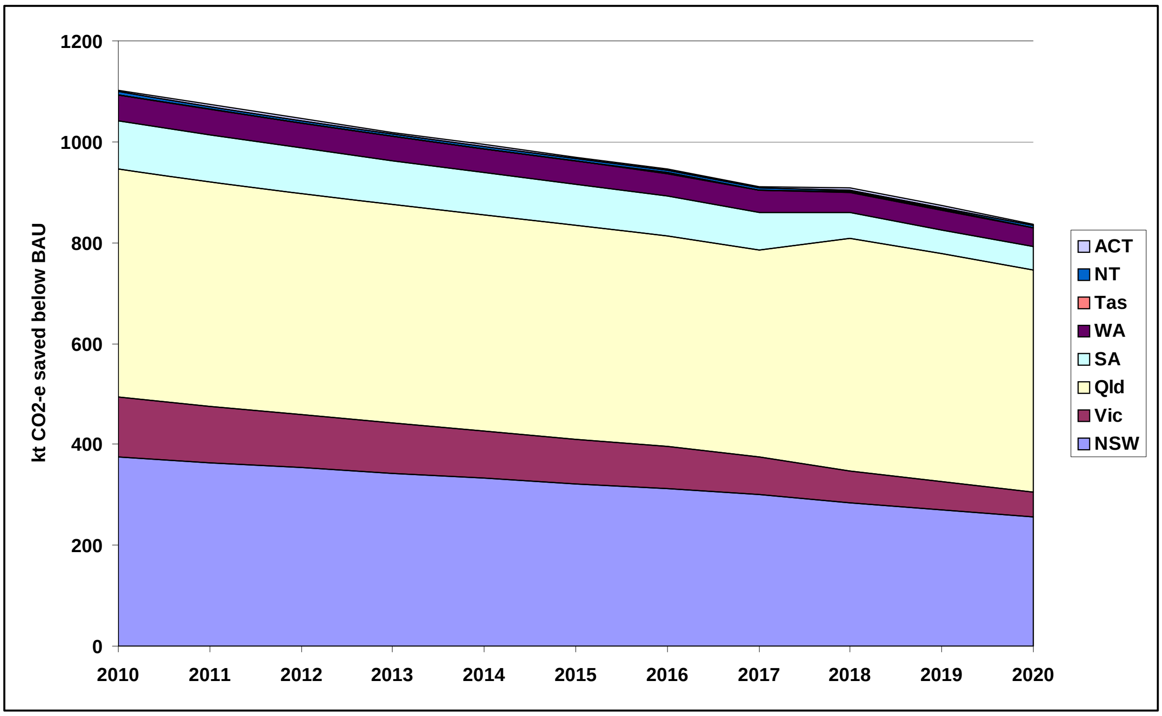


Greenhouse gas emissions

It is projected that the proposed regulations will reduce greenhouse gas emissions from water heaters installed in new houses by about 1100 kt CO_2-e/yr in 2010 (compared with the no regulations case), falling to a reduction of about 840 kt CO_2-e by 2020 (Figure 47). Even though more houses are built in each successive year, the greenhouse–intensity of the electricity supply falls under the influence of the CPRS, so the greenhouse benefit of each water heater diversion from electric resistance to solar, heat pump or gas declines. Nevertheless, the proposed regulation would avoid about 10,680 kt (10.7 Mt) of CO2-e of emissions between 2010 and 2020 (inclusive). About 45% of the emission savings would be in Queensland, because of the high projected rate of house construction and the high rate of diversions from electric resistance to solar and heat pump (the rate of diversion is lower in other States, where the gas market share is higher). NSW is projected to account for about 33% of the national greenhouse savings, and Victoria, SA, WA and ACT for 22% combined.

The jurisdictions with no regulations at present, Tasmania and the NT, would account for about less than 1.0% of the national savings, or a reduction of about 60 kt CO_2-e in emissions over the period 2010-2020. The share is low because these are small jurisdictions by population, and Tasmania has the least greenhouse gas-intensive electricity supply (see Figure 17, which is based on projected average rather than projected marginal emissions).

Figure 47 Projected reduction in greenhouse gas emissions, Proposed Regulation case compared with No Regulations case



Appendix 6 Proposed Text for BCA

PART 2.6 ENERGY EFFICIENCY

VERIFICATION METHODS

V2.6.3 Verification for water heater in a hot water supply system

(a) Compliance with P2.6.2 for a water heater in a hot water supply system is verified when the annual greenhouse gas intensity of the water heater does not exceed 100 g CO2-e/MJ of thermal energy load determined in accordance with AS/NZS 4234.

(b) The greenhouse gas intensity of the water heater in (a) is the sum of the annual greenhouse gas emissions from each energy source in g CO_2-e divided by the annual thermal energy load of the water heater.

(c) The annual greenhouse gas emission for each energy source in (b) is the product of-

- (i) the annual amount of energy consumed from that energy source; and
- (ii) the emission factor of-
  - (A) if the energy source is electricity, 272 g CO_2-e/MJ; or
  - (B) if the energy source is liquefied petroleum gas, 65 g CO_2-e/MJ; or
  - (C) if the energy source is natural gas, 61 g CO_2-e/MJ; or
  - (D) if the energy source is wood or biomass, 4 g CO_2-e/MJ.

PART 3.12 ENERGY EFFICIENCY

DEFINITIONS

Electric Resistance Water Heater means a water heater that has no means of heating water other than electric resistance.[25]

Renewable Energy Certificate means a certificate issued under the Commonwealth Government's Mandatory Renewable Energy Target scheme.

PART 3.12.5 SERVICES

A. Acceptable construction manual

3.12.5.0

(a) A hot water supply system must be designed and installed in accordance with Section 8 of AS/NZS 3500.4 or clause 3.38 of AS/NZS 3500.5.

(b) A solar hot water supply system in climate zones 1, 2 and 3 is not required to comply with (a).

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[25] This definition should be included in the BCA (2009). It is necessary to the understanding of 'Acceptable Construction Practice'

B. Acceptable construction practice

3.12.5.6 Water heater in a hot water supply system

(a) A water heater in a hot water supply system must be—
(i) a solar water heater complying with (b); or
(ii) a heat pump water heater complying with (b); or
(iii) a gas water heater complying with (c); or
(iv) an electric resistance water heater only in the circumstances described in (d).

(b) A solar water heater and a heat pump water heater must have the following performance—
(i) for a building with 1 or 2 bedrooms—
(A) at least 14 Renewable Energy Certificates for the zone where it is being installed; or
(B) an energy saving of not less than 40% in accordance with AS/NZS 4234 for 'small' system; and

(ii) for a building with 3 or 4 bedrooms—
(A) at least 22 Renewable Energy Certificates for the zone where it is being installed; or
(B) an energy saving of not less than 60% in accordance with AS/NZS 4234 for a 'medium' system; and

(iii) for a building with more than 4 bedrooms—
(A) at least 28 Renewable Energy Certificates for the zone where it is being installed; or
(B) an energy saving of not less than 60% in accordance with AS/NZS 4234 for a 'large' system .

(c) A gas heater must be rated at no less than 5 stars in accordance with AS 4552.

(d) An electric resistance water heater may be installed when—
(i) the electricity is generated entirely from a renewable energy source; or
(ii) the building has—
(A) not more than 1 bedroom; and
(B) not more than 1 electric resistance water heater installed; and
(B)
(C) the water heater has no storage capacity or a hot water delivery of not more than 50 litres in accordance with AS 1056.1;
or

(iii) the building has—
(A) a water heater that complies with (b) or (c); and—(B) not more than 1 electric resistance water heater installed; and
(C) the water heater has no storage capacity; or

a hot water delivery of not more than 50 litres in accordance with AS 1056.1.